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PROJECT MANUAL



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318 SHADEVILLE ROAD
CRAWFORDVILLE, FL. 32327

CRA PROJECT NUMBER : 24071

JULY 21, 2025
(100% CONSTRUCTION DOCUMENTS)

VOLUME II

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions of this Section apply to all Division 22 Specification Sections.

1.2 SUMMARY

- A. Section includes basic requirements for plumbing systems.
- B. Related Work:
 - 1. Division 03 – Concrete
 - a. Refer to Division 03 for rough grouting in and around work, patching concrete cut to accommodate work, and sumps for work.
 - b. Comply with the requirements of Division 03 for curbs, foundations, inertia bases, and equipment pads for equipment.
 - 2. Division 05 – Metals
 - a. Refer to Division 05 for framed openings for equipment.
 - b. Comply with the requirements of Division 05 for supports for work.
 - 3. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 4. Division 07 – Thermal and Moisture Protection
 - a. Refer to Division 07 for installation of roof curbs and roof supports and for caulking and waterproofing of wall- and roof-mounted work.
 - b. Comply with the requirements of Division 07 for penetration firestopping and furnishing roof curbs and roof supports for equipment and piping.
 - 5. Division 08 – Openings
 - a. Refer to Division 08 for installation of access doors and frames and for louvers and vents.
 - b. Comply with the requirements of Division 08 for access doors and frames and for louvers and vents, unless otherwise included in the Contract Documents.
 - 6. Division 09 – Finishes
 - a. Refer to Division 09 for paint products and applications in finished spaces.
 - b. Comply with the requirements of Division 09 for paint products and applications identified in the Contract Documents.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

7. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
8. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
9. Division 23 – Heating, Ventilation, and Air-Conditioning
 - a. Refer to Division 23 for all heating, ventilation, and air-conditioning work.
 - b. Comply with requirements of Division 23 for related equipment and components and for connections to systems.
10. Division 25 – Instrumentation and Control
 - a. Refer to Division 25 for instrumentation and control systems.
 - b. Comply with the requirements of Division 25 for installation of and integration with instrumentation and control components.
11. Division 26 – Electrical
 - a. Refer to Division 26 for all electrical work.
12. Division 27 – Communications
 - a. Refer to Division 27 for all communications work.
13. Division 28 – Electronic Safety and Security
 - a. Refer to Division 28 for all electronic safety and security work.
 - b. Coordinate with Division 28 for integration with fire-alarm systems.
14. Division 29 – Fire Safety and Emergency Communications
 - a. Refer to Division 29 for all fire safety and emergency communications work.
 - b. Coordinate with Division 29 for integration with fire safety and emergency communications systems.
15. Division 31 – Earthwork
 - a. Refer to Division 31 for all site related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 31 for site clearing, earth moving, and dewatering within five feet outside the building and otherwise as indicated in the Contract Documents.
16. Division 33 – Utilities
 - a. Refer to Division 33 for all utility related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 33 for utility work within five feet outside the building and otherwise as indicated in the Contract Documents.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, “experienced” unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Furnish: Supply and deliver to project site, ready for subsequent requirements.
- C. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
- D. Provide: Furnish and install, complete and ready for intended use.
- E. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- F. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.
- G. Concealed Work: Work hidden from view, including inside chases, furred spaces, **or above ceilings**.
- H. Exposed Work: Work open to view, including inside mechanical and equipment rooms.

1.4 QUALITY ASSURANCE

- A. General:
 - 1. It is the intent of the plans and specifications to obtain a complete, operable and satisfactory installation.
 - 2. All materials shall be new, be properly labeled and/or identified and be in full compliance with the contract documents.
 - 3. All work shall comply with applicable Codes and Standards.
 - 4. Manufacturer's model names and numbers used in these specifications are subject to change per manufacturer's action. Contractor shall therefore verify them with manufacturer's representative before ordering any product or equipment
- B. Furnish new and unused materials and equipment manufactured in the U.S.A. Where two or more units of the same type or class of equipment are required provide units of a single manufacturer.

1.5 CODES AND STANDARDS

- A. Perform work in accordance with the following codes and any applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
 - 1. ASHRAE
 - a. Standard 90.1 Energy Standard for Buildings Except Low Rise Residential Buildings
 - 2. Occupational Safety and Health Regulations (OSHA).
 - 3. National Fire Codes

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

- a. NFPA 1 Fire Code – 2021 (Florida Edition)
 - b. NFPA 70 National Electrical Code – 2020
 - c. NFPA 101 Life Safety Code – 2021 (Florida Edition)
- 4. Florida Building Code, 2023 Edition
 - a. Building Code
 - b. Energy Conservation Code
 - c. Mechanical Code
 - d. Plumbing Code
 - e. Accessibility Code
- 5. Florida Statutes
 - a. Chapter 471 Engineering
 - b. Chapter 533.80 Building Construction Standards; Florida Building Code - Enforcement
- 6. Florida Administrative Code
 - a. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - b. Chapter 61G15-34 Responsibility Rules of Professional Engineers Concerning the Design of Mechanical Systems
 - c. Chapter 69A-3 Fire Prevention – General Provisions
 - d. Chapter 69A-60 The Florida Fire Prevention Code
- B. Resolve, in writing, any code violation discovered in contract documents with the Engineer prior to bidding. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. The Contractor shall include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and drawings required to comply with all applicable laws, ordinances, rules, and regulations.
- D. Where there is conflict between the Contract Documents and the applicable Codes, the Codes shall govern, except where the requirements of the Contract Documents are more stringent.

1.6 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments, or supplements in effect on date bids are received. Specifications and standards are minimum requirements for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
- B. Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition of the standard at the time project is bid unless otherwise specified herein

1.7 DELEGATED-DESIGN SERVICES

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

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

1.8 PERMITS FEES AND INSPECTIONS

- A. Obtain and pay for all permits, fees, tap fees, connection charges, demand charges, systems charges, impact fees, and inspections.
- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.9 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
 - 1. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer in writing prior to bid date; however, the most stringent requirement shall govern.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.10 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 - 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Prepare RFIs as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 - 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

- g. Incomplete RFIs or inaccurately prepared RFIs.
- 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.

1.11 **SUBMITTALS**

- A. Submittals (including Product Data, Shop Drawings, and any other Action Submittal or Information Submittal) will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions, Division 01, and the following:
 - 1. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are approved by the Engineer.
 - 3. Submittals shall only contain relevant product data. Remove or strikeout irrelevant product data.
 - 4. Prepare submittals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
 - 5. Options: Identify options requiring selection by Engineer.
 - 6. Deviations: Clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 - 7. Revisions: Include relevant additional information and revisions, other than those specifically requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached submittal sheet.
 - 8. Contractor's Review:
 - a. Submittals shall have been reviewed and approved by the General Contractor / Construction Manager. Include approval stamp, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - b. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.
 - 9. Electrical Modifications:
 - a. The electrical design indicated on the plans supports the Basis of Design specifications for the Plumbing systems at the time of design.
 - b. If Plumbing equipment is submitted with different electrical requirements, it is the responsibility of the Contractor to resolve all required electrical design changes, including, but not limited to: wire and conduit size, type or size of disconnect or overload protection, breaker coordination, point(s) of connection, etc. Any corrections required shall be provided at no additional cost.
 - c. Submittal shall clearly show the electrical design revisions with a written statement that this change will be provided at no additional cost. Submittals made with no written reference to the electrical design revisions will be presumed to work with the electrical design.
- B. Processing Time: Time of review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of the failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

1. Allow not less than 15 days for submittal review. Allow not less than 21 days for review of large or complex submittals. Submittals received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 2. If Contractor transmits more than five submittals over two consecutive business days, review time shall increase by no less than 7 days for submittal review.
 3. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 4. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received. Time of review shall commence on receipt of all other related submittals.
- C. The Contractor shall not be relieved of responsibility for deviations from requirements of the contract documents by the Engineer's approval of shop drawings, product data, samples, or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal, and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in shop drawings, product data, samples, or similar submittals by the Engineer's approval thereof.
- D. Submittal Review Fees:
1. Additional Reviews: Submittals on any particular phase of Work will receive only one review and one re-review (if required). If additional reviews are required beyond these two, the Contractor will be charged \$200.00 per hour for review time, in addition to any expedited review charges. This fee shall be paid to the Engineer prior to Submittal release.
 2. Expedited Reviews: If General Contractor / Construction Manager requests for an expedited review, whether by official request or unofficially by assigning a review time less than required above, the General Contractor / Construction Manager will be charged \$1,000.00 per Submittal, in addition to any charges for additional reviews. This fee shall be paid to the Engineer prior to Submittal release.

1.12 COORDINATION DRAWINGS NOT REQUIRED

- A. Should the Contractor elect to provide Coordination Drawings when not expressly required by the Engineer, such Drawings shall be considered for informational purposes only. The Engineer will not conduct a review of these Drawings, and their submission or any implied approval shall not relieve the Contractor of the obligation to fully comply with the requirements set forth in the Construction Documents. The Contractor remains solely responsible for ensuring that all work meets the contract specifications and standards, regardless of the content or status of the Coordination Drawings.

1.13 SUBSTITUTIONS

- A. By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Substitution Requests shall include, at a minimum:
1. Statement indicating why specified material, equipment, or installation method cannot be provided, if applicable.
 2. Coordination of information, including a list of changes and revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

3. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include an annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 5. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 6. Cost information, including a proposal of change, if any, in the Contract Sum.
 7. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 8. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- C. Procurement Substitution Requests submitted prior to receipt of bids will be received and considered by Owner when the following conditions are satisfied, as determined by Engineer; otherwise, requests will be returned without action:
1. Requests for substitution of materials and equipment are received no later than 10 days prior to date of bid opening.
 2. Extensive revisions to the Contract Documents are not required.
 3. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
 4. The request is fully documented and properly submitted.
- D. Substitutions for Cause, as required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms will be received and considered by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 2. Substitution request is fully documented and properly submitted.
 3. Requested substitution has received necessary approvals of authorities having jurisdiction.
 4. Requested substitution is compatible with other portions of the Work.
 5. Requested substitution has been coordinated with other portions of the Work.
 6. Requested substitution provides specified warranty.
 7. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- E. Substitutions for Convenience, not required in order to meet other Project requirements but may offer advantage to Contractor or Owner, will be received and considered by Owner, as determined by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is received within 60 days after the Notice of Award.
 2. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

- additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
3. Requested substitution does not require extensive revisions to the Contract Documents.
 4. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 5. Substitution request is fully documented and properly submitted.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. Requested substitution is compatible with other portions of the Work.
 8. Requested substitution has been coordinated with other portions of the Work.
 9. Requested substitution provides specified warranty.
 10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- F. If a requested substitution is approved but contains differences or omissions not specifically identified to the attention of the Engineer in the substitution request, the Owner reserves the right to require equal or similar features to be added to the substituted products or to have the substituted products replaced at the Contractor's expense.

1.14 PROJECT RECORD DOCUMENTS

- A. Recording: Maintain one copy of the Contract Documents and Shop Drawings during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation:
1. Contract Drawings and Shop Drawings:
 - a. Mark revisions to show where the actual installation varies from that shown originally.
 - b. Mark record sets completely and accurately, including important information that was either shown schematically or omitted from original Drawings.
 - c. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - d. Record underground and under-slab piping installed, dimensioning exact location and elevation of piping.
 2. Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 3. Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
- C. Deliver: Prior to Final Completion, provide record documents to Owner as indicated below:
1. Record Drawings: Submit PDF electronic files of scanned record prints and one set of prints.
 2. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
 3. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 4. Miscellaneous Record Submittals: Submit annotated PDF electronic files directories of each submittal.

1.15 OPERATION AND MAINTENANCE MANUALS

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

- A. Prepare and submit a comprehensive manual of emergency, operation, and maintenance data and materials in full accordance with the General and Supplementary Conditions, Division 01, and the following:
 - 1. Operations and Maintenance Manuals: Assemble a complete set of data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system, including:
 - a. Information required for daily operation and management, operating standards, and routine and special operating procedures.
 - b. Manufacturers' maintenance documentation, preventative maintenance procedures and frequency, repair procedures, wiring and systems diagrams, list of spare parts, and warranty information.
 - 2. Submit manuals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. Submittals shall be in searchable PDF format and not a scanned copy.

1.16 DEMONSTRATION AND TRAINING

- A. Prepare and provide services of qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system in accordance with the General and Supplementary Conditions, Division 01, individual Specification Sections, and the following:
 - 1. Demonstration and training shall occur upon completion of the Work and at a time designated by the Owner's representative.
 - 2. Provide a high-resolution, digital video recording of each training session to the Owner.

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

1.18 WARRANTY

- A. Warranty work and equipment within specified warranty period. During the warranty period, provide labor and materials to make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship without expense to the Owner.
 - 1. Warranty Period: One year from date of Substantial Completion.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
- C. Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving the Contractor of responsibilities during the warranty period.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

PART 2 - PRODUCTS (NONE)

PART 3 - EXECUTION

3.1 CONTRACT DOCUMENTS

- A. Examine all drawings and specifications carefully before submitting a bid. **Architectural drawings take precedence over mechanical or electrical drawings with reference to building construction.**
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.
- C. The drawings indicate required size and points of termination of pipes, conduits, and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the responsibility of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.
- E. Any and all questions about a subcontractor's scope of work responsibility shall be addressed to and answered by the General Contractor / Construction Manager.
- F. Questions About Construction Documents: Any and all questions shall be submitted through the proper channels IN WRITING and, in turn, shall be answered by the Engineer in writing. All telephone conversations shall be considered unofficial and, as such, shall not be considered official or binding responses to Contractor's questions.
- G. Drawings, specifications, or other documents issued by the Engineer in electronic format and/or electronic media are provided for convenience only and are not intended for use as Contract Documents.
 - 1. The electronic files are provided merely as a convenience to the Recipient.
 - 2. The electronic files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.
 - 3. The Engineer makes no representation, warranty, or guarantee that electronic files:
 - a. Are suitable for any other usage or purpose.
 - b. Have any particular durability.
 - c. Will not damage or impair the Recipient's computer or software.
 - d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.
 - 4. Due to the unsecured nature of the electronic files and the inability of Engineer or the Recipient to establish controls over their use, the Engineer assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained therein. The Recipient shall at all times refer to the signed and sealed drawings, specification or other documents for the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of the electronic files.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

3.2 SUPERVISION OF WORK

- A. Perform all work under the direct supervision of an experienced, qualified superintendent. The Engineer has the right to remove a superintendent who, in the Engineer's opinion, is not satisfactory.

3.3 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.4 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.
- E. Interruption of Service: Before any existing equipment or system is shut down for disconnecting or tie-ins, coordinate with Engineer and Owner regarding acceptable dates and times for this Work to be performed. Work shall be performed at the time best suited for the Owner, which typically is either on weekends, holidays, and/or after normal working hours. Services shall be restored the same day unless prior arrangements are made. All overtime or premium costs associated with this Work shall be included in the Contractor's bid.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

3.5 INSTALLATION

- A. Install materials and equipment in a professional manner. The Engineer may direct replacement of items which, in the Engineer's opinion, do not present a professional appearance or do not allow adequate space for maintenance. Replace or reinstall items at the expense of the Contractor.
- B. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- C. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- D. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- G. Obstructions
 - 1. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
 - 2. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
 - 3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
 - 4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.
- H. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof, or ceiling to the satisfaction of the authority having jurisdiction.
- I. Structural Elements: Do not cut structural elements without written approval from Engineer. Notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. If approved by Engineer:
 - 1. Shore, brace, and support structural elements during cutting and patching.
 - 2. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

- J. Space Requirements: Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
- K. Tools and Equipment: Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.
- L. Phasing: Provide all temporary valves, piping, ductwork, equipment, and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.6 OWNER-INSTALLED PRODUCTS

- A. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

3.7 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- F. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
- G. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- H. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

- I. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- J. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable or with in-place materials.
 - 1. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 2. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.
- K. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.8 PAINTING

- A. Comply with requirements with General and Supplementary Conditions, Division 01, Division 09, and individual Specification Sections.
- B. Touch-up factory finishes on equipment provided under Division 21. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.
- C. Paint the following work where exposed to view:
 - 1. Uninsulated Metal Piping (bare copper piping not required to be painted unless noted otherwise):
 - a. Other: To be determined by Engineer
 - 2. Uninsulated plastic piping
 - 3. Tanks that do not have factory-applied final finishes.
 - 4. Equipment, and pipe insulation having a cotton or canvas insulation covering or other paintable jacket material, as outlined in individual Specification Sections.
- D. Paint the following work where exposed in occupied spaces:

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

1. Equipment and pipe insulation having a cotton or canvas insulation covering or other paintable jacket material, as outlined in individual Specification Sections.
2. Other items as directed by Engineer.

E. Paint the following work where concealed from and/or exposed to view:

1. Reuse or Reclaimed Water Supply: Purple

3.9 REPAIR OF WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

3.10 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests
 1. Include all tests specified and/or required under laws, rules and regulations of all departments having jurisdiction. Tests shall also be performed as indicated herein and other sections of the specifications.
 2. After all systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems.
 3. All parts of the work and associated equipment shall be tested and adjusted to work properly and be left in perfect operating condition.
 4. Correct defects disclosed by these tests without any additional cost to the Owner. Repeat tests on repaired or replaced work.
 5. Maintain a log of all tests being conducted and have it available for review by the Engineer. Log to indicate date, type of tests, duration, and defects noted and when corrected.
 6. Special tests on individual systems are specified under individual Specification Sections.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

3.11 CLEANING

- A. Progress Cleaning: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Final Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove labels that are not permanent.
 - c. Wipe surfaces of equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

END OF SECTION 220100

SECTION 220100 - GENERAL PROVISIONS FOR PLUMBING (continued):

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SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT (continued):

- C. Service Factor: 1.15.
- D. Power Factor: 0.80.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT (continued):

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT (continued):

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SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Grout.
 - 4. Silicone sealants.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends.
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 GROUT

- A. Description: Non-shrinking, for interior and exterior sealing openings in non-fire-rated walls or floors.

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING (continued):

- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. Sealant shall have a VOC content of 250 g/L or less.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
 - 1. Sealant shall have a VOC content of 250 g/L or less.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
 - 1. Sealant shall have a VOC content of 250 g/L or less.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING (continued):

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Division 07 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 1. Install fittings that are large enough to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to **2 inches (50 mm)** above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Division 07.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller than **NPS 6 (DN 150)**: Steel pipe sleeves.
 - b. Piping **NPS 6 (DN 150)** and Larger: Steel pipe sleeves.
 2. Interior Partitions:
 - a. Piping Smaller Than **NPS 6 (DN 150)**: Steel pipe sleeves.
 - b. Piping **NPS 6 (DN 150)** and Larger: Galvanized-steel sheet sleeves.

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING (continued):

3. Concrete Slabs with Water Proof Membrane and Roof Decks: Stack-sleeve fittings.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and polished brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.
- E. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

PART 3 - EXECUTION

3.1 INSTALLATION

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING (continued):

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece cast brass with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece stamped steel with polished, chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece cast brass with rough-brass finish.
 - g. Bare Piping in Equipment Rooms: One-piece cast brass with rough-brass finish.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Trerice H.O. Co.; BX9 or comparable product by one of the following:
 - a. Weiss Instruments, Inc.
 - b. Winters Instruments - U.S.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.

SECTION 220519 - METERS AND GAGES FOR DOMESTIC WATER PIPING (continued):

6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in **deg F (deg C)**.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
9. Connector: **1-1/4 inches (32 mm)**, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR (copper nicket 90-10).
4. Material for Use with Steel Piping: CRES (stainless steel).
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1 (DN 15, DN 20, or NPS 25)**, ASME B1.20.1 pipe threads.
7. Internal Threads: **1/2, 3/4, and 1 inch (13, 19, and 25 mm)**, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Trerice H.O. Co.; 600CB or comparable product by one of the following:
 - a. **Ashcroft Inc.**
 - b. **Miljoco Corporation.**
 - c. **Weiss Instruments, Inc.**
 - d. **Winters Instruments - U.S.**
2. Standard: ASME B40.100.
3. Case: Solid-front, pressure relief type(s); cast aluminum; **4-1/2-inch (114-mm)** nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with **NPS 1/4 (DN 8)**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in **psi (kPa)**.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.

SECTION 220519 - METERS AND GAGES FOR DOMESTIC WATER PIPING (continued):

11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with **NPS 1/4 (DN 8)**, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with **NPS 1/4 (DN 8)**, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of **2 inches (51 mm)** into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install thermometers in the following locations:
 1. Inlet and outlet of each water heater.
- I. Install pressure gages in the following locations:
 1. Building water service entrance into building.
 2. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

SECTION 220519 - METERS AND GAGES FOR DOMESTIC WATER PIPING (continued):

- A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
 - 1. Metal case, industrial-style, liquid-in-glass type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C).
- B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be the following:
 - 1. Solid-front, pressure-relief, direct-mounted, metal case.
- B. Pressure gages at suction and discharge of each domestic water pump shall be the following:
 - 1. Solid-front, pressure-relief, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1100 kPa).

END OF SECTION 220519

SECTION 220523.11 - GENERAL DUTY VALVES FOR DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Bronze swing check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

SECTION 220523.11 - GENERAL DUTY VALVES FOR DOMESTIC WATER PIPING (continued):

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B31.9 for building services piping valves.
 - 3. ASME B16.1 for flanges on iron valves.
 - 4. ASME B16.5 for flanges on steel valves.
 - 5. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 6. ASME B31.9 for building service piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. NSF Compliance: NSF 61 for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Actuator Types:
 - 1. Gear Actuator: For valves **NPS 8 (DN 200)** and larger.
 - 2. Handlever: For valves **NPS 6 (DN 150)** and smaller.
- I. Valves in Insulated Piping:
 - 1. Include **2-inch (50-mm)** stem extensions.
 - 2. Extended operating handles of non-thermal conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.
- J. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
 - 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.

SECTION 220523.11 - GENERAL DUTY VALVES FOR DOMESTIC WATER PIPING (continued):

- f. [Watts Regulator Co.; a division of Watts Water Technologies, Inc.](#)

2. Description:

- a. Standard: MSS SP-110 or MSS-145.
- b. CWP Rating: 600 psig (4140 kPa).
- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded or soldered[or press].
- f. Seats: PTFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel, vented.
- i. Port: Full.

2.3 **BRONZE SWING CHECK VALVES**

A. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:

- 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Crane Co.; Crane Valve Group; Crane Valves.](#)
 - b. [Milwaukee Valve Company.](#)
 - c. [NIBCO INC.](#)
 - d. [Watts Regulator Co.; a division of Watts Water Technologies, Inc.](#)

2. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 300 psig (2070 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: PTFE.

B. Bronze Swing Check Valves, Press Ends:

1. Description:

- a. Standard: MSS SP-80 and MSS SP-139.
- b. CWP Rating: Minimum 200 psig (1380 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 584, bronze.
- e. Ends: Press.
- f. Press Ends Connection Rating: Minimum 200 psig (1380 kPa).
- g. Disc: Brass or bronze.

PART 3 - EXECUTION

3.1 **EXAMINATION**

SECTION 220523.11 - GENERAL DUTY VALVES FOR DOMESTIC WATER PIPING (continued):

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. If valve applications are not indicated, use the following:
 - 1. Shutoff Service:
 - a. **NPS 2 (DN 50)** and Smaller: Ball valves.
 - 2. Pump-Discharge Check Valves:
 - a. **NPS 2 (DN 50)** and Smaller: Bronze swing check valves with nonmetallic disc.

SECTION 220523.11 - GENERAL DUTY VALVES FOR DOMESTIC WATER PIPING (continued):

- C. Select valves with the following end connections:
 - 1. For Copper Tubing, **NPS 2 (DN 50)** and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

3.5 **DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE**

- A. Pipe **NPS 2 (DN 50)** and Smaller:
 - 1. Bronze ball valves, two-piece with full port and stainless-steel trim. Provide with threaded or solder **or press connection** joint ends.
 - 2. Bronze swing check valves with nonmetallic disc, Class 150, with threaded **or press connection** joint ends.

END OF SECTION 220523.11

SECTION 220523.11 - GENERAL DUTY VALVES FOR DOMESTIC WATER PIPING (continued):

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SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Pipe-positioning systems.
 - 6. Insulation couplings.
 - 7. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Insulation couplings.
 - 4. Equipment supports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT (continued):

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

- A.** Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Cooper B-Line, Inc.](#)
 - b. [Flex-Strut Inc.](#)
 - c. [Unistrut Corporation; Tyco International, Ltd.](#)
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Electroplated zinc or Hot-dip galvanized.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT (continued):

4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dip galvanized

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 INSULATION COUPLINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide [FNW; Ferguson Enterprises, Inc.](#); Figure 7897 (flexible elastomeric insulation) / Figure 7899 (mineral fiber insulation) or a comparable product by one of the following:
 1. [Eaton.](#)
 2. [Unistrut; Part of Atkore International.](#)
- B. Description: Insulation coupling designed to support insulated pipes and for use with metal framing system mounted clamps and either flexible elastomeric or mineral fiber insulation.
- C. Material: Molded with high-strength thermoplastic.
- D. UL Classified 2043 for use in plenum and air handling systems.
- E. Temperature Rating: -60 deg F to +225 deg F.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.9 MATERIALS

- A. Aluminum: [ASTM B 221](#) ([ASTM B 221M](#)).
- B. Carbon Steel: ASTM A 1011/A 1011M.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT (continued):

- C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A 240/A 240M.
- E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: **5000-psi** (**34.5-MPa**), 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Division 07 for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb** (**90 kg**).

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than **4 inches** (**100 mm**) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Stand Installation:
 - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT (continued):

- F. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- N. Insulated Piping:
 - 1. Install insulation couplings for pipes mounted to metal framing systems based on pipe size and insulation material. Arrange for grouping of parallel runs of piping and support together on metal framing system.
 - a. Flexible Elastomeric Insulation: For pipe NPS 4 (DN 100) and Smaller
 - b. Mineral Fiber Insulation: For pipe NPS 4 (DN 100) and Smaller
 - 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 3. Install MSS SP-58, Type 40 protective shields on piping not using insulation couplings. Shields shall span an arc of 180 degrees. Secure shield to pipe on both ends with stainless steel bands.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT (continued):

- B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 / D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to **1-1/2 inches (40 mm)**.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils (0.05 mm)**.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Division 09.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780 / A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT (continued):

- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24 (DN 15 to DN 600)** if little or no insulation is required.
 - 3. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers **NPS 3/4 to NPS 24 (DN 24 to DN 600)**.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- K. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- N. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT (continued):

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Ceiling marker labels.
 - 3. Pipe labels.
 - 4. Valve tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT (continued):

- B. Label Content: Include equipment's Drawing designation or unique equipment number.
- C. Equipment Label Schedule: For each item of equipment to be labeled, tabulate equipment label content. Equipment schedule shall be included in operation and maintenance data.

2.2 CEILING MARKER LABELS

- A. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
- B. Letter Color: Black.
- C. Background Color: Clear.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- E. Minimum Letter Size: 1/2 inch (13 mm).
- F. Label Content: Include either the equipment tag identifier or a clear description of the concealed component, along with the system or service abbreviation. Label content shall match identifiers shown on Drawings or be descriptive enough for field recognition and maintenance access.
 - 1. System of Service Abbreviations: "CWS, HWS, HWR, SAN, GAS, CA, VAC".
 - 2. Components: "VALVE, CIRCUIT SETTER".

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT (continued):

operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 CEILING MARKER LABEL INSTALLATION

- A. Apply labels for each concealed major item of plumbing equipment or component requiring service or maintenance.
- B. Align labels neatly, parallel to ceiling edges or panel orientation.
- C. Apply after ceiling installation and verification of concealed item locations.
- D. Do not install labels on surfaces subject to frequent replacement or repainting without coordination.
- E. Locate ceiling marker labels where accessible and visible.
- F. Application Locations:
 1. Suspended Acoustical Tile Ceilings (ACT):
 - a. Apply label to the face of the ceiling grid tee directly adjacent to or centered over the concealed item.
 - b. If grid location is not feasible, affix to accessible tile surface, avoiding any tile likely to be replaced or removed.
 2. Gypsum Board or Hard-Lid Ceilings with Access Panels:

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT (continued):

- a. Apply label directly to the surface of the access panel.
 - b. Label shall be centered, upright, and clearly legible from floor level.
3. Exposed Ceilings or Open Structures:
 - a. Apply label to the nearest permanent building surface or equipment mounting plate visible from below.
 - b. If no surface is available, affix to suspended tag or placard mounted below the item.
4. Multiple Components at Single Access Location:
 - a. Use a single label listing all concealed components above the ceiling at that location, aligned vertically or in column format.
 - b. Use consistent labeling format and spacing.

3.5 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of **50 feet (15 m)** along each run. Reduce intervals to **25 feet (7.6 m)** in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions. Install marker tape with arrows around the entire circumference of the pipe at the beginning and end of the pipe-label content.
- C. Pipe Label Color Schedule:
 1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape:

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT (continued):

- a. Cold Water: 1-1/2 inches (38 mm), round.
 - b. Hot Water: 1-1/2 inches (38 mm), round.
2. Valve-Tag Colors:
- a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - c. Low-Pressure Compressed Air: Natural.
 - d. High-Pressure Compressed Air: Natural.

END OF SECTION 220553

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT (continued):

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SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic hot-water piping.
 - 2. Domestic recirculating hot-water piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation where applicable.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

- 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing, where applicable.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

- a. [Johns Manville; Micro-Lok HP.](#)
 - b. [Owens Corning; SSL II with ASJ Max Fiberglass Pipe Insulation.](#)
2. Type I, **850 Deg F (454 Deg C)** Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. UL listed and labeled for installation over PVC and other polymer pipes within a plenum.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.](#)

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.](#)
 - b. [Eagle Bridges - Marathon Industries; 225.](#)
 - c. [Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.](#)
 - d. [Mon-Eco Industries, Inc.; 22-25.](#)
 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.](#)
 - b. [Eagle Bridges - Marathon Industries; 225.](#)
 - c. [Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.](#)
 - d. [Mon-Eco Industries, Inc.; 22-25.](#)
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM E96, greater than **1.0 perm** (0.66 metric perms) at manufacturer's recommended dry film thickness.
 3. Service Temperature Range: **Minus 20 to plus 180 deg F** (Minus 29 to plus 82 deg C).
 4. Color: White.

2.5 SEALANTS

- A. Joint Sealants for Cellular-Glass Products:
 1. Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: **Minus 100 to plus 300 deg F** (Minus 73 to plus 149 deg C).
 5. Color: White or gray.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Metal Jacket Flashing Sealants:

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).**
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).**
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately **2 oz./sq. yd. (68 g/sq. m)** with a thread count of **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)** for covering pipe and pipe fittings.
 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

- a. [Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.](#)

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Johns Manville; Zeston.](#)
 - b. [P.I.C. Plastics, Inc.; FG Series.](#)
 - c. [Proto Corporation; LoSmoke.](#)
 - d. [Speedline Corporation; SmokeSafe.](#)
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
 1. Aluminum Jacket: Comply with **ASTM B209** (**ASTM B209M**), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: **2.5-mil-** (**0.063-mm-**) thick polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: **2.5-mil-** (**0.063-mm-**) thick polysurlyn.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Width: **3 inches** (**75 mm**).
 2. Thickness: **11.5 mils** (**0.29 mm**).
 3. Adhesion: **90 ounces force/inch** (**1.0 N/mm**) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: **40 lbf/inch** (**7.2 N/mm**) in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches (50 mm).
 - 2. Thickness: 6 mils (0.15 mm).
 - 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.10 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
 - 2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal.
- B. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Above Ambient Systems:
 - 1. Where mastic is indicated provide breather mastic.
 - 2. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal integrity unless otherwise indicated.
 - 3. Install insulation continuously through hangers and around anchor attachments.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Provide factory applied ASJ-SSL jacket.

B. Insulation Installation on Pipe Flanges, Fittings, Elbows, Valves and Pipe Specialties:

1. Insulate pipe elbows and tee fittings using preformed fitting insulation. Each piece shall be butted tightly against adjoining piece.
2. Insulate flanges and unions using a section of oversized preformed pipe insulation. Install preformed pipe insulation to outer diameter of pipe flange. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with insulating cement.
3. Insulate strainers, valves, and other pipe specialties using preformed fitting insulation. When preformed sections are not available, install mitered sections of pipe insulation. Secure mitered sections with wire or bands.
4. Arrange valve insulation to permit access to packing and to allow valve operation without disturbing insulation.
5. In concealed locations install fitted PVC cover over preformed fitting insulation. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
6. Cover pipe fittings, valves, strainers, flanges, unions, and other specialties in exposed locations and any segmented insulated surfaces with a layer of finishing cement and install field-applied glass-cloth jacket.
7. Apply breather mastic at exposed ends of insulation at pipe flanges, unions, and fittings.
8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulation Installation on Instrument Connections:

1. Install insulation on instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes.
2. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with mastic.
3. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of mastic.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.
4. Finish to achieve smooth, uniform finish.

B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant rec-

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

ommended by insulation manufacturer. Secure jacket with stainless-steel bands **12 inches (300 mm)** o.c. and at end joints.

1. Do not install metal jacket over glass-cloth jacket.

3.7 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below. Color per schedule below.
 1. Semi-gloss Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, semi-gloss, latex-emulsion size.
 2. Paint exposed piping without field applied metal jacket.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Color per schedule below.
- C. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.
 1. White.
- D. Do not field paint aluminum jackets.

3.8 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water:
 1. **NPS 1-1/4 (DN 32)** and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1-1/2 inch (38 mm)** thick.
 2. **NPS 1-1/2 (DN 40)** and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1-1/2 inch (38 mm)** thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. Aluminum, Corrugated: 0.016 inch (0.41 mm) thick.
- E. Exposed fittings, valves, strainers, flanges, unions, and other specialties:
 - 1. Glass cloth jacket.

END OF SECTION 220719.12

SECTION 220719.12 - INSULATION FOR DOMESTIC HOT-WATER PIPING (continued):

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SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. PVC pipe and fittings.
 - 3. Piping joining materials.
 - 4. Encasement for piping.
 - 5. Transition fittings.
 - 6. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Pipe and tube.
 - 2. Fittings.
 - 3. Joining materials.
 - 4. Transition fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than 5 days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Owner's written permission.

1.6 WARRANTY

SECTION 221116 - DOMESTIC WATER PIPING (continued):

- A. PP-RCT Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.
 - 1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
 - 2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test and any other manufacturer requirements.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.
- B. Furnish new and unused piping materials manufactured in the United States of America. Piping shall be marked with country of origin from the manufacturer.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: **ASTM B88, Type L (ASTM B88M, Type B)**.
- B. Annealed-Temper Copper Tube: **ASTM B88, Type K (ASTM B88M, Type A)**.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- F. Wrought Copper Unions: ASME B16.22.
- G. Copper Tube, Pressure-Seal-Joint Fittings:
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Viega LLC** ; Pro-Press Copper. or a comparable product by one of the following:
 - a. Mueller Streamline Co.; a company of Mueller Industries.
 - 2. Fittings: Cast-bronze or wrought-copper with EPDM O-ring seal in each end.
 - 3. Minimum **200-psig (1379-kPa)** working-pressure rating at **250 deg F (121 deg C)**.

2.3 PVC PIPE AND FITTINGS

- A. PVC Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.
- B. PVC Socket Fittings: ASTM D2466 for Schedule 40.
- C. PVC Schedule 80 Threaded Fittings: ASTM D2464.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys.
- D. Flux: ASTM B813, water flushable.
- E. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Form: Sheet .
- C. Color: Black.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Description:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

E. Plastic-to-Metal Transition Unions:

1. Description:
 - a. CPVC four-part union.
 - b. Brass or stainless steel threaded end.
 - c. Solvent-cement-joint or threaded plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

2.7 SINGLE-PIECE, CUSTOMIZABLE, IN-BUILDING RISER

- A. Description: Single-piece, extended 90-degree fitting that passes under the foundation without joints and extends through the floor to transition from exterior underground piping to interior aboveground piping.
1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Ames Fire & Water-works; Series IBR (NPS 4 (DN 100) and Larger) / Series IBR2 (NPS 3 (DN 80) and Smaller)** or a comparable product by one of the following:
 - a. **Watts; Series TR / TR2.**
- B. Tubing: ASTM A312; Type 304 stainless steel tubing.
- C. End Connections:
1. **NPS 2 (DN 50):** Threaded or grooved.
 - a. Threaded: ASTM B1.20.1
 - b. Grooved: AWWA C606 for roll grooved pipe.
- D. Lengths:
1. **NPS 3 (DN 80) and Smaller:** Customizable leg lengths, from **3-feet (0.9 m)** to **16-feet (4.9 m)**, not to exceed a combined length of **19-feet (5.8 m)**.
- E. Maximum Working Pressure: **200 psig (1379 kPa)**.
- F. Approvals: NFPA 24, FM Class 1920, UL HKQA.
- G. Accessories include the following:
1. Test cap and coupler.
 2. Flange adapter.

2.8 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
1. Standard: ASSE 1079.
 2. Pressure Rating: **150 psig (1035 kPa)**.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
1. Standard: ASSE 1079.
 2. Factory-fabricated, bolted, companion-flange assembly.
 3. Pressure Rating: 150 psig (1035 kPa).
 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
1. Nonconducting materials for field assembly of companion flanges.
 2. Pressure Rating: 150 psig (1035 kPa).
 3. Gasket: Neoprene or phenolic.
 4. Bolt Sleeves: Phenolic or polyethylene.
 5. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic cold-water, building-service piping, NPS 3 (DN 80) and smaller, shall be one of the following:
1. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
- D. Under-building-slab, domestic cold-water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Annealed-temper copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic cold-water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); wrought-copper, solder-joint fittings; and soldered joints.
 2. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
- F. Aboveground domestic hot-water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); wrought-copper, solder-joint fittings; and soldered joints.
 2. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

3.2 EARTHWORK

- A. Comply with requirements in Division 31 for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.
- D. Install valves according to Section 220523.11 "General Duty Valves for Domestic Water Piping."
- E. Install domestic water piping level without pitch and plumb.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- N. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gages for Plumbing Piping."
- O. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- P. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

SECTION 221116 - DOMESTIC WATER PIPING (continued):

- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - 3. PVC Piping: Join according to ASTM D2855.
- H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
- I. Socket-Fusion, Electrofusion, or Butt-Fusion Joints: Use manufacturer-recommended tools and procedure.

3.5 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for **NPS 1-1/2 (DN 40)** and Smaller: Fitting-type coupling.
 - 2. Fittings for **NPS 2 (DN 50)** and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping **NPS 2 (DN 50)** and Smaller: Plastic-to-metal transition unions.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

3.6 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for **NPS 2 (DN 50)** and Smaller: Use dielectric unions.
- C. Dielectric Fittings for **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Use dielectric flange kits.
- D. Dielectric Fittings for **NPS 5 (DN 125)** and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Install hangers for copper tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with requirements herein, manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - 1. Maximum Support Spacing:
 - a. Systems with medium 70°F and below: 6 feet.
 - b. Systems with medium above 70°F: 4 feet.
 - 2. Hangers and Clamps: Metric sized with minimum 0.125-inch rubber-lined (EPDM). Do not use metal hangers and clamps or IPS sized products.
 - a. Anchors (Fixed Points): Tighten clamp to restrict axial movement, but do not over-tighten the clamp. Locate anchors at changes in directions and take-offs within **12 inches (300 mm)** of fittings. Vertical risers shall be installed only with anchors.
 - b. Guides (Sliding Points): Adjust clamp to allow axial movement. Located guides along straight sections of piping. Do not use on vertical risers.
- D. Support horizontal piping within **12 inches (300 mm)** of each fitting.
- E. Support vertical runs of copper tubing and piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support vertical runs of CPVC, PVC, and PP-R piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect to underground water-service piping where it passes under the building. Extend underground water-service piping and connect to building domestic water piping systems at locations and pipe sizes indicated using single-piece, in-building risers.
 - 1. Coordinate horizontal and vertical lengths of single-piece, in-building risers to extend from the exterior of the building, underneath the foundation, and through the floor up to between **24 inches (610 mm)** and **36 inches (910 mm)** above finished floor.
 - 2. Coordinate horizontal and vertical end connections of single-piece, in-building risers with underground water-service piping and domestic water piping inside the building.
 - 3. Terminate domestic water piping within the building at the service entrance until building domestic water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's domestic water piping systems when those systems are installed.
- E. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for **NPS 2-1/2 (DN 65)** and larger.

3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Check plumbing specialties and verify proper settings, adjustments, and operation.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

3.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unenclosed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of **50 psig (345 kPa)** above operating pressure but not less than **150 psig (1034 kPa)**, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
- f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

SECTION 221116 - DOMESTIC WATER PIPING (continued):

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 221116

SECTION 221116 - DOMESTIC WATER PIPING (continued):

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SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Balancing valves.
 - 3. Temperature-actuated, water mixing valves.
 - 4. Hose bibbs.
 - 5. Wall hydrants.
 - 6. Drain valves.
 - 7. Water-hammer arresters.
 - 8. Trap-seal primer device.

1.3 DEFINITIONS

- A. AMI: Advanced Metering Infrastructure.
- B. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES (continued):

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: **125 psig (860 kPa)** unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Hose-Connection Vacuum Breakers:

- 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Watts; 8B or comparable product by one of the following:
 - a. [Conbraco Industries, Inc](#)
 - b. [Zurn Industries, LLC](#)
 - c. [Plumbing Products Group](#)
 - d. [Wilkins Water Control Products](#)
- 2. Standard: ASSE 1011.
- 3. Body: Bronze, nonremovable, with manual drain.
- 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- 5. Finish: Rough bronze.

- B. Pressure Vacuum Breakers:

- 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Watts; LF800M4QT or comparable product by one of the following:
 - a. [Conbraco Industries, Inc](#)
 - b. [Zurn Industries, LLC](#)
 - c. [Plumbing Products Group](#)
 - d. [Wilkins Water Control Products](#)
- 2. Standard: ASSE 1020.
- 3. Operation: Continuous-pressure applications.
- 4. Pressure Loss: **5 psig (35 kPa)** maximum, through middle third of flow range.
- 5. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.4 BALANCING VALVES

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES (continued):

A. Memory-Stop Balancing Valves:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide NIBCO Inc.; T1710 or comparable product by one of the following:
 - a. **Conbraco Industries, Inc.**
 - b. **Milwaukee Valve Company.**
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: **400-psig (2760-kPa)** minimum CWP.
4. Size: **NPS 2 (DN 50)** or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass or stainless steel.
8. Seats and Seals: Replaceable.
9. End Connections: Threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **Lawler Manufacturing Company, Inc.**
 - b. **Leonard Valve Company.**
 - c. **Powers; a division of Watts Water Technologies, Inc.**
 - d. **Symmons Industries, Inc.**
2. Standard: ASSE 1017.
3. Pressure Rating: **125 psig (860 kPa)** minimum unless otherwise indicated.
4. Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5. Material: Bronze body, lead free, with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: As indicated on Plans.
9. Pressure Drop at Design Flow Rate: As indicated on Plans.
10. Valve Finish: Rough bronze.

2.6 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: **NPS 1/2 or NPS 3/4 (DN 15 or DN 20)** threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: **125 psig (860 kPa)**.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES (continued):

8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Non-freeze Wall Hydrants:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn; Z1320-C or comparable product by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts Drainage Products.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: **125 psig (860 kPa).**
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: **NPS 3/4 or NPS 1 (DN 20 or DN 25).**
7. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Operating Keys(s): One with each wall hydrant.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: **400-psig (2760-kPa)** minimum CWP.
3. Size: **NPS 3/4 (DN 20).**
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES (continued):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn; 1250XL or comparable product by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Watts Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.10 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Precision Plumbing Products; P1-500 or comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1018.
3. Pressure Rating: **125 psig (860 kPa)** minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: **NPS 1/2 (DN 15)** threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: **NPS 1/2 (DN 15)** threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
8. Provide adjusting screw to adjust between high and low pressures.

2.11 TRAP-SEAL PRIMER SYSTEMS

A. Electronic Trap-Seal Primer Systems:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Precision Plumbing Products; PTS-x-500 or comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1044.
3. Inlet Size: **NPS 3/4, ASTM B88, Type L (DN 20, ASTM B88M, Type B)**; copper, water tubing.
4. Cabinet: Surface-mounted steel box with stainless steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120 V ac power.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES (continued):

6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: From four to twelve, as required..
8. Size Outlets: **NPS 1/2 (DN 15)**.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
- B. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- C. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- D. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Division 26.
- B. Ground equipment in accordance with Division 26
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

- A. Connect control wiring in accordance with Division 26.

3.5 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Primary, thermostatic, water mixing valves.

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES (continued):

- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Name-plates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.
- D. Adjust each pressure vacuum breaker, reduced-pressure-principle backflow preventer, and double-check, backflow-prevention assembly in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, and double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES (continued):

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SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. In-line, sealless centrifugal pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS (continued):

- B. UL Compliance: UL 778 for motor-operated water pumps.
- C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Armstrong Pumps Inc
 - 2. Bell & Gossett Domestic Pump; ITT Corporation
 - 3. TACO Incorporated
- B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
- C. Pump Construction:
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
 - 2. Minimum Working Pressure: 125 psig (860 kPa).
 - 3. Maximum Continuous Operating Temperature: 220 deg F (104 deg C).
 - 4. Casing: Bronze, with threaded or companion-flange connections.
 - 5. Impeller: Plastic.
 - 6. Motor: Single speed.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - 1. Type: Water-immersion temperature sensor, for installation in piping.
 - 2. Range: 65 to 200 deg F (18 to 93 deg C).
 - 3. Enclosure: NEMA 250, Type 4X.
 - 4. Operation of Pump: On or off.
 - 5. Transformer: Provide if required.
 - 6. Power Requirement: 120 V ac.
 - 7. Settings: Start pump at 110 deg F (43 deg C) and stop pump at 120 deg F (49 deg C).
- B. Timers: Electric, for control of hot-water circulation pump.
 - 1. Type: Programmable, seven-day clock with manual override on-off switch.
 - 2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS (continued):

3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Mount pumps in orientation complying with manufacturer's written instructions.
- C. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
 1. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
 2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- D. Install pressure switches in water-supply piping.
- E. Install thermostats in hot-water return piping.
- F. Install timers adjacent to water heater.

3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
- C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Vertically mounted, in-line, multi-stage, close-coupled centrifugal pumps.
 - b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS (continued):

for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in Section 220523.11 "General Duty Valves for Domestic Water Piping."

- E. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tapings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Domestic Water Piping."

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.
- C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Set thermostats, and timers for automatic starting and stopping operation of pumps.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS (continued):

- b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
- 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
- 7. Start motor.
- 8. Open discharge valve slowly.
- 9. Adjust temperature settings on thermostats.
- 10. Adjust timer settings.

3.8 ADJUSTING

- A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS (continued):

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SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Hubless, cast-iron soil pipe and fittings.
 - 2. PVC pipe and fittings.
 - 3. Specialty pipe fittings.
 - 4. Plenum fire wrap.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.6 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
 - 2. Waste, Force-Main Piping: 50 psig (345 kPa).

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Furnish new and unused piping materials manufactured in the United States of America. Piping shall be marked with country of origin from the manufacturer.
- C. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 888 or CISPI 301.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky (SD 4000).
 - b. Clamp-All Corp (Hi-Torq 80).
 - c. MIFAB, Inc (MI-XHUB).
 - d. Mission Rubber Company; a division of MCP Industries, Inc (HeavyWeight).
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Solvent Cement: ASTM D 2564.
1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Pressure Transition Couplings:
 - a. Standard: AWWA C219.
 - b. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - c. Center-Sleeve Material: Manufacturer's standard.
 - d. Gasket Material: Natural or synthetic rubber.
 - e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
 - a. Description:
 - 1) Standard: ASSE 1079.

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

- 2) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
 - a. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig (1035 kPa).
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.

2.6 PLENUM FIRE WRAP

- A. Material: High-temperature fiber blanket thermal insulation encapsulated in fiberglass-reinforced aluminum foil.
- B. Density: 6 pcf.
- C. Thickness: 1/2 inch.
- D. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping **NPS 3 (DN 80)** and smaller; 1 percent downward in direction of flow for piping **NPS 4 (DN 100)** and larger.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Install aboveground PVC piping according to ASTM D 2665.
- Q. Install underground PVC piping according to ASTM D 2321.
 - 1. The installation of plastic pipe beneath a building built on unstable soil shall be accomplished by suspending piping systems from structural slabs in accordance with ASTM F2536 (Standard

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

Guide for Installing Plastic DWV Piping Suspended from On-Grade Slabs) and piping manufacturer's technical and installation manual.

- R. Wrap PVC piping installed in plenums with fire resistant wrap.
- S. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- T. Install underground, ductile-iron, force-main piping according to AWWA C600.
 - 1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
 - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
- U. Install force mains at elevations indicated.
- V. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- X. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- D. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- G. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:
 - a. **NPS 1-1/2 (DN 40)** and Smaller: Fitting-type transition couplings.
 - b. **NPS 2 (DN 50)** and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for **NPS 2 (DN 50)** and Smaller: Use dielectric unions.
 - 3. Dielectric Fittings for **NPS 2-1/2 to NPS 4 (DN 65 to DN 100)**: Use dielectric flange kits.
 - 4. Dielectric Fittings for **NPS 5 (DN 125)** and Larger: Use dielectric flange kits.

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

3.5 VALVE INSTALLATION

- A. Install valves according to Section 220523.31 "General Duty Valves for Sanitary Waste and Storm Drainage Piping."
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install full-port ball valve for piping **NPS 2 (DN 50)** and smaller.
 - 3. Install gate valve for piping **NPS 2-1/2 (DN 65)** and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves.
 - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Install individual, straight, horizontal piping runs:
 - a. **100 Feet (30 m)** and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than **100 Feet (30 m)**: MSS Type 43, adjustable roller hangers.
 - c. Longer Than **100 Feet (30 m)** if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs **100 Feet (30 m)** or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install hangers for cast-iron, steel, and copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping and tubing within **12 inches (300 mm)** of each fitting, valve, and coupling.
- E. Support vertical runs of cast iron, steel, and copper soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

- F. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Install horizontal backwater valves with cleanout cover flush with floor.
 - 6. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 7. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections **NPS 2-1/2 (DN 65)** and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping **NPS 2 (DN 50)** and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping **NPS 2-1/2 (DN 65)** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water (30 kPa)**.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1-inch wg (250 Pa)**.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping **NPS 4 (DN 100)** and smaller shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, vent piping **NPS 4 (DN 100)** and smaller shall be any of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 - 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Underground, soil, waste, and vent piping **NPS 4 (DN 100)** and smaller shall be any of the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221316 - SANITARY WASTE AND VENT PIPING (continued):

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SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Miscellaneous sanitary drainage piping specialties.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile butadiene styrene.
- B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES (continued):

A. Cast-Iron Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Josam Company; Josam Div.](#)
 - b. [MIFAB, Inc.](#)
 - c. [Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.](#)
 - d. [Watts Drainage Products Inc.](#)
 - e. [Zurn Plumbing Products Group; Specification Drainage Operation.](#)
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. [Basis-of-Design Product:](#) Subject to compliance with requirements, provide Zurn; Z1400-K or a comparable product by one of the following:
 - a. [Josam Company; Josam Div.](#)
 - b. [Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.](#)
 - c. [Watts Drainage Products Inc.](#)
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside caulk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Medium Duty.
13. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. [Basis-of-Design Product:](#) Subject to compliance with requirements, provide Zurn; Z1446 or a comparable product by one of the following:
 - a. [Josam Company; Josam Div.](#)
 - b. [MIFAB, Inc.](#)
 - c. [Smith, Jay R. Mfg. Co.; d of Smith Industries, Inc.](#)
 - d. [Watts Drainage Products Inc \(CO-460-RD\).](#)
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES (continued):

- a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze cover plate with screw.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. **NPS 2 (DN 50): 4-inch- (100-mm-)** minimum water seal.
 - b. **NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-)** minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with **NPS 1/2 (DN 15)** side inlet.

D. Floor-Drain, Inline Trap Seal:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Green Drain, Inc.
 - b. Jay R. Smith Mfg Co; a division of Morris Group International.
 - c. Josam Company.
 - d. MIFAB, Inc.
 - e. RectorSeal Plumbing; A CSW Industrials Company.
2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: Polymer.
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: ICC-ES or IAPMO listed.
6. Size: Same as floor drain outlet or strainer throat.

E. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES (continued):

3. Inlet: Opening in top of body.
 4. Outlet: Larger than inlet.
 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- F. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend **2 inches (51 mm)** above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 2. Size: As required for close fit to riser or stack piping.
- G. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 2. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to **NPS 4 (DN 100)**. Use **NPS 4 (DN 100)** for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of **50 feet (15 m)** for piping **NPS 4 (DN 100)** and smaller and **100 feet (30 m)** for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install fixture air-admittance valves on fixture drain piping.
- E. Install air-admittance-valve wall boxes recessed in wall.
- F. Assemble open drain fittings and install with top of hub **2 inches (51 mm)** above floor.
- G. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES (continued):

- I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- J. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- K. Install wood-blocking reinforcement for wall-mounting-type specialties.
- L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES (continued):

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SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Floor drains.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Watts; FD-100-A (Round) / Watts: FD-100-M (Square) or a comparable product by one of the following:
 - a. **Josam Company; Josam Div.**
 - b. **MIFAB, Inc.**
 - c. **Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.**
 - d. **Zurn Plumbing Products Group; Specification Drainage Operation.**
 - 2. Standard: ASME A112.6.3.
 - 3. Pattern: Floor drain.
 - 4. Body: Gray iron, with seepage flange, anchoring flange, and clamping device.

SECTION 221319.13 - SANITARY DRAINS (continued):

5. Outlet: Bottom, push-on type with gasket.
6. Inlet: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
7. Strainer: Nickel bronze, medium duty, shape as indicated below:
 - a. Tile Floors: Square, 6 inch x 6 inch (152 mm x 152 mm).
 - b. All Floors Except Tile Floors: Round, 6 inch (152 mm) for all floors except tile floors.
8. Trap: Deep-seal P-trap.
9. Funnel: Provide where indicated on plans.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
 - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
 - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

SECTION 221319.13 - SANITARY DRAINS (continued):

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Name-plates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 **PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221319.13 - SANITARY DRAINS (continued):

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SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of electric, domestic-water heater.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS (continued):

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: One year.
 - b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. A. O. Smith Corporation.
 - b. Bradford White Corporation.
 - c. Lochinvar, LLC.
 - d. PVI: A WATTS Brand.
 - e. State Industries.
 - 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 - 3. Standard: UL 1453.
 - 4. Storage-Tank Construction: ASME-code, steel vertical arrangement.

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS (continued):

- a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) **NPS 2 (DN 50)** and Smaller: Threaded ends in accordance with ASME B1.20.1.
 - 2) **NPS 2-1/2 (DN 65)** and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: **150 psig (1035 kPa)**.
 - c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
5. Factory-Installed, Storage-Tank Appurtenances:
- a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - c. Insulation: Comply with ASHRAE/IES 90.1.
 - d. Jacket: Steel with enameled finish or high-impact composite material.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.
6. Special Requirements: NSF 5 construction.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **A. O. Smith Corporation.**
 - b. **AMTROL, Inc.**
 - c. **State Industries.**
 - d. **Taco Comfort Solutions.**
2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
4. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
5. Capacity and Characteristics:

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS (continued):

- a. Working-Pressure Rating: 150 psig (1035 kPa).
 - b. Capacity Acceptable: 2 gal. (7.6 L) minimum.
 - c. Air Precharge Pressure: 40 psig (275 kPa).
- B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.
- D. Heat-Trap Fittings: ASHRAE/IES 90.1.
- E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
- F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- G. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- H. Domestic-Water Heater Suspended Platform:
- 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide [Holdrite QuickStand 50-SWHP-WM](#) or approved equal.
 - 2. Corrosion-resistant metal platform not less than the base of the water heater for wall mounting, capable of supporting domestic-water heater and water. Platform shall have raised edge and NPS 1 metal drain fitting with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads to serve as a drain pan.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Division 03.
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS (continued):

- B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.11 "General Duty Valves for Domestic Water Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- E. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Domestic Water Piping."
- F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- G. Fill electric, domestic-water heaters with water.
- H. Charge domestic-water expansion tanks with air to required system pressure.
- I. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS (continued):

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- 3.5 DEMONSTRATION
- A. Train Owner's maintenance personnel to adjust, operate, and maintain electric, domestic-water heaters.

END OF SECTION 223300

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Urinals.
 - 3. Lavatories.
 - 4. Sinks.
 - 5. Water coolers, drinking fountains, and bottle filling stations.
 - 6. Bathtubs.
 - 7. Service sinks and basins.
 - 8. Outlet boxes.
 - 9. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures and accessories to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flush-o-meter-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.
 - 2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES (continued):

4. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size of water cooler indicated, but no fewer than one of each.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

A. Fixture (WC-#):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. TOTO USA, Inc.
 - d. Zurn Industries.

B. Accessories:

1. Flushometer: Valve or tank, as indicated on Drawings.
2. Toilet Seat: As indicated on Drawings.
3. Water Closet Carrier (for Wall-Mounted Applications):
 - a. ASME A112.6.1M, waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
 - b. Water-Closet Mounting Height: As indicated in drawings.

2.2 URINALS

A. Fixture (UR-#):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Sloan Valve Company.
 - d. TOTO USA, Inc.
 - e. Zurn Industries.

B. Accessories:

1. Flushometer Valve: As indicated on Drawings.
2. Urinal Carrier:
 - a. ASME A112.6.1M. with fixture support plates and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
 - b. Urinal Mounting Height: As indicated on Drawings.

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES (continued):

2.3 LAVATORIES

A. Fixture (LV-#):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard.
 - b. Bradley Corporation.
 - c. Kohler Co.
 - d. TOTO USA, Inc.
 - e. Zurn Industries.

B. Accessories:

1. Faucet: As indicated on Drawings.
2. Thermostatic Mixing Valve: As indicated on Drawings (for tempered water applications only).
3. Waste Fittings: As indicated on Drawings.
4. Supply Fittings:
 - a. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
 - b. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping and either wheel or cross handle operation.
 - c. Risers: ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.
5. Lavatory Carrier (for Wall-Mounted Applications):
 - a. ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel up-rights.
 - b. Lavatory Mounting Height: As indicated on Drawings.

2.4 SINKS

A. Fixture (SK-#):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Elkay Manufacturing Company.
 - b. Fiat Products.
 - c. Franke Group.
 - d. Just Manufacturing Company.

B. Accessories:

1. Faucet: As indicated on Drawings.
2. Thermostatic Mixing Valve: As indicated on Drawings.
3. Waste Fittings: As indicated on Drawings.
4. Supply Fittings:
 - a. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES (continued):

- b. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping and either wheel or cross handle operation.
 - c. Risers: ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.
- 5. Sink Carrier (for Wall-Mounted Applications):
 - a. ASME A112.6.1M, Type II, concealed-arm sink carrier with rectangular, steel uprights.
 - b. Sink Mounting Height: As indicated on Drawings.

2.5 WATER COOLERS, DRINKING FOUNTAINS, & BOTTLE FILLING STATIONS

A. Fixture (EWC-#, DF-#, or BFS-#):

- 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Elkay Manufacturing Co.
 - b. Halsey Taylor.
 - c. Haws Corporation.
 - d. Oasis International.

B. Accessories:

- 1. Faucet: As indicated on Drawings.
- 2. Waste Fittings: ASME A112.18.2 / CSA B125.2, brass P-trap.
- 3. Supply Fittings:
 - a. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
 - b. Supply Stops: Comply with requirements in Section 220523.12 "Ball Valves for Domestic Water Piping."
 - c. Supply Piping: ASME A112.18.1/CSA B125.1, copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- 4. Water Cooler Carrier:
 - a. ASME A112.6.1M with fixture support plates and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
 - b. Mounting Height: As indicated on Drawings.

2.6 SERVICE SINKS & BASINS

A. Fixture (MSB-#):

- 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Fiat Products.
 - b. Stern Williams Co., Inc.

B. Accessories:

- 1. Faucet: As indicated on Drawings.

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES (continued):

2. Rim Guard: As indicated on Drawings.
3. Flexible Hose: As indicated on Drawings.
4. Mop Hanger: As indicated on Drawings.
5. Waste Fittings: As indicated on Drawings.
6. Supply Fittings:
 - a. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
 - b. Supply Stops: Comply with requirements in Section 220523.12 "Ball Valves for Domestic Water Piping."
 - c. Supply Piping: ASME A112.18.1/CSA B125.1, copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

2.7 OUTLET BOXES

A. Icemaker Outlet Boxes (IMB):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. **Guy Gray; IPS Corporation.**
 - b. **Oatey.**
2. Mounting: Recessed.
3. Material and Finish: White powder-coated steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include **NPS 1/2 (DN 15)** or smaller copper tube outlet.
5. Accessory: Water hammer arrestor.
6. Supply Shutoff Fitting: **NPS 1/2 (DN 15)** gate, globe, or ball valve and **NPS 1/2 (DN 15)** copper, water tubing.

2.8 GROUT

- A. Standard: ASTM C 1107 / C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: **5000-psi (34.5-MPa)**, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES (continued):

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

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install water closets level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
4. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
5. Install supports, affixed to building substrate, wall-mounted water closets.
6. Use carrier supports with waste-fitting assembly and seal.
7. Install toilet seats on water closets.

B. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC / ANSI A117.1.
4. Install supports, affixed to building substrate, for wall-hung urinals.
5. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
6. Use carriers without waste fitting for urinals with tubular waste piping.
7. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flush-o-meter-Valve Installation:

1. Install flush-o-meter-valve, water-supply fitting on each supply to each water closet and urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flush-o-meter valves for accessible water closets and urinals with handle mounted on open side of compartment.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Lavatories:

1. Install lavatories level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install counter-mounting lavatories in and attached to casework.
4. Indicate on Drawing those lavatories that are required to be accessible.
5. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
6. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
7. Install traps on fixture outlets.
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719.14 "Insulation for ADA Plumbing Fixtures."

E. Sinks:

1. Install sinks level and plumb according to roughing-in drawings.

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES (continued):

2. Install supports, affixed to building substrate, for wall-hung sinks.
3. Install counter-mounting sinks in and attached to casework.
4. Indicate on Drawings those sinks that are required to be accessible.
5. Install accessible wall-mounted sinks at handicapped / elderly mounting height according to ICC/ANSI A117.1.
6. Set floor-mounted sinks in leveling bed of cement grout.
7. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
8. Install traps on fixture outlets.
9. Install unions on inlets and outlets of point-of-use sediment interceptors and dilution tanks.
10. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
11. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719.14 "Insulation for ADA Plumbing Fixtures."

F. Water Coolers, Drinking Fountains, and Bottle Filling Stations:

1. Set freestanding pressure water coolers on floor.
2. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
3. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
4. Install traps on fixture outlets.

G. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 06.

H. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

I. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Division 07.

3.3 CONNECTIONS

- A. Connect water closets and urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Connect lavatories, sinks, water coolers, and showers with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES (continued):

- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- E. Where installing piping adjacent to plumbing fixture, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning plumbing fixtures, accessories, fittings, and controls.
- B. Adjust water pressure at flush-o-meter valves and faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, accessories, and fittings with manufacturers' recommended cleaning methods and materials.
- C. Install protective covering for installed plumbing fixtures, accessories, and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224200

SECTION 230100 - GENERAL PROVISIONS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions of this Section apply to all Division 23 Specification Sections.

1.2 SUMMARY

- A. Section includes basic requirements for heating, ventilation, and air-conditioning systems.
- B. Related Work:
 - 1. Division 03 – Concrete
 - a. Refer to Division 03 for rough grouting in and around work, patching concrete cut to accommodate work, and sumps for work.
 - b. Comply with the requirements of Division 03 for curbs, foundations, inertia bases, and equipment pads for equipment.
 - 2. Division 05 – Metals
 - a. Refer to Division 05 for framed openings for equipment.
 - b. Comply with the requirements of Division 05 for supports for work.
 - 3. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 4. Division 07 – Thermal and Moisture Protection
 - a. Refer to Division 07 for installation of roof curbs and roof supports and for caulking and waterproofing of wall- and roof-mounted work.
 - b. Comply with the requirements of Division 07 for penetration firestopping and furnishing roof curbs and roof supports for equipment and piping.
 - 5. Division 08 – Openings
 - a. Refer to Division 08 for installation of access doors and frames and for louvers and vents.
 - b. Comply with the requirements of Division 08 for access doors and frames and for louvers and vents, unless otherwise included in the Contract Documents.
 - 6. Division 09 – Finishes
 - a. Refer to Division 09 for paint products and applications in finished spaces.
 - b. Comply with the requirements of Division 09 for paint products and applications identified in the Contract Documents.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

7. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
8. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
9. Division 22 – Plumbing
 - a. Refer to Division 22 for all plumbing work.
 - b. Comply with requirements of Division 22 for related equipment and components and for connections to systems.
10. Division 25 – Instrumentation and Control
 - a. Refer to Division 25 for instrumentation and control systems.
 - b. Comply with the requirements of Division 25 for installation of and integration with instrumentation and control components.
11. Division 26 – Electrical
 - a. Refer to Division 26 for all electrical work.
12. Division 27 – Communications
 - a. Refer to Division 27 for all communications work.
13. Division 28 – Electronic Safety and Security
 - a. Refer to Division 28 for all electronic safety and security work.
 - b. Coordinate with Division 28 for integration with security systems.
14. Division 29 – Fire Safety and Emergency Communications
 - a. Refer to Division 29 for all fire safety and emergency communications work.
 - b. Coordinate with Division 29 for integration with fire safety and emergency communications systems.
15. Division 31 – Earthwork
 - a. Refer to Division 31 for all site related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 31 for site clearing, earth moving, and dewatering within five feet outside the building and otherwise as indicated in the Contract Documents.
16. Division 33 – Utilities
 - a. Refer to Division 33 for all utility related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 33 for utility work within five feet outside the building and otherwise as indicated in the Contract Documents.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, “experienced” unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Furnish: Supply and deliver to project site, ready for subsequent requirements.
- C. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
- D. Provide: Furnish and install, complete and ready for intended use.
- E. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- F. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.
- G. Concealed Work: Work hidden from view, including inside chases, furred spaces, **or above ceilings**.
- H. Exposed Work: Work open to view, including inside mechanical and equipment rooms.

1.4 QUALITY ASSURANCE

- A. General:
 - 1. It is the intent of the plans and specifications to obtain a complete, operable and satisfactory installation.
 - 2. All materials shall be new, be properly labeled and/or identified and be in full compliance with the contract documents.
 - 3. All work shall comply with applicable Codes and Standards.
 - 4. Manufacturer's model names and numbers used in these specifications are subject to change per manufacturer's action. Contractor shall therefore verify them with manufacturer's representative before ordering any product or equipment
- B. Furnish new and unused materials and equipment manufactured in the U.S.A. Where two or more units of the same type or class of equipment are required provide units of a single manufacturer.

1.5 CODES AND STANDARDS

- A. Perform work in accordance with the following codes and any applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
 - 1. ASHRAE
 - a. Standard 15 Safety Standard for Refrigeration Systems - 2019
 - b. Standard 55 Thermal Environmental Conditions for Human Occupancy – 2017
 - c. Standard 62.1 Ventilation Standard for Acceptable Indoor air Quality - 2019
 - d. Standard 90.1 Energy Standard for Buildings Except Low Rise Residential Buildings - 2019

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

2. Occupational Safety and Health Regulations (OSHA).
 3. National Fire Codes
 - a. NFPA 70 National Electrical Code – 2020
 - b. NFPA 90A Standard for the Installation of Air Conditioning and Ventilation Systems - 2021
 - c. NFPA 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems - 2021
 - d. NFPA 91 Standard for the Installation of Blower and Exhaust Systems - 2020
 - e. NFPA 101 Life Safety Code – 2021 (Florida Edition)
 4. Florida Building Code, 2023 Edition
 - a. Building Code
 - b. Energy Conservation Code
 - c. Mechanical Code
 - d. Plumbing Code
 - e. Accessibility Code
 5. Florida Statutes
 - a. Chapter 471 Engineering
 - b. Chapter 533.80 Building Construction Standards; Florida Building Code - Enforcement
 6. Florida Administrative Code
 - a. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - b. Chapter 61G15-34 Responsibility Rules of Professional Engineers Concerning the Design of Mechanical Systems
 - 7.
- B. Resolve, in writing, any code violation discovered in contract documents with the Engineer prior to bidding. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. The Contractor shall include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and drawings required to comply with all applicable laws, ordinances, rules, and regulations.
- D. Where there is conflict between the Contract Documents and the applicable Codes, the Codes shall govern, except where the requirements of the Contract Documents are more stringent.
- 1.6 **REFERENCE SPECIFICATIONS AND STANDARDS**
- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments, or supplements in effect on date bids are received. Specifications and standards are minimum requirements for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
- B. Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition of the standard at the time project is bid unless otherwise specified herein

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

1.7 DELEGATED-DESIGN SERVICES

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

1.8 PERMITS FEES AND INSPECTIONS

- A. Obtain and pay for all permits, fees, tap fees, connection charges, demand charges, systems charges, impact fees, and inspections.
- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.9 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
 - 1. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer in writing prior to bid date; however, the most stringent requirement shall govern.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.10 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 - 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Prepare RFIs as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 - 1. The following Contractor-generated RFIs will be returned without action:

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

- a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.

1.11 SUBMITTALS

- A. Submittals (including Product Data, Shop Drawings, and any other Action Submittal or Information Submittal) will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions, Division 01, and the following:
1. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are approved by the Engineer.
 3. Submittals shall only contain relevant product data. Remove or strikeout irrelevant product data.
 4. Prepare submittals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
 5. Options: Identify options requiring selection by Engineer.
 6. Deviations: Clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 7. Revisions: Include relevant additional information and revisions, other than those specifically requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached submittal sheet.
 8. Contractor's Review:
 - a. Submittals shall have been reviewed and approved by the General Contractor / Construction Manager. Include approval stamp, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - b. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.
 9. Electrical Modifications:
 - a. The electrical design indicated on the plans supports the Basis of Design specifications for the HVAC systems at the time of design.
 - b. If HVAC equipment is submitted with different electrical requirements, it is the responsibility of the Contractor to resolve all required electrical design changes, including, but not limited to: wire and conduit size, type or size of disconnect or overload protection, breaker coordination, point(s) of connection, etc. Any corrections required shall be provided at no additional cost.
 - c. Submittal shall clearly show the electrical design revisions with a written statement that this change will be provided at no additional cost. Submittals made with no written reference to the electrical design revisions will be presumed to work with the electrical design.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

- B. Processing Time: Time of review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of the failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Allow not less than 15 days for submittal review. Allow not less than 21 days for review of large or complex submittals. Submittals received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 2. If Contractor transmits more than five submittals over two consecutive business days, review time shall increase by no less than 7 days for submittal review.
 3. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 4. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received. Time of review shall commence on receipt of all other related submittals.
- C. The Contractor shall not be relieved of responsibility for deviations from requirements of the contract documents by the Engineer's approval of shop drawings, product data, samples, or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal, and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in shop drawings, product data, samples, or similar submittals by the Engineer's approval thereof.
- D. Submittal Review Fees:
1. Additional Reviews: Submittals on any particular phase of Work will receive only one review and one re-review (if required). If additional reviews are required beyond these two, the Contractor will be charged \$200.00 per hour for review time, in addition to any expedited review charges. This fee shall be paid to the Engineer prior to Submittal release.
 2. Expedited Reviews: If General Contractor / Construction Manager requests for an expedited review, whether by official request or unofficially by assigning a review time less than required above, the General Contractor / Construction Manager will be charged \$1,000.00 per Submittal, in addition to any charges for additional reviews. This fee shall be paid to the Engineer prior to Submittal release.

1.12 COORDINATION DRAWINGS (NOT REQUIRED)

- A. Should the Contractor elect to provide Coordination Drawings when not expressly required by the Engineer, such Drawings shall be considered for informational purposes only. The Engineer will not conduct a review of these Drawings, and their submission or any implied approval shall not relieve the Contractor of the obligation to fully comply with the requirements set forth in the Construction Documents. The Contractor remains solely responsible for ensuring that all work meets the contract specifications and standards, regardless of the content or status of the Coordination Drawings.

1.13 SUBSTITUTIONS

- A. By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Substitution Requests shall include, at a minimum:

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

1. Statement indicating why specified material, equipment, or installation method cannot be provided, if applicable.
 2. Coordination of information, including a list of changes and revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 3. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include an annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 5. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 6. Cost information, including a proposal of change, if any, in the Contract Sum.
 7. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 8. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- C. Procurement Substitution Requests submitted prior to receipt of bids will be received and considered by Owner when the following conditions are satisfied, as determined by Engineer; otherwise, requests will be returned without action:
1. Requests for substitution of materials and equipment are received no later than 10 days prior to date of bid opening.
 2. Extensive revisions to the Contract Documents are not required.
 3. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
 4. The request is fully documented and properly submitted.
- D. Substitutions for Cause, as required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms will be received and considered by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 2. Substitution request is fully documented and properly submitted.
 3. Requested substitution has received necessary approvals of authorities having jurisdiction.
 4. Requested substitution is compatible with other portions of the Work.
 5. Requested substitution has been coordinated with other portions of the Work.
 6. Requested substitution provides specified warranty.
 7. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- E. Substitutions for Convenience, not required in order to meet other Project requirements but may offer advantage to Contractor or Owner, will be received and considered by Owner, as determined by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

1. Requested substitution is received within 60 days after the Notice of Award.
2. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
3. Requested substitution does not require extensive revisions to the Contract Documents.
4. Requested substitution is consistent with the Contract Documents and will produce indicated results.
5. Substitution request is fully documented and properly submitted.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.
10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

- F. If a requested substitution is approved but contains differences or omissions not specifically identified to the attention of the Engineer in the substitution request, the Owner reserves the right to require equal or similar features to be added to the substituted products or to have the substituted products replaced at the Contractor's expense.

1.14 PROJECT RECORD DOCUMENTS

- A. Recording: Maintain one copy of the Contract Documents and Shop Drawings during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation:
1. Contract Drawings and Shop Drawings:
 - a. Mark revisions to show where the actual installation varies from that shown originally.
 - b. Mark record sets completely and accurately, including important information that was either shown schematically or omitted from original Drawings.
 - c. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - d. Record underground and under-slab piping installed, dimensioning exact location and elevation of piping.
 2. Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 3. Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
- C. Deliver: Prior to Final Completion, provide record documents to Owner as indicated below:
1. Record Drawings: Submit PDF electronic files of scanned record prints and one set of prints.
 2. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
 3. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 4. Miscellaneous Record Submittals: Submit annotated PDF electronic files directories of each submittal.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

1.15 OPERATION AND MAINTENANCE MANUALS

- A. Prepare and submit a comprehensive manual of emergency, operation, and maintenance data and materials in full accordance with the General and Supplementary Conditions, Division 01, and the following:
 - 1. Operations and Maintenance Manuals: Assemble a complete set of data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system, including:
 - a. Information required for daily operation and management, operating standards, and routine and special operating procedures.
 - b. Manufacturers' maintenance documentation, preventative maintenance procedures and frequency, repair procedures, wiring and systems diagrams, list of spare parts, and warranty information.
 - 2. Submit manuals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. Submittals shall be in searchable PDF format and not a scanned copy.

1.16 DEMONSTRATION AND TRAINING

- A. Prepare and provide services of qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system in accordance with the General and Supplementary Conditions, Division 01, individual Specification Sections, and the following:
 - 1. Demonstration and training shall occur upon completion of the Work and at a time designated by the Owner's representative.
 - 2. Provide a high-resolution, digital video recording of each training session to the Owner.

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

1.18 WARRANTY

- A. Warranty work and equipment within specified warranty period. During the warranty period, provide labor and materials to make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship without expense to the Owner.
 - 1. Warranty Period: One year from date of Substantial Completion.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
- C. Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving the Contractor of responsibilities during the warranty period.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

PART 2 - PRODUCTS (NONE)

PART 3 - EXECUTION

3.1 CONTRACT DOCUMENTS

- A. Examine all drawings and specifications carefully before submitting a bid. **Architectural drawings take precedence over mechanical or electrical drawings with reference to building construction.**
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.
- C. The drawings indicate required size and points of termination of pipes, conduits, and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the responsibility of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.
- E. Any and all questions about a subcontractor's scope of work responsibility shall be addressed to and answered by the General Contractor / Construction Manager.
- F. Questions About Construction Documents: Any and all questions shall be submitted through the proper channels IN WRITING and, in turn, shall be answered by the Engineer in writing. All telephone conversations shall be considered unofficial and, as such, shall not be considered official or binding responses to Contractor's questions.
- G. Drawings, specifications, or other documents issued by the Engineer in electronic format and/or electronic media are provided for convenience only and are not intended for use as Contract Documents.
 - 1. The electronic files are provided merely as a convenience to the Recipient.
 - 2. The electronic files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.
 - 3. The Engineer makes no representation, warranty, or guarantee that electronic files:
 - a. Are suitable for any other usage or purpose.
 - b. Have any particular durability.
 - c. Will not damage or impair the Recipient's computer or software.
 - d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.
 - 4. Due to the unsecured nature of the electronic files and the inability of Engineer or the Recipient to establish controls over their use, the Engineer assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained therein. The Recipient shall at all times refer to the signed and sealed drawings, specification or other documents for the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of the electronic files.

3.2 SUPERVISION OF WORK

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

- A. Perform all work under the direct supervision of an experienced, qualified superintendent. The Engineer has the right to remove a superintendent who, in the Engineer's opinion, is not satisfactory.

3.3 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.4 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.
- E. Interruption of Service: Before any existing equipment or system is shut down for disconnecting or tie-ins, coordinate with Engineer and Owner regarding acceptable dates and times for this Work to be performed. Work shall be performed at the time best suited for the Owner, which typically is either on weekends, holidays, and/or after normal working hours. Services shall be restored the same day unless prior arrangements are made. All overtime or premium costs associated with this Work shall be included in the Contractor's bid.

3.5 INSTALLATION

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

- A. Install materials and equipment in a professional manner. The Engineer may direct replacement of items which, in the Engineer's opinion, do not present a professional appearance or do not allow adequate space for maintenance. Replace or reinstall items at the expense of the Contractor.
- B. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- C. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- D. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- G. Obstructions
 - 1. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
 - 2. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
 - 3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
 - 4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.
- H. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof, or ceiling to the satisfaction of the authority having jurisdiction.
- I. Structural Elements: Do not cut structural elements without written approval from Engineer. Notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. If approved by Engineer:
 - 1. Shore, brace, and support structural elements during cutting and patching.
 - 2. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- J. Space Requirements: Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

- K. Tools and Equipment: Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.
- L. Phasing: Provide all temporary valves, piping, ductwork, equipment, and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.6 OWNER-INSTALLED PRODUCTS

- A. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

3.7 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- F. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
- G. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- H. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- I. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- J. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable or with in-place materials.
1. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 2. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.
- K. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.8 PAINTING

- A. Comply with requirements with General and Supplementary Conditions, Division 01, Division 09, and individual Specification Sections.
- B. Touch-up factory finishes on equipment provided under Division 23. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.
- C. Paint the following work where exposed to view:
1. Uninsulated Metal Piping (bare copper piping not required to be painted unless noted otherwise):
 - a. Other: To be determined by Engineer
 2. Uninsulated plastic piping
 3. Tanks that do not have factory-applied final finishes.
 4. Duct, equipment, and pipe insulation having a cotton or canvas insulation covering or other paintable jacket material, as outlined in individual Specification Sections.
- D. Paint the following work where exposed in occupied spaces:
1. Duct, equipment, and pipe insulation having a cotton or canvas insulation covering or other paintable jacket material, as outlined in individual Specification Sections.
 2. Other items as directed by Engineer.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

- E. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.9 REPAIR OF WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

3.10 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Furnish a letter from an authorized factory representative of the air conditioning unit manufacturer stating that the complete refrigeration installation including pipe sizing and routing and operating and safety controls has been checked and is operating properly.
- C. Tests
 - 1. Include all tests specified and/or required under laws, rules and regulations of all departments having jurisdiction. Tests shall also be performed as indicated herein and other sections of the specifications.
 - 2. After all systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems.
 - 3. All parts of the work and associated equipment shall be tested and adjusted to work properly and be left in perfect operating condition.
 - 4. Correct defects disclosed by these tests without any additional cost to the Owner. Repeat tests on repaired or replaced work.
 - 5. Maintain a log of all tests being conducted and have it available for review by the Engineer. Log to indicate date, type of tests, duration, and defects noted and when corrected.
 - 6. Special tests on individual systems are specified under individual Specification Sections.
- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

3.11 CLEANING

- A. Progress Cleaning: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Final Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove labels that are not permanent.
 - c. Wipe surfaces of equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

END OF SECTION 230100

SECTION 230100 - GENERAL PROVISIONS FOR HVAC (continued):

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT (continued):

- C. Service Factor: 1.15.
- D. Power factor: 0.80.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
- B. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- C. Motors 1/20 HP and Smaller: Shaded-pole type.
- D. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT (continued):

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT (continued):

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SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Grout.
 - 3. Silicone sealants.
- B. Related Requirements:
 - 1. Division 07 for penetration Firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 GROUT

- A. Description: Non-shrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING (continued):

- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, non-traffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
 - 1. Sealant shall have a VOC content of 250 g/L or less.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and non-traffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
 - 1. Sealant shall have a VOC content of 250 g/L or less.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
 - 1. Sealant shall have a VOC content of 250 g/L or less.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- C. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
- D. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING (continued):

pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified Division 07.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than **NPS 6 (DN 150)**: Steel pipe sleeves.
 - b. Piping **NPS 6 (DN 150)** and Larger: Steel pipe sleeves.
 - 2. Interior Partitions:
 - a. Piping Smaller Than **NPS 6 (DN 150)**: Steel pipe sleeves .

END OF SECTION 230517

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING (continued):

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SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and polished brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Insulated Piping: One-piece stamped steel with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING (continued):

- d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
- e. Bare Piping in Unfinished Service Spaces: One-piece cast brass with rough-brass finish.
- f. Bare Piping in Equipment Rooms: One-piece cast brass with rough-brass finish.

3.2 **FIELD QUALITY CONTROL**

- A. Using new materials, replace broken and damaged escutcheons.

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Insulation couplings.
 - 6. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Insulation couplings.
 - 5. Equipment supports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC (continued):

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Cooper B-Line, Inc.](#)
 - b. [Flex-Strut Inc.](#)
 - c. [Unistrut Corporation](#); Tyco International, Ltd.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Electroplated zinc indoors and Hot-dip galvanized outdoors.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC (continued):

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dip galvanized.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 INSULATION COUPLINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide [FNW; Ferguson Enterprises, Inc.](#); Figure 7897 (flexible elastomeric insulation) / Figure 7899 (mineral fiber insulation) or a comparable product by one of the following:
 1. [Eaton.](#)
 2. [Unistrut; Part of Atkore International.](#)
- B. Description: Insulation coupling designed to support insulated pipes and for use with metal framing system mounted clamps and either flexible elastomeric or mineral fiber insulation.
- C. Material: Molded with high-strength thermoplastic.
- D. UL Classified 2043 for use in plenum and air handling systems.
- E. Temperature Rating: **-60 deg F to +225 deg F.**

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MATERIALS

- A. Aluminum: **ASTM B 221** (**ASTM B 221M**).
- B. Carbon Steel: ASTM A 1011 / A 1011M.
- C. Structural Steel: ASTM A 36 / A 36M, carbon-steel plates, shapes, and bars; galvanized.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC (continued):

- D. Stainless Steel: ASTM A 240 / A 240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Grout: ASTM C 1107 / C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: **5000-psi (34.5-MPa)**, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Division 07 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb (90 kg)**.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36 / A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1 / D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than **4 inches (100 mm)** thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC (continued):

- G. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **NPS 2-1/2 (DN 65)** and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
 - 1. Install insulation couplings for pipes mounted to metal framing systems based on pipe size and insulation material. Arrange for grouping of parallel runs of piping and support together on metal framing system.
 - a. Flexible Elastomeric Insulation: For pipe **NPS 4 (DN 100)** and Smaller
 - b. Mineral Fiber Insulation: For pipe **NPS 4 (DN 100)** and Smaller
 - 2. Install MSS SP-58, Type 40, protective shields on piping not using insulation couplings. Shields shall span an arc of 180 degrees. Secure shield to pipe on both ends with stainless steel bands.
 - 3. Shield Dimensions for Pipe: Not less than the following:
 - a. **NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm)** long and **0.048 inch (1.22 mm)** thick.
 - b. **NPS 4 (DN 100): 12 inches (305 mm)** long and **0.06 inch (1.52 mm)** thick.
 - c. **NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm)** long and **0.06 inch (1.52 mm)** thick.
 - d. **NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm)** long and **0.075 inch (1.91 mm)** thick.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC (continued):

- C. Field Welding: Comply with AWS D1.1 / D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to **1-1/2 inches (40 mm)**.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils (0.05 mm)**.
- B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780 / A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC (continued):

- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes **NPS 1/2 to NPS 30 (DN 15 to DN 750)**.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24 (DN 15 to DN 600)** if little or no insulation is required.
 - 3. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36 (DN 100 to DN 900)**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 4. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes **NPS 2-1/2 to NPS 24 (DN 65 to DN 600)**, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 5. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42 (DN 50 to DN 1050)** if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers **NPS 3/4 to NPS 24 (DN 24 to DN 600)**.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- L. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC (continued):

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SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Elastomeric hangers.
 - 4. Spring hangers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For each vibration isolation device.
 - 1. Include design calculations for designing vibration isolation bases.
 - 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind restraints and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - 3. Wind-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings.

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC (continued):

Identify components, list their strengths, and indicate directions and values of forces. Indicate association with vibration isolation devices.

- c. Coordinate wind-restraint details with requirements in other Sections for equipment mounted outdoors.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Mason Industries, Inc.; Mason Super W or comparable product by one of the following:
 - a. **Kinetics Noise Control, Inc.**
 - b. **Vibration Mountings & Controls, Inc.**
 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 3. Size: Factory or field cut to match requirements of supported equipment.
 4. Pad Material: Oil and water resistant with elastomeric properties.
 5. Surface Pattern: Waffle pattern.

2.2 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Mason Industries, Inc.; Mason ND or comparable product by one of the following:
 - a. **Kinetics Noise Control, Inc.**
 - b. **Vibration Mountings & Controls, Inc.**
 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC (continued):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Mason Industries, Inc.; Mason HD or comparable product by one of the following:
 - a. **Kinetics Noise Control, Inc.**
 - b. **Vibration Mountings & Controls, Inc.**
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Mason Industries, Inc.; HS-B or comparable product by one of the following:
 - a. **Kinetics Noise Control, Inc.**
 - b. **Vibration Mountings & Controls, Inc.**
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC (continued):

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Ceiling marker labels.
 - 3. Pipe labels.
 - 4. Valve tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.
- E. Control System Diagrams and Descriptions: For each control system to include in maintenance manuals.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT (continued):

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number.
- C. Equipment Label Schedule: For each item of equipment to be labeled, tabulate equipment label information. Equipment schedule shall be included in operation and maintenance data.

2.2 CEILING MARKER LABELS

- A. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
- B. Letter Color: Black.
- C. Background Color: Clear.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- E. Minimum Letter Size: 1/2 inch (13 mm).
- F. Label Content: Include either the equipment tag identifier or a clear description of the concealed component, along with the system or service abbreviation. Label content shall match identifiers shown on Drawings or be descriptive enough for field recognition and maintenance access.
1. System of Service Abbreviations: " HVAC".

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT (continued):

1. Tag Material: Brass, **0.032-inch (0.8-mm)** minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- B. Valve Schedules: For each piping system, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 CEILING MARKER LABEL INSTALLATION

- A. Apply labels for each concealed major item of mechanical equipment or component requiring service or maintenance.
- B. Align labels neatly, parallel to ceiling edges or panel orientation.
- C. Apply after ceiling installation and verification of concealed item locations.
- D. Do not install labels on surfaces subject to frequent replacement or repainting without coordination.
- E. Locate ceiling marker labels where accessible and visible.
- F. Application Locations:
1. Suspended Acoustical Tile Ceilings (ACT):

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT (continued):

- a. Apply label to the face of the ceiling grid tee directly adjacent to or centered over the concealed item.
 - b. If grid location is not feasible, affix to accessible tile surface, avoiding any tile likely to be replaced or removed.
2. Gypsum Board or Hard-Lid Ceilings with Access Panels:
 - a. Apply label directly to the surface of the access panel.
 - b. Label shall be centered, upright, and clearly legible from floor level.
3. Exposed Ceilings or Open Structures:
 - a. Apply label to the nearest permanent building surface or equipment mounting plate visible from below.
 - b. If no surface is available, affix to suspended tag or placard mounted below the item.
4. Multiple Components at Single Access Location:
 - a. Use a single label listing all concealed components above the ceiling at that location, aligned vertically or in column format.
 - b. Use consistent labeling format and spacing.

3.5 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of **50 feet (15 m)** along each run. Reduce intervals to **25 feet (7.6 m)** in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions. Install marker tape with arrows around the entire circumference of the pipe at the beginning and end of the pipe-label content.
- C. Pipe Label Color Schedule:
 1. Refrigerant Piping: Black letters on a safety-orange background.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT (continued):

- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape: 1-1/2 inches (38 mm), round
 2. Valve-Tag Colors:
 - a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
 - b. Flammable Fluids: Black letters on a safety-yellow background.
 - c. Combustible Fluids: White letters on a safety-brown background.
 - d. Potable and Other Water: White letters on a safety-green background.
 - e. Compressed Air: White letters on a safety-blue background.
 - f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

END OF SECTION 230553

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT (continued):

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - 2.
 - 3. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Condensing units.
 - 4. Sound tests.
 - 5. Vibration tests.
 - 6. Duct leakage tests.
 - 7. Control system verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.
- H. Special Inspector: An entity engaged to inspect smoke control systems.

1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Report Format Submittals: Within 60 days of Contractor's Notice to Proceed, submit the following as specified in "Preparation" Article.
 1. TAB strategies and step-by-step procedures.
 2. System readiness checklists.
- C. Certified TAB reports: Submit a minimum of 14 days prior to scheduled Substantial Completion.

1.6 INFORMATIONAL SUBMITTALS

- A. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- B. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- C. Instrument calibration reports, to include the following:
 1. Instrument type and make.
 2. Serial number.
 3. Application.
 4. Dates of use.
 5. Dates of calibration.

1.7 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC or NEBB.
 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB. A TAB Field Supervisor shall be on the project site at all times during TAB work and shall have a minimum three years' of TAB experience with air, water, sound, and vibration testing.
 - a. NEBB: Certified Professional (TAB-CP) or Certified Technician (TAB-CT).
 - b. AABC: Certified Test and Balance Engineer (TBE) or Certified Technician.
 2. TAB Technician: Employee of the TAB specialist and certified by AABC or NEBB as a TAB technician.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- a. NEBB: Certified Technician (TAB-CT).
 - b. AABC: Certified Technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- E. Warranty: Comply with the program requirements of either:
 - 1. AABC National Performance Guaranty.
 - 2. NEBB Conformance Certification.

1.8 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.9 TAB CONTRACTOR'S RESPONSIBILITIES

- A. Attend testing, adjusting, and balancing review and coordination meeting.
- B. Participate in verification of the TAB report by the CxA or Engineer for verification and diagnostic purposes.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one of the following:
 - 1. FTS Test and Balance
 - a. Location: Tallahassee, Florida
 - b. Contact: Heath Allbaugh, CP
 - c. Phone Number: (850) 519-7845
 - 2. HVAC Testing Services, Inc.
 - a. Location: Thomasville, Georgia
 - b. Contact: Greg Lang, CP / Pete Lang

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- c. Phone Number: (229) 227-0255
- 3. Indoor Air Professionals, Inc.
 - a. Location: Fort Myers, Florida
 - b. Contact: Joseph Molloy, III, CP
 - c. Phone Number: (239) 707-9732
- 4. Dynamic Analysis, Inc.
 - a. Location: Pensacola, Florida
 - b. Contact: Brian Barr, CP
 - c. Phone Number: (850) 492-8325
- 5. W.W. Gay Mechanical
 - a. Location: Jacksonville, Florida
 - b. Contact: Don Eshelman, CP
 - c. Phone Number: (904) 394-7298

3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Project specific forms with specific identification for all equipment and systems. Project specific forms shall include design data for all equipment and systems to be tested and descriptions of any other necessary supporting data required in the final report that will be included (i.e. fan/pump curves, layout drawings, balancing valve charts, etc).
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" , and in this Section.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
 6. Determine and make appropriate modifications for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Re-adjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.
 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 6. Measure and record all operating data.
 7. Record final fan-performance data.

3.7 PROCEDURES FOR MOTORS

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.8 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.
- B. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.

3.10 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

3.11 CONTROLS VERIFICATION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- A. In conjunction with system balancing, perform the following:
 - 1. Verify temperature control system is operating within the design limitations.
 - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 - 3. Verify that controllers are calibrated and function as intended.
 - 4. Verify that controller set points are as indicated.
 - 5. Verify the operation of lockout or interlock systems.
 - 6. Verify the operation of valve and damper actuators.
 - 7. Verify that controlled devices are properly installed and connected to correct controller.
 - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.12 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.13 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
 - 4. Include warranty certificate meeting the requirements of one of the following programs:
 - a. AABC – National Performance Guaranty

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- b. NEBB – Conformance Certification
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Fan curves, marked with operating conditions.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 14. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Pipe and valve sizes and locations.
 - 4. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in **inches (mm)**, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in **inches (mm)**, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in **cfm (L/s)**.
 - b. Total system static pressure in **inches wg (Pa)**.
 - c. Fan rpm.
 - d. Discharge static pressure in **inches wg (Pa)**.
 - e. Filter static-pressure differential in **inches wg (Pa)**.
 - f. Preheat-coil static-pressure differential in **inches wg (Pa)**.
 - g. Cooling-coil static-pressure differential in **inches wg (Pa)**.
 - h. Heating-coil static-pressure differential in **inches wg (Pa)**.
 - i. Outdoor airflow in **cfm (L/s)**.
 - j. Return airflow in **cfm (L/s)**.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
- a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in **fins per inch (mm) o.c.**
 - f. Make and model number.
 - g. Face area in **sq. ft. (sq. m)**.
 - h. Tube size in **NPS (DN)**.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
- a. Airflow rate in **cfm (L/s)**.
 - b. Average face velocity in **fpm (m/s)**.
 - c. Air pressure drop in **inches wg (Pa)**.

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC (continued):

- d. Outdoor-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
 - e. Return-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
 - f. Entering-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
 - g. Leaving-air, wet- and dry-bulb temperatures in **deg F (deg C)**.
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in **psig (kPa)**.
 - j. Refrigerant suction temperature in **deg F (deg C)**.
- G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in **Btu/h (kW)**.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in **cfm (L/s)**.
 - i. Face area in **sq. ft. (sq. m)**.
 - j. Minimum face velocity in **fpm (m/s)**.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in **Btu/h (kW)**.
 - b. Airflow rate in **cfm (L/s)**.
 - c. Air velocity in **fpm (m/s)**.
 - d. Entering-air temperature in **deg F (deg C)**.
 - e. Leaving-air temperature in **deg F (deg C)**.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in **inches (mm)**, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in **inches (mm)**.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in **inches (mm)**, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in **inches (mm)**.

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- g. Number, make, and size of belts.
 - h. Belt tension in lbs.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in **cfm** (L/s).
 - b. Total system static pressure in **inches wg** (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in **inches wg** (Pa).
 - e. Suction static pressure in **inches wg** (Pa).
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in **deg F** (deg C).
 - d. Duct static pressure in **inches wg** (Pa).
 - e. Duct size in **inches** (mm).
 - f. Duct area in **sq. ft.** (sq. m).
 - g. Indicated airflow rate in **cfm** (L/s).
 - h. Indicated velocity in **fpm** (m/s).
 - i. Actual airflow rate in **cfm** (L/s).
 - j. Actual average velocity in **fpm** (m/s).
 - k. Barometric pressure in **psig** (Pa).
- J. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in **sq. ft.** (sq. m).
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in **cfm** (L/s).
 - b. Air velocity in **fpm** (m/s).
 - c. Preliminary airflow rate as needed in **cfm** (L/s).
 - d. Preliminary velocity as needed in **fpm** (m/s).
 - e. Final airflow rate in **cfm** (L/s).
 - f. Final velocity in **fpm** (m/s).
 - g. Space temperature in **deg F** (deg C).
- K. Instrument Calibration Reports:

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1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.15 VERIFICATION OF TAB REPORT

- A. At Engineer's option, **Engineer** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- B. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- C. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- D. If TAB work fails, proceed as follows:
 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty or NEBB Headquarters regarding the NEBB Conformance Certification.
- E. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply, return, and outdoor air.
 - 2. Indoor, exposed supply, return, and outdoor air.
 - 3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- B. Related Sections:
 - 1. Section 233113.11 "Metal Ducts for General HVAC" for duct liners.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings:
 - 1. Detail application for each type of insulation and hanger.
 - 2. Detail insulation application for each type of insulation.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," and "Indoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [CertainTeed Corp.; Commercial Board.](#)
 - b. [Johns Manville; 800 Series Spin-Glas.](#)
 - c. [Knauf Insulation; Insulation Board.](#)
 - d. [Owens Corning; Fiberglas 700 Series.](#)
- H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied **ASJ and FSK** jacket complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is **2.5 lb/cu. ft. (40 kg/cu. m)** or more. Thermal conductivity (k-value) at **100 deg F (55 deg C)** is **0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K)** or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [CertainTeed Corp.; CrimpWrap.](#)
 - b. [Johns Manville; MicroFlex.](#)
 - c. [Knauf Insulation; Pipe and Tank Insulation.](#)
 - d. [Owens Corning; Fiberglas Pipe and Tank Insulation.](#)

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.](#)
 - b. [Eagle Bridges - Marathon Industries; 225.](#)
 - c. [Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.](#)
 - d. [Mon-Eco Industries, Inc.; 22-25.](#)
 2. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. **Products:** Subject to compliance with requirements, provide one of the following:

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- a. [Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.](#)
 - b. [Eagle Bridges - Marathon Industries; 225.](#)
 - c. [Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.](#)
2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
 1. VOC Content: 50 g/L or less.
 2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.](#)
 - b. [Vimasco Corporation; 749.](#)
 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).**
 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Childers Brand; H. B. Fuller Construction Products; CP-10.](#)
 - b. [Eagle Bridges - Marathon Industries; 550.](#)
 - c. [Foster Brand; H. B. Fuller Construction Products; 46-50.](#)
 - d. [Mon-Eco Industries, Inc; 55-50.](#)
 2. [Vimasco Corporation; WC-1/WC-5.](#)Water-Vapor Permeance: ASTM E96, greater than **1.0 perm (0.66 metric perms)** at manufacturer's recommended dry film thickness.
 3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).**
 4. Color: White.

2.4 SEALANTS

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

A. FSK Flashing Sealants:

1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - c. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F** (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. ASJ Flashing Sealants:

1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F** (Minus 40 to plus 121 deg C).
5. Color: White.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

- ### **A. Woven Glass-Fiber Fabric: Approximately **6 oz./sq. yd.** (203 g/sq. m) with a thread count of **5 strands by 5 strands/sq. in.** (2 strands by 2 strands/sq. mm) for covering ducts.**
1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- a. [Childers Brand; H. B. Fuller Construction Products; Chil-Glas Number 5.](#)

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [ABI, Ideal Tape Division](#); 428 AWF ASJ.
 - b. [Avery Dennison Corporation](#), Specialty Tapes Division; Fasson 0836.
 - c. [Compac Corporation](#); 104 and 105.
 2. [Venture Tape](#); 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ Width: **3 inches (75 mm)**.
 3. Thickness: **11.5 mils (0.29 mm)**.
 4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [ABI, Ideal Tape Division](#); 491 AWF FSK.
 - b. [Avery Dennison Corporation](#), Specialty Tapes Division; Fasson 0827.
 - c. [Compac Corporation](#); 110 and 111.
 - d. [Venture Tape](#); 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 2. Width: **3 inches (75 mm)**.
 3. Thickness: **6.5 mils (0.16 mm)**.
 4. Adhesion: **90 ounces force/inch (1.0 N/mm)** in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: **40 lbf/inch (7.2 N/mm)** in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.9 SECUREMENTS

- A. Bands:
 1. Aluminum: **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005; Temper H-14, **0.020 inch (0.51 mm)** thick, **1/2 inch (13 mm)** wide with wing seal.
 2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Midwest Fasteners, Inc.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, **0.030 inch (0.76 mm)** thick by **2 inches (50 mm)** square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Insulation-Retaining Washers: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than **1-1/2 inches (38 mm)** in diameter.
 - a. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal **3/4-inch- (19-mm-) wide, stainless steel or Monel.**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with **3-inch- (75-mm-)** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches (100 mm)** o.c.
 - 3. Overlap jacket longitudinal seams at least **1-1/2 inches (38 mm)**. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **4 inches (100 mm)** o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches (100 mm)** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least **2 inches (50 mm)**.
 - 1. Comply with requirements in Division 07.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.
 - 1. Install metal, adhesively attached, perforated-base insulation hangers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions **18 inches (450 mm)** and smaller, place pins along longitudinal centerline of duct. Space **3 inches (75 mm)** maximum from insulation end joints, and **16 inches (400 mm)** o.c.
 - b. On duct sides with dimensions larger than **18 inches (450 mm)**, place pins **16 inches (400 mm)** o.c. each way, and **3 inches (75 mm)** maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing **2 inches (50 mm)** from one edge and one end of insulation segment. Secure laps to adjacent insulation section with **1/2-inch (13-mm)** outward-clinching staples, **1 inch (25 mm)** o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, field-applied fabric-reinforcing mesh, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with mastic to maintain vapor-barrier seal.

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
 3. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
 4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Install metal, adhesively attached, perforated-base insulation hangers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, field-applied fabric-reinforcing mesh, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
 4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
 - 2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 - 1. Install lap or joint strips with same material as jacket.
 - 2. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.7 FINISHES

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below .
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.

3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply, return, and outdoor air.
 - 2. Indoor, exposed supply, return, and outdoor air.
 - 3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
- B. Items Not Insulated:
 - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 2. Factory-insulated flexible ducts.
 - 3. Factory-insulated plenums and casings.
 - 4. Flexible connectors.
 - 5. Vibration-control devices.
 - 6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Supply air duct and plenum insulation shall be the following:
 - 1. Concealed, round and flat-oval ducts:

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- a. Mineral-Fiber Blanket, 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 2. Concealed, rectangular ducts:
 - a. Mineral-Fiber Blanket: 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 3. Concealed, plenums:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 4. Exposed, round and flat-oval ducts:
 - a. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
 5. Exposed, rectangular ducts:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and nominal density.
 6. Exposed, plenums:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- B. Return air duct and plenum insulation shall be the following:
1. Concealed, round and flat-oval ducts:
 - a. Mineral-Fiber Blanket, 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 2. Concealed, rectangular ducts:
 - a. Mineral-Fiber Blanket: 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 3. Concealed, plenums:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 4. Exposed, round and flat-oval ducts:
 - a. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
 5. Exposed, rectangular ducts:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and nominal density.
 6. Exposed, plenums:

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

- a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- C. Outdoor air duct and plenum insulation shall be the following:
 - 1. Concealed, round and flat-oval ducts:
 - a. Mineral-Fiber Blanket, 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 - 2. Concealed, rectangular ducts:
 - a. Mineral-Fiber Blanket: 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 - 3. Concealed, plenums:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 4. Exposed, round and flat-oval ducts:
 - a. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
 - 5. Exposed, rectangular ducts:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and nominal density.
 - 6. Exposed, plenums:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
- D. Exhaust air duct and plenum insulation shall be the following:
 - 1. Concealed, round and flat-oval ducts between isolation damper and penetration of building exterior:
 - a. Mineral-Fiber Blanket, 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 - 2. Concealed, rectangular ducts between isolation damper and penetration of building exterior:
 - a. Mineral-Fiber Blanket: 2-3/16 inches (56 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
 - 3. Concealed, plenums:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
 - 4. Exposed, round and flat-oval ducts between isolation damper and penetration of building exterior:
 - a. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

SECTION 230713.11 - INSULATION FOR INDOOR GENERAL HVAC DUCTS (continued):

5. Exposed, rectangular ducts between isolation damper and penetration of building exterior:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and nominal density.
6. Exposed, plenums:
 - a. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

END OF SECTION 230713.11

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping, indoors and outdoors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING (continued):

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.2 ADHESIVES

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING (continued):

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armaccel LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.

2.3 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 1. VOC Content: 50 g/L or less.
 - 2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80 / 30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).**
 - 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 5. Color: White.
- C. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
 - b. Marathon Industries; 570.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95 / 60-96.
 - 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 3. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).**
 - 4. Color: White.

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING (continued):

2.4 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately **2 oz./sq. yd. (68 g/sq. m)** with a thread count of **10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm)** for covering pipe and pipe fittings.
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. **Childers Brand**, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.

2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. Metal Jacket:
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. **Childers Brand**, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. **ITW Insulation Systems**; Aluminum and Stainless Steel Jacketing.
 - c. **RPR Products, Inc.**; Insul-Mate.
 - 2. Aluminum Jacket: Comply with **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: **2.5-mil- (0.063-mm-)** thick polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: .
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.6 SECUREMENTS

- A. Bands:
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. **ITW Insulation Systems**; Gerrard Strapping and Seals.
 - b. **RPR Products, Inc.**; Insul-Mate Strapping, Seals, and Springs.
 - 2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; **0.015 inch (0.38 mm)** thick, **1/2 inch (13 mm)** wide with wing seal.
- B. Wire: **0.062-inch (1.6-mm)** soft-annealed, stainless steel.

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING (continued):

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Below Ambient Systems.
 - 1. Provide continuous vapor barrier; seal joints, longitudinal seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic and joint sealant.
 - 2. Where mastic is indicated provide vapor-barrier mastic as required for indoor or outdoor application.

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING (continued):

- 3. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 - 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING (continued):

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
 - 2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of mastic.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
 - 4. Finish to achieve smooth, uniform finish.
- B. Where metal jackets are indicated, install with **2-inch (50-mm)** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands **12 inches (300 mm)** o.c. and at end joints.
- C. Do not install metal jacket over field-applied glass-cloth jacket unless indicated in schedule.
- D. Where PVC piping is installed in a plenum, install plenum fire resistant wrap over PVC piping. Install plenum fire resistant wrap over any PVC piping insulated with flexible elastomeric insulated, if installed in a plenum.

3.7 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Color per schedule below.
- B. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.
 - 1. White.
- C. Do not field paint aluminum jackets.

3.8 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below **60 Deg F (16 Deg C)**:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: **3/4 inch (19 mm)** thick.

3.10 OUTDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below **60 Deg F (16 Deg C)**:

SECTION 230719.11 - INSULATION FOR CONDENSATE DRAIN PIPING (continued):

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: **3/4 inch (19 mm)** thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed:
 1. None.
- C. Piping, Exposed:
 1. Aluminum, Corrugated: **0.016 inch (0.41 mm)** thick.
- D. Fittings, valves, strainers, flanges, unions, and other specialties, Concealed:
 1. None.
- E. Fittings, valves, strainers, flanges, unions, and other specialties, Exposed:
 1. Glass cloth jacket.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed:
 1. Aluminum, Corrugated: **0.024 inch (0.61 mm)** thick.
- C. Piping, Exposed:
 1. Aluminum, Corrugated: **0.024 inch (0.61 mm)** thick.
- D. Fittings, unions, and other specialties, Concealed:
 1. None.
- E. Fittings, unions, and other specialties, Exposed:
 1. Glass cloth jacket, install metal jacket over finished glass-cloth jacket.

END OF SECTION 230719.11

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Refrigerant suction and hot-gas piping, indoors and outdoors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Detail application of field-applied jackets.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
 - 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Aeroflex USA, Inc.; Aerocel.](#)
 - b. [Armacell LLC; AP Armaflex.](#)
 - c. [K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.](#)

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

- a. [Aeroflex USA, Inc.](#); Aeroseal.
- b. [Armacell LLC](#); Armaflex 520 Adhesive.
- c. [Foster Brand](#), Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
- d. [K-Flex USA](#); R-373 Contact Adhesive.

2.3 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
 1. VOC Content: 50 g/L or less.
 2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.
 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Foster Brand](#), Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80 / 30-90.
 - b. [Vimasco Corporation](#); 749.
 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 3. Service Temperature Range: **Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**.
 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 5. Color: White.
- C. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Childers Brand](#), Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
 - b. Marathon Industries; 570.
 - c. [Foster Brand](#), Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95 / 60-96.
 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 3. Service Temperature Range: **Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C)**.
 4. Color: White.

2.4 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. Metal Jacket:

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. **Childers Brand**, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. **ITW Insulation Systems**; Aluminum and Stainless Steel Jacketing.
 - c. **RPR Products, Inc.**; Insul-Mate.
2. Aluminum Jacket: Comply with **ASTM B209 (ASTM B209M)**, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: **2.5-mil- (0.063-mm-)** thick polysurlyn.
 - d. Moisture Barrier for Outdoor Applications: .
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.5 SECUREMENTS

A. Bands:

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. **ITW Insulation Systems**; Gerrard Strapping and Seals.
 - b. **RPR Products, Inc.**; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; **0.015 inch (0.38 mm)** thick, **1/2 inch (13 mm)** wide with wing seal.

B. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- #### **A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.**
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- #### **A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.**

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Below Ambient Systems.
 - 1. Provide continuous vapor barrier; seal joints, longitudinal seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic and joint sealant.
 - 2. Where mastic is indicated provide vapor-barrier mastic as required for indoor or outdoor application.
 - 3. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches (50 mm)**.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
 2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of mastic.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
 4. Finish to achieve smooth, uniform finish.
- B. Where metal jackets are indicated, install with **2-inch (50-mm)** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands **12 inches (300 mm)** o.c. and at end joints.

3.7 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.
1. Semi-glass Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof. Color per schedule below.
 - a. Finish Coat Material: Interior, semi-gloss, latex-emulsion size.
 2. Paint exposed piping without field applied metal jacket.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Color per schedule below.
- C. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.
1. White.
- D. Do not field paint aluminum jackets.

3.8 PIPING INSULATION SCHEDULE, GENERAL

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: **1 inch (25 mm)** thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: **1 inch (25 mm)** thick.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: **1 inch (25 mm)** thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: **1 inch (25 mm)** thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed:
 - 1. None.
- C. Piping, Exposed:
 - 1. Aluminum, Corrugated: **0.016 inch (0.41 mm)** thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

C. Piping, Concealed:

1. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

D. Piping, Exposed:

1. Aluminum, Corrugated: 0.024 inch (0.61 mm) thick.

END OF SECTION 230719.16

SECTION 230719.16 - INSULATION FOR REFRIGERANT PIPING (continued):

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SECTION 232113.11 - CONDENSATE DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Piping joining materials.
3. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. Condensate-Drain Piping: 150 deg F (66 deg C).

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L (ASTM B88M, Type B).
- B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- C. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4 (DN 100).
- D. Copper-Tube, Pressure-Seal-Joint Fittings - Copper or Bronze:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mueller Streamline Co.; a company of Mueller Industries.
 - b. Victaulic Company.
 - c. Viega LLC.

SECTION 232113.11 - CONDENSATE DRAIN PIPING (continued):

2. Source Limitations: Obtain copper-tube pressure-seal-joint fittings from single manufacturer.
3. Housing: Copper or bronze.
4. O-Rings and Pipe Stops: EPDM.
5. Tools: Manufacturer's special tools.
6. Minimum **200 psig (1370 kPa)** working pressure rating at **250 deg F (121 deg C)**.

2.3 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32, lead-free alloys.
- B. Flux: ASTM B813, water flushable.
- C. Solvent Cements for PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.
 1. PVC solvent cement shall have a VOC content of 510 g/L or less.
 2. Adhesive primer shall have a VOC content of 550 g/L or less.
 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:
 1. **Type L (Type B)**, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

3.2 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.

SECTION 232113.11 - CONDENSATE DRAIN PIPING (continued):

- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- N. Install valves according to Section 230523.11 "General Duty Valves for Hydronic Piping."
- O. Install unions in piping, **NPS 2 (DN 50)** and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- P. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- D. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

SECTION 232113.11 - CONDENSATE DRAIN PIPING (continued):

- C. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within **12 inches (300 mm)** of each fitting and coupling.
- E. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.6 FIELD QUALITY CONTROL

- A. Prepare hydronic piping in accordance with ASME B31.9 and as follows:
 - 1. Leave joints uninsulated and exposed for examination during test.
 - 2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
 - 3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - 4. Prepare written report of testing.

END OF SECTION 232113.11

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Valves and specialties.
 - 3. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Delegated-Design Submittal: For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- B. Shop Drawings:
 - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
 - 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 3. Show interface and spatial relationships between piping and equipment.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

SECTION 232300 - REFRIGERANT PIPING (continued):

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-32:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).
- B. Line Test Pressure for Refrigerant R-410a:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).
- C. Line Test Pressure for Refrigerant R-454b:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) or ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Copper Pressure-Seal Fittings for Refrigerant Piping:
 - 1. Standard: UL 207; certified by UL for field installation. Certification as a UL-recognized component alone is unacceptable.
 - 2. Housing: Copper.
 - 3. O-Rings: HNBR or compatible with specific refrigerant.
 - 4. Tools: Manufacturer's approved special tools.
 - 5. Minimum Rated Pressure: 700 psig (48 bar).

2.3 VALVES AND SPECIALTIES

- A. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.

SECTION 232300 - REFRIGERANT PIPING (continued):

4. End Connections: Copper spring.
 5. Working Pressure Rating: 500 psig (3450 kPa).
- B. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig (2760 kPa).
 6. Maximum Operating Temperature: 240 deg F (116 deg C).
- C. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F (4.4 deg C).
 6. Superheat: Adjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig (4820 kPa).
- D. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in parts per million (ppm).
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig (3450 kPa).
 7. Maximum Operating Temperature: 240 deg F (116 deg C).
- E. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated alumina or charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
 7. Working Pressure Rating: 500 psig (3450 kPa).
 8. Maximum Operating Temperature: 240 deg F (116 deg C).

2.4 REFRIGERANTS

- A. R-32, ASHRAE 34: Difluoromethane.

SECTION 232300 - REFRIGERANT PIPING (continued):

R-410A, ASHRAE 34: Pentafluoroethane/Difluoromethane.

- B. R-454B, ASHRAE 34: R-32 (68.9%) / R-1234yf (31.1%).

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS SCHEDULES

- A. Refrigerant: As indicated on Drawings and applicable Division 23 sections for the specified equipment.
- B. Suction, Hot-Gas, and Liquid Tubing Applications, **NPS 4 (DN 100)** and Smaller: Copper, Type **ACR** or Type **L (B)**, drawn-temper tubing and wrought-copper fittings with soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type **ACR** or Type **L (B)**, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- B. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- C. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- D. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- E. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- F. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- G. Install receivers sized to accommodate pump-down charge.
- H. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

SECTION 232300 - REFRIGERANT PIPING (continued):

- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Install refrigerant piping in protective conduit where installed belowground.
- L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- M. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Liquid lines may be installed level.
- N. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- P. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

SECTION 232300 - REFRIGERANT PIPING (continued):

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install the following pipe attachments:
 - 1. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within **12 inches (300 mm)** of each fitting.
- E. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to **500 micrometers (67 Pa)**. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to **2 psig (14 kPa)**.
 - 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

SECTION 232300 - REFRIGERANT PIPING (continued):

- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- D. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 232300 - REFRIGERANT PIPING (continued):

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SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes duct services for supply, return, outdoor air, and general exhaust (ASHRAE 62.1, Class 1 and 2):
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and flat-oval ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
- B. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

- C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather, comply with requirements per "Ductwork Exposed to Weather" Article.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. For ducts with longest side less than 36 inches (914 mm), select joint types in accordance with Figure 2-1.
 - 2. For ducts with longest side 36 inches (914 mm) or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather, comply with requirements per "Ductwork Exposed to Weather" Article.

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

3. Basis-of-Design Product: Subject to compliance with requirements, provide SEMCO, LLC: SEMCO Single-Wall Round Duct & Fittings or a comparable product by one of the following:
 - a. Crown Products Company, Inc.
 - b. McGill AirFlow LLC.
 - c. Sheet Metal Connectors, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 1. Transverse Joints in Ducts Larger Than **60 (1524) Inches (mm)** in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 1. Fabricate round ducts larger than **90 inches (2286 mm)** in diameter with butt-welded longitudinal seams.
 2. Fabricate flat-oval ducts larger than **72 inches (1830 mm)** in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 1. Galvanized Coating Designation: **G90 (Z275)**.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.
- D. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

- E. Tie Rods: Galvanized steel, **1/4-inch- (6-mm-)** minimum diameter for lengths **36 inches (900 mm)** or less; **3/8-inch- (10-mm-)** minimum diameter for lengths longer than **36 inches (900 mm)**.

2.5 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 2. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. Adhesive shall have a VOC content of 80 g/L or less.
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.106-inch- (2.6-mm-)** diameter shank, length to suit depth of insulation indicated with integral **1-1/2-inch (38-mm)** galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from **0.016-inch- (0.41-mm-)** thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than **1-1/2 inches (38 mm)** in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of **2500 fpm (12.7 m/s)** or greater.
 7. Secure liner with mechanical fasteners **4 inches (100 mm)** from corners and at intervals not exceeding **12 inches (300 mm)** transversely; at **3 inches (75 mm)** from transverse joints and at intervals not exceeding **18 inches (450 mm)** longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than **2500 fpm (12.7 m/s)** or where indicated.

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10 inch wg (2500 Pa), positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Solvent-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. Sealant shall have a VOC content of 420 g/L or less.
 9. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
 11. Service: Indoor or outdoor.
 12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C920.
 1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

5. Use: O.
 6. Sealant shall have a VOC content of 420 g/L or less.
 7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of **1 inch (25 mm)**, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least **1-1/2 inches (38 mm)**.
- J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.
- M. Elbows: Use long-radius elbows wherever they fit.
 - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
 - 2. Fabricate 90-degree round elbows with a minimum of three segments for **12 inches (300 mm)** and smaller and a minimum of five segments for **14 inches (350 mm)** and larger.
- N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1220 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

1. The allowable duct leakage for each test section shall be based on a percentage of the total design airflow for that section. An additional allowance shall be included for leakage associated with manual balancing dampers.
2. The total allowable leakage shall be calculated as follows:
 - a. Allowable Leakage (CFM) = $(X\% \times \text{Total Design Airflow}) + (5 \text{ CFM} \times \text{Number of Manual Balancing Dampers})$
 - b. Where:
 - 1) X% represents the allowable percentage of design airflow.
 - 2) Total Design Airflow is the sum of design airflows for all outlets served by the test section
3. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
4. Test the following systems:
 - a. Ducts with a Pressure Class of **3-Inch wg (750 Pa) or Greater**: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
5. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
6. Testing of each duct section is to be performed with access doors, coils, filters, dampers, branch connections, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
7. Test for leaks before applying external insulation.
8. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
9. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

1. Submit complete leakage test reports for review, including design airflow, test pressure, number of dampers, measured leakage, and pass/fail result.

3.8 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

3.9 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 - 1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
 - 2.
- B. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive **2-inch wg**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (2% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive **3-inch wg (750 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (1% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (1% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
- C. Return Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (2% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (1% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
 - 3. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (1% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
- D. Exhaust Ducts:

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (2% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
 2. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (1% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (2% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (1% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative **2-inch wg (500 Pa)**.
 - b. Minimum SMACNA Seal Class: A
 - c. Maximum Allowable Leakage: (1% of Total Design Airflow) + (5 cfm per Manual Balancing Damper).
- F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
- G. Liner:
1. Transfer Ducts: Flexible elastomeric, **1 inch(es) (25 mm)** thick.
- H. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

SECTION 233113.11 - METAL DUCTS FOR GENERAL HVAC (continued):

- 1) Mitered elbows are not permitted in Noise Critical Spaces.
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Welded.
- I. Branch Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: 45-degree entry.
 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm (5 m/s) or Lower: Conical tap.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
 - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 233113.11

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Manual volume dampers.
 - 3. Control dampers.
 - 4. Fire dampers.
 - 5. Flange connectors.
 - 6. Turning vanes.
 - 7. Duct-mounted access doors.
 - 8. Duct access panel assemblies.
 - 9. Flexible connectors.
 - 10. Duct accessory hardware.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Ruskin Company**; CBD4 or a comparable product by one of the following:
 - 1. **Greenheck Fan Corporation**.
 - 2. **Nailor Industries Inc.**
- B. Description: Gravity balanced with adjustable counterweights.
- C. Performance:
 - 1. Maximum Air Velocity: **2000 fpm (10 m/s)**.
 - 2. Maximum System Pressure: **3 inches wg (0.8 kPa)**.
 - 3. AMCA Certification: Test and rate in accordance with AMCA 511.
- D. Construction:
 - 1. Frame:
 - a. Hat shaped.
 - b. **0.093-inch- (2.4-mm-)** thick extruded aluminum, with welded or mechanically attached corners.
 - 2. Blades:
 - a. Multiple single-piece blades.
 - b. End pivoted, maximum **6-inch (150-mm)** width, **0.050-inch- (1.2-mm-)** thick aluminum sheet with sealed edges.
 - 3. Blade Action: Parallel.
- E. Blade Seals: Extruded vinyl, mechanically locked.
- F. Blade Axles:
 - 1. Material: Nonmetallic.
 - 2. Diameter: **0.50 inch (13 mm)** .
- G. Tie Bars and Brackets: Aluminum.
- H. Return Spring: Adjustable tension.
- I. Bearings: Steel ball.
- J. Accessories:

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

1. Adjustment device to permit setting for varying differential static pressure between **0.01-inch wg (0.003 kPa)** and **0.05-inch wg (0.013 kPa)**.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Ruskin Company**; MD35 (rectangular) and MDRS25 (round) or a comparable product by one of the following:
 - a. **Greenheck Fan Corporation**.
 - b. **Nailor Industries Inc.**
2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding **40 cfm/sq. ft. (203 L/s per sq. m)** against **1-inch wg (250-Pa)** differential static pressure.
3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
4. Frames:
 - a. Hat-shaped, **16-gauge- (1.6-mm-)** thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Opposed-blade design (rectangular).
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel; **16 gauge (1.6 mm)** thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
 - a. Molded synthetic.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
8. Tie Bars and Brackets: Galvanized steel.
9. Locking device to hold damper blades in a fixed position without vibration.

2.4 CONTROL DAMPERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Ruskin Company**; CD60 or a comparable product by one of the following:
1. **Greenheck Fan Corporation**.

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

2. [Nailor Industries Inc.](#)

B. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:

1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:
 - a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-inch wg (250-Pa) differential static pressure.
3. Pressure Drop: 0.05 inch wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm (15 m/s).
5. Temperature: Minus 25 to plus 180 deg F (Minus 32 to plus 83 deg C).
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:
 - a. Hat, U, or angle shaped.
 - b. 16-gauge- (1.6-mm-) thick, galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
 - a. Multiple blade with maximum blade width of 6 inches (150 mm).
 - b. Opposed-blade design.
 - c. Galvanized steel.
 - d. 14-gauge- (1.9-mm-) thick air foil dual skin.
5. Blade Edging Seals:
 - a. Replaceable Closed-cell neoprene.
 - b. Inflatable seal blade edging, or replaceable rubber seals.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch (13-mm) diameter; galvanized steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:
 - a. Oil-impregnated stainless steel sleeve.

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

- b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.
- E. Damper Operators: Comply with requirements in Section 250923.12 "Control Damper Accessories."

2.5 FIRE DAMPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Company; DIBD or a comparable product by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
- B. Type: Dynamic; rated and labeled in accordance with UL 555 by an NRTL.
- C. Closing rating in ducts up to **4-inch wg (1-kPa)** static pressure class and minimum **2000 fpm (1 m/s)** velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed galvanized sheet steel, interlocking. Material gauge is to be in accordance with UL listing.
- I. Horizontal Dampers: Include blade lock and stainless steel closure spring.
- J. Heat-Responsive Device:
 - 1. Replaceable, **165 deg F (74 deg C)** rated, fusible links.

2.6 FLANGE CONNECTORS

- A. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
- B. Material: Galvanized steel.
- C. Gauge and Shape: Match connecting ductwork.

2.7 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vaness and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- C. Vane Construction:
 - 1. Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

2.8 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. 24-gauge- (0.70-mm-) thick galvanized steel or 24-gauge- (0.70-mm-) thick stainless steel door panel.
 - d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - a. 24-gauge- (0.70-mm-) thick galvanized steel or 0.032-inch- (0.81-mm-) thick aluminum frame.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges and two compression latches with outside and inside handles.

2.9 DUCT ACCESS PANEL ASSEMBLIES

- A. Access panels used in cooking applications:
 - 1. Labeled compliant to NFPA 96 for grease duct access doors.
 - 2. Labeled in accordance with UL 1978 by an NRTL.
- B. Panel and Frame: Minimum thickness 16-gauge (1.6-mm) stainless steel.
- C. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- D. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).
- E. Minimum Pressure Rating: 10 inches wg (2500 Pa) positive or negative.

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

2.10 FLEXIBLE CONNECTORS

- A. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Materials: Flame-retardant or noncombustible fabrics.
- D. Coatings and Adhesives: Comply with UL 181, Class 1.
- E. Metal-Edged Connectors: Factory fabricated with a fabric strip **5-3/4 inches (146 mm)** wide attached to two strips of **2-3/4-inch- (70-mm-)** wide, **0.028-inch- (0.7-mm-)** thick, galvanized sheet steel or **0.032-inch- (0.8-mm-)** thick aluminum sheets. Provide metal compatible with connected ducts.
- F. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: **26 oz./sq. yd. (880 g/sq. m).**
 - 2. Tensile Strength: **480 lbf/inch (84 N/mm)** in the warp and [**360 lbf/inch (63 N/mm)**] in the filling.
 - 3. Service Temperature: **Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).**

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

2.12 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: **G90 (Z275).**
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2D finish for concealed ducts and No. 2B finish for exposed ducts.
- C. Aluminum Sheets: Comply with **ASTM B209 (ASTM B209M)**, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with **ASTM B221 (ASTM B221M)**, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.
- F. Tie Rods: Galvanized steel, **1/4-inch (6-mm)** minimum diameter for lengths **36 inches (900 mm)** or less; **3/8-inch (10-mm)** minimum diameter for lengths longer than **36 inches (900 mm).**

PART 3 - EXECUTION

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

3.1 COORDINATION OF WORK WITH OTHER TRADES

A. Smoke Dampers and Combination Fire and Smoke Dampers:

1. Damper furnished and installed by Division 23.
2. Damper actuator furnished and installed by Division 23.
3. Electrical power for damper actuator furnished and installed by Division 26.
4. Smoke detector furnished by Division 29.
5. Smoke detector installed in ductwork by Division 23.
6. Control and/or signal wiring for smoke detector and damper actuator furnished and installed by Division 29.

B. Control Dampers:

1. Damper furnished and installed by Division 23.
2. Damper actuator furnished and installed by Division 25.

3.2 INSTALLATION

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- H. Install fire and smoke dampers in accordance with UL listing.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Upstream and downstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links.
 7. At each change in direction and at maximum **50-ft. (15-m)** spacing.
 8. Upstream from turning vanes.
 9. Control devices requiring inspection.
 10. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
1. One-Hand or Inspection Access: **8 by 5 inches (200 by 125 mm)**.
 2. Two-Hand Access: **12 by 6 inches (300 by 150 mm)**.
 3. Head and Hand Access: **18 by 10 inches (460 by 250 mm)**.
 4. Head and Shoulders Access: **21 by 14 inches (530 by 355 mm)**.
 5. Body Access: **25 by 14 inches (635 by 355 mm)**.
 6. Body plus Ladder Access: **25 by 17 inches (635 by 430 mm)**.
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of **5 inches wg (1250 Pa)** and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Install duct test holes where required for testing and balancing purposes.

3.3 FLEXIBLE CONNECTOR SCHEDULE

- A. Indoor equipment, non-corrosive environment with airstream not in excess of **200 deg F (93 deg C)**: Indoor system, flexible connector fabric.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.

END OF SECTION 233300

SECTION 233300 - AIR DUCT ACCESSORIES (continued):

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SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulated flexible ducts.
 - 2. Flexible duct elbow supports.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

- A. **Products:** Subject to compliance with requirements, provide one of the following:
 - 1. **Flexmaster U.S.A., Inc;** 1M.
 - 2. **JP Lamborn Co.;** AMR.
 - 3. **Thermaflex; a Flex-Tek Group company;** M-KE.
 - 4. **Atco;** UPC 036.
- B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film or polyethylene fabric supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

SECTION 233346 - FLEXIBLE DUCTS (continued):

1. Pressure Rating: 10-inch wg (2500 Pa) positive and 1.0-inch wg (250 Pa) negative.
2. Maximum Air Velocity: 4000 fpm (20 m/s).
3. Temperature Range: Minus 10 to plus 160 deg F (Minus 23 to plus 71 deg C).
4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.4 FLEXIBLE DUCT ELBOW SUPPORTS

- A. **Products:** Subject to compliance with requirements, provide one of the following:
 1. **Flexmaster U.S.A., Inc;** FlexRight.
 2. **Malco;** FDS1.
 3. **Titus;** FlexRight.
 4. **Thermaflex; a Flex-Tek Group company;** FlexFlow.
- B. 90-degree Elbow: UL 2043, universal-mount, one-piece, fully adjustable, radius-forming brace to support 4-inch (102-mm) through 16-inch (406-mm) diameter flexible air ducts; copolymer polypropylene.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units to supply ducts with maximum 24-inch (600-mm) lengths of flexible duct. Do not use flexible ducts to change directions.
- D. Connect diffusers to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with draw bands.
- F. Installation:
 1. Install ducts fully extended.
 2. Do not bend ducts across sharp corners.
 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 5. Install flexible ducts in a direct line, without sags, twists, or turns.
 6. Install flexible duct elbow supports in accordance with manufacturer's instructions.
 7. Install flexible duct elbow supports over outer jacket of flexible ducts to form smooth, 90-degree bends to eliminate flexible duct kinks and airflow restrictions. Secure flexible duct to flexible duct elbow support with nylon cable ties.

SECTION 233346 - FLEXIBLE DUCTS (continued):

8. Install flexible duct elbow supports at 90-degree bends at the following locations:
 - a. Diffusers, registers, and grilles.
 - b. Duct take-offs and taps.
 - c. Air devices with round inlets and outlets.
 - d. Flexible ducts being used as elbows.
- G. Supporting Flexible Ducts:
 1. Suspend flexible ducts with bands 1-1/2 inches (38 mm) wide or wider and spaced a maximum of 48 inches (1200 mm) apart. Maximum centerline sag between supports shall not exceed 1/2 inch (13 mm) per 12 inches (300 mm).
 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
 4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches (1800 mm) o.c.

END OF SECTION 233346

SECTION 233346 - FLEXIBLE DUCTS (continued):

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SECTION 233423.12 - CEILING-MOUNTED VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ceiling-mounted ventilators.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Certified fan performance curves with system operating conditions indicated.
 - 4. Certified fan sound-power ratings.
 - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 6. Material thickness and finishes, including color charts.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Fan speed controllers.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED VENTILATORS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. [Carnes Company.](#)
 - 2. [Greenheck Fan Corporation.](#)
 - 3. [Loren Cook Company.](#)
 - 4. [PennBarry.](#)
- B. Housing: Steel, lined with acoustical insulation.

SECTION 233423.12 - CEILING-MOUNTED VENTILATORS (continued):

- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.
- D. Back-draft damper: Integral.
- E. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Accessories:
 - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
 - 3. Isolation: Rubber-in-shear vibration isolators.

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.

SECTION 233423.12 - CEILING-MOUNTED VENTILATORS (continued):

- B. Ceiling Units: Suspend units from structure; use steel wire or metal straps with elastomeric hangers. Vibration-control devices are specified in Section 230548.13 "Vibration Controls for HVAC".
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Division 26.
- B. Ground equipment according to Division 26.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Division 25.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that there is adequate maintenance and access space.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 6. Adjust belt tension.
 - 7. Adjust damper linkages for proper damper operation.
 - 8. Verify lubrication for bearings and other moving parts.
 - 9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct-work systems are in fully open position.

SECTION 233423.12 - CEILING-MOUNTED VENTILATORS (continued):

10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 11. Shut unit down and reconnect automatic temperature-control operators.
 12. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Diffuser-type air terminal units.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

SECTION 233600 - AIR TERMINAL UNITS (continued):

- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 DIFFUSER-TYPE AIR TERMINAL UNITS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide Acutherm; TF-HC or a comparable product by one of the following:
 - 1. Price Industries.
 - 2. Thermal Products, Corp.
 - 3. Titus.
- B. Configuration: Volume-damper, diffuser, and controller assembly.
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- D. Diffuser: Galvanized steel with white baked-enamel finish.
- E. Pressure Relief Bypass Rings (for use in non-ducted return air plenums): Galvanized steel with free moving shutter installed over diffuser inlet neck.
- F. Minimum Flow Stops: Factory installed, adjustable screw type for field adjustments to minimum airflow settings.
- G. Control Sequence: Diffusion dampers open and close to regulate airflow into the room in response to room temperature. The dampers are mechanically actuated by internal, factory-set thermal element thermostats, one for cooling and one for heating, with limited field adjustment.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.3 CONNECTIONS

- A. Comply with requirements in Section 233113.11 "Metal Ducts for General HVAC"

SECTION 233600 - AIR TERMINAL UNITS (continued):

3.4 **DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233600 - AIR TERMINAL UNITS (continued):

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SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Square ceiling diffusers.
 - 2.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 SQUARE CEILING DIFFUSERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Price Industries**; SPD or a comparable product by one of the following:
 - 1. **Carnes Company.**
 - 2. **METALAIRE, Inc.**
 - 3. **Nailor Industries Inc.**
 - 4. **Titus.**
 - 5. **Tuttle & Bailey.**
- B. Devices shall be specifically designed for variable-air-volume flows.
- C. Material: Aluminum.
- D. Finish: Baked enamel, white.
- E. Face Size: **24 by 24 inches (600 by 600 mm).**
- F. Face Style: Plaque.
- G. Pattern: Adjustable.

SECTION 233713.13 - AIR DIFFUSERS (continued):

- H. Insulation: Factory applied, foil faced, R-6 insulation formed to fit contour of diffuser back, continuously glued and sealed around perimeter of outer cone to form vapor seal.
- I. Accessories:
 - 1. Dampers: Radial opposed blade, where indicated on Plans.
 - 2. Plaster (trim) ring: For installations in hard ceiling applications.
 - 3. Sectorizing baffles: Where indicated on Plans.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION **233713.13**

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fixed face registers and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 REGISTERS

- A. Fixed Face Register:
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Price Industries**; 630 (no filter) and 630FF (with filter) or a comparable product by one of the following:
 - a. **Carnes Company.**
 - b. **METALAIRE, Inc.**
 - c. **Nailor Industries Inc.**
 - d. **Titus.**
 - e. **Tuttle & Bailey.**
 - 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Face Blade Arrangement: Vertical spaced **3/4 inch (19 mm)** apart.
 - 5. Frame: **1 inch (25 mm)** wide.
 - 6. Mounting: Countersunk screw.
 - 7. Damper Type: Adjustable, aluminum, opposed blade.

2.2 GRILLES

SECTION 233713.23 - REGISTERS AND GRILLES (continued):

A. Fixed Face Grille:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Price Industries**; 630 (no filter) and 630FF (with filter) or a comparable product by one of the following:
 - a. **Carnes Company.**
 - b. **METALAIRE, Inc.**
 - c. **Nailor Industries Inc.**
 - d. **Titus.**
 - e. **Tuttle & Bailey.**
2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal; spaced **3/4 inch (19 mm)** apart.
5. Frame: **1 inch (25 mm)** wide.
6. Mounting: Countersunk screw or Lay in, as required by ceiling type.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

SECTION 233713.23 - REGISTERS AND GRILLES (continued):

END OF SECTION 233713.23

SECTION 233713.23 - REGISTERS AND GRILLES (continued):

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SECTION 233919 - FIXED LOUVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed extruded-aluminum louvers.

1.2 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 550.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 550 and AMCA 540 by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.5 QUALITY ASSURANCE

SECTION 233919 - FIXED LOUVERS (continued):

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

- 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.
 - 1. Wind Loads:
 - a. Determine loads based on pressures as indicated on Drawings.
- B. Windborne-Debris-Impact Resistance: Louvers located within 30 feet (9.1 m) of grade pass enhanced protection, when tested in accordance with AMCA 540.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 550 and AMCA 540.
- D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

SECTION 233919 - FIXED LOUVERS (continued):

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal Front Blades with Vertical Rear Blades, Wind-Driven-Rain-Resistant, Windborne-Debris-Impact-Resistant Louver, Extruded Aluminum:
1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Ruskin:** HZ700MD or a comparable product by one of the following:
 - a. **Greenheck Fan Corporation:** EHV-550D.
 - b. **Pottorff:** EDV-545
 2. Louver Depth: **5.375 inches (136 mm)**.
 3. Frame Nominal Thickness: **0.080 inch (2.03 mm)**.
 4. Blades:
 - a. Front Blade: Horizontal, drainable blade style not less than **0.080 inch (2.03 mm)**.
 - b. Rear Blade: Vertical, wind-driven-rain-resistant style not less than **0.050 inch (1 mm)**.
 5. Louver Performance Ratings:
 - a. Free Area: Not less than **8.0 sq.ft (0.74 sq. m)** for **48-inch- (1220-mm-)** wide by **48-inch- (1220-mm-)** high louver.
 - b. Air Performance: Not more than **0.20-inch wg (40-Pa)** static pressure drop at **700-fpm (3.6-m/s)** free-area exhaust velocity.
 - c. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of **8 inches (200 mm)** per hour and a wind speed of **50 mph (22.4 m/s)** at a core-area intake velocity of **803 fpm (4.0 m/s)**.
 6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
 7. AMCA Rating: AMCA 540, AMCA 550.

2.4 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
1. Screen Location for Fixed Louvers: Interior face.
 2. Screening Type: Bird screening.
- B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of **6 inches (150 mm)** from each corner and at **12 inches (300 mm)** o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
 2. Finish: Same finish as louver frames to which louver screens are attached.
 3. Type: Non-rewirable, U-shaped frames.
- D. Louver Screening for Aluminum Louvers:
1. Bird Screening, Aluminum: **1/2-inch- (13-mm-)** square mesh, **0.063-inch (1.60-mm)** wire.

2.5 MATERIALS

SECTION 233919 - FIXED LOUVERS (continued):

- A. Aluminum Extrusions: **ASTM B221** (**ASTM B221M**), Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: **ASTM B209** (**ASTM B209M**), Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
 - 2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
 - 3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel fasteners.
 - 4. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Post installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
 - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Exterior flange unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or **72 inches** (**1830 mm**) o.c., whichever is less.
 - 1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
- G. Provide extended sills for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

SECTION 233919 - FIXED LOUVERS (continued):

2.7 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. Superior-Performance Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
 - 2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

SECTION 233919 - FIXED LOUVERS (continued):

- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 233919

SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pleated panel filters.
 - 2. Filter gauges.

1.3 DEFINITIONS

- A. HIPS: High-impact polystyrene.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide one complete set(s) of filters for each filter bank. If system includes prefilters, provide only prefilters.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.

1.8 DELIVERY, STORAGE, AND HANDLING

SECTION 234100 - PARTICULATE AIR FILTRATION (continued):

- A. Deliver and store products in a clean, dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
 - 1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
 - 2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
 - 3. Replace installed products damaged during construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance:
 - 1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
 - 2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.
- B. Comply with NFPA 90A and NFPA 90B.
- C. Comply with UL 900.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PLEATED PANEL FILTERS - STANDARD

- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Camfil**; AP-Thirteen or comparable product by one of the following:
 - a. **AAF / Flanders.**
 - b. **Airguard.**
 - c. **Purafil, Inc.**
- B. Source Limitations: Obtain from single source from single manufacturer.
- C. Capacities and Characteristics:
 - 1. Depth: **1 inch (25 mm)**, **2 inches (50 mm)**, or **4 inches (100 mm)** nominal, as indicated in Equipment Schedules.

SECTION 234100 - PARTICULATE AIR FILTRATION (continued):

2. Maximum or Rated Face Velocity: 625 fpm (3.2 m/s).
3. Initial Resistance: 0.25-inch wg (62 Pa) at 350 fpm (1.8 m/s).
4. Recommended Final Resistance: 1.0 inches wg (249 Pa).
5. Minimum Efficiency Reporting Value: MERV 13, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

D. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.

1. Separators shall be bonded to the media to maintain pleat configuration.
2. Welded-wire grid shall be on downstream side to maintain pleat.
3. Media shall be bonded to frame to prevent air bypass.
4. Support members on upstream and downstream sides to maintain pleat spacing.

E. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

2.3 PLEATED PANEL FILTERS – MOISTURE RESISTANT

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Camfil; Opti-Pac Durable or comparable product by one of the following:
 - a. AAF / Flanders; PrecisionCell III.

B. Source Limitations: Obtain from single source from single manufacturer.

C. Capacities and Characteristics:

1. Depth: 2 inches (50 mm) or 4 inches (100 mm) nominal, as indicated in Equipment Schedules.
2. Maximum or Rated Face Velocity: 625 fpm (3.2 m/s).
3. Initial Resistance: 0.25-inch wg (62 Pa) at 350 fpm (1.8 m/s).
4. Recommended Final Resistance: 1.5 inches wg (373 Pa).
5. Minimum Efficiency Reporting Value: MERV 13, with "Composite Average Particle Size Efficiency, Percent in Size Range, Micrometers" according to ASHRAE 52.2.

D. Media: Synthetic polypropylene fibers coated with nonflammable adhesive.

1. Separators shall be bonded to the media to maintain pleat configuration.
2. Media shall be bonded to frame to prevent air bypass.

E. Filter-Media Frame: Plastic frame bonded to the entire periphery of media.

2.4 FILTER GAUGES

A. Diaphragm-type gauge with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Dwyer Instruments, Inc; Series 2000 or comparable product by one of the following:
 - a. Airguard.

SECTION 234100 - PARTICULATE AIR FILTRATION (continued):

- B. Source Limitations: Obtain from single source from single manufacturer.
 - 1. Diameter: 4-1/2 inches (115 mm).
 - 2. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa).
- C. Accessories: Static-pressure tips, tubing, gauge connections, and mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF FILTERS

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Install filter gauge for each filter bank.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- E. Coordinate filter installations with duct and air-handling-unit installations.

3.3 INSTALLATION OF FILTER GAUGES

- A. Install filter gauge for each filter bank.
- B. Install filter-gauge, static-pressure tips upstream and downstream from filters. Install filter gauges on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

3.4 FILTER SCHEDULE

- A. Indoor equipment with outside airflow less than 100 percent of supply airflow:
 - 1. Pleated panel filters - standard.
- B. Indoor equipment with outside airflow equal to 100 percent of supply airflow:
 - 1. Pleated panel filters – moisture resistant.
- C. Outdoor equipment:

SECTION 234100 - PARTICULATE AIR FILTRATION (continued):

1. Pleated panel filters – moisture resistant.

3.5 **CLEANING**

- A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

SECTION 234100 - PARTICULATE AIR FILTRATION (continued):

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SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set for each unit.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

2.1 MANUFACTURERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. AAON
 2. Desert-Aire

2.2 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Cabinet Thermal Performance:
1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
 2. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- C. Cabinet Surface Condensation:
1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
 2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.
- D. Maximum Cabinet Leakage: 1 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.
- E. Cabinet Deflection Performance:
1. Walls and roof deflection shall be within 1/200 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
 2. Floor deflections shall be within 1/240 of the span considering the worst-case condition caused by the following:
 - a. Service personnel.
 - b. Internal components.
 - c. Design working pressure defined for the walls and roof.
- F. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. Construction: Double wall.
- B. Exterior Casing Material: Galvanized steel with paint finish.
- C. Interior Casing Material: Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

- E. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- F. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- G. Cabinet Insulation:
 - 1. Type: Flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.
 - 2. Thickness: 2 inches (50 mm).
 - 3. Insulation Adhesive: Comply with ASTM C 916, Type I.
 - 4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
- H. Condensate Drain Pans:
 - 1. Shape: Rectangular, with 2 percent slope in at least two planes to direct water toward drain connection.
 - 2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches (50 mm) deep.
 - 3. Configuration: Double wall, with space between walls filled with foam insulation and moisture-tight seal.
 - 4. Material: Stainless-steel sheet.
 - 5. Drain Connection:
 - a. Located on one end of pan, at lowest point of pan.
 - b. Terminated with threaded nipple.
 - c. Minimum Connection Size: NPS 1 (DN 25).
 - 6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- I. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

2.4 SUPPLY FAN

- A. Plenum Fan Type: Single width, non-overloading, with backward-inclined or airfoil blades.
 - 1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
 - 2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
 - 3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
 - 4. Fan Enclosure: Easily removable enclosure around rotating parts.
 - 5. Fan Balance: Precision balance fan below 0.08 inch/s (2.0 mm/s) at design speed with filter in.
- B. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.5 service factor.
- C. Motors:

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- D. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with elastomeric isolators.

2.5 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410.
- B. Coil Casing Material: Manufacturer's standard material.
- C. Tube Material: Copper.
- D. Tube Header Material: Manufacturer's standard material.
- E. Fin Material: Aluminum.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Capacity Reduction: Circuit coils for interleaved control.
- I. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- J. Coating: Corrosion-resistant coating after assembly.

2.6 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
- D. Unit shall be configured as heat pump. Refrigeration circuit shall be equipped with thermal expansion and check valve on the indoor coil.
- E. Refrigerant: R-454B.
 1. Classified as Safety Group A2L according to ASHRAE 34.
 2. Provide unit with operating charge of refrigerant.
- F. Refrigeration System Specialties:
 1. Expansion valve with replaceable thermostatic element.
 2. Refrigerant dryer.
 3. High-pressure switch.
 4. Low-pressure switch.
 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
 6. Brass service valves installed in discharge and liquid lines.
 7. Liquid line sight glass.

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

G. Capacity Control:

1. Modulating hot gas reheat shall be provided on the lead refrigeration circuit. Refrigeration circuit shall be provided with interlaced hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. Modulating reheat valves shall be factory. Reheat line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed with a grommet on the exterior of the unit casing to minimize air leakage.
2. Lead refrigerant circuit shall be provided with external hot gas bypass to protect against evaporator frosting at low suction pressure and to prevent excessive compressor cycling. Hot gas bypass line connections shall be labeled, extend beyond the unit casing and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed with a grommet on the exterior of the unit casing to minimize air leakage.

H. Refrigerant condenser and reheat condenser coils:

1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410.
2. Tube Material: Copper.
3. Fin Material: Aluminum.
4. Fin and Tube Joint: Mechanical bond.
5. Leak Test: Coils shall be leak tested with air underwater.
6. Coating: Corrosion-resistant coating after assembly.

I. Condenser Fan Assembly:

1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
2. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Fan Safety Guards: Steel with corrosion-resistant coating.

J. Safety Controls:

1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

2.7 ELECTRIC-RESISTANCE HEATING COIL

A. UL Compliance: Comply with requirements in UL 1995, "Heating and Cooling Equipment."

B. Electric-Resistance Heating Elements:

1. Coiled Resistance Wire: 80 percent nickel and 20 percent chromium.
2. Tubular-Steel Sheath: Compacted magnesium oxide powder.
3. Fins: Spiral-wound, copper-plated, steel fins continuously brazed to sheath.
4. Heating Capacity: Low density 35 W per sq. in. (54 kW per sq. m), factory wired for single-point wiring connection; with time delay for element staging and overcurrent- and overheat-protection devices.
5. Safety Controls:

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

- a. Blower-motor interlock, air-pressure switch.
- b. Quiet mercury contactors.
- c. Time delay between steps.
- d. Integral, non-fused power disconnect switch.

2.8 CORROSION-RESISTANT COATINGS

- A. Corrosion-Resistant Coating: Coat **coils and fan guards** with a corrosion-resistant coating capable of withstanding a **3,000**-hour salt-spray test according to ASTM B 117.

1. Standards:
 - a. ASTM B 117 for salt spray.
 - b. ASTM D 2794 for minimum impact resistance of **100 in-lb (11.3 N-m)**.
 - c. ASTM D 3359 for cross hatch adhesion of 5B.
2. Application: **Immersion or Spray**.
3. Thickness: **1 mil**
4. Gloss: Minimum gloss of 50 gloss units on a single angle 60-degree meter.
5. UV Protection: Spray applied topcoat.

2.9 FILTERS

- A. Filters are specified on plans.

2.10 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Disconnect by electrical contractor.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 2. NEMA KS 1, heavy-duty, nonfusible switch.
 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Control Relays: Auxiliary and adjustable time-delay relays.

2.11 CONTROLS

- A. Control equipment and sequence of operation are specified on floor plans and division 25 specifications.
- B. Control Wiring: Factory wire connection for controls' power supply.
- C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- D. Unit-Mounted Status Panel:
 - 1. Cooling / Off / Heating Controls: Control operational mode.
 - 2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
 - 3. Status Lights:
 - a. Filter dirty.
 - b. Fan operating.
 - c. Cooling operating.
 - d. Heating operating.
 - e. Smoke alarm.
 - f. General alarm.
 - 4. Digital Numeric Display:
 - a. Outdoor airflow.
 - b. Supply airflow.
 - c. Outdoor dry-bulb temperature.
 - d. Outdoor dew point temperature.
 - e. Supply temperature.
- E. Refrigeration System Controls:
 - 1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than **28 Btu/lb (65 kJ/kg)** of dry air or outdoor-air temperature is less than **60 deg F (15 deg C)**.
 - 2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than **60 deg F (15 deg C)**.
 - 3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 55 percent.
- F. Electric-Resistance Heat Controls:

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

1. Remote sensor for field installation in supply-air duct with sensor adjustment located in control panel to control electric coil to maintain temperature.
2. Capacity Controls: Modulating SCR.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Equipment Mounting:
 1. Install air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- D. Install separate devices furnished by manufacturer and not factory installed.
- E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Duct Connections:
 1. Comply with requirements in Section 233113 "Metal Ducts."
 2. Drawings indicate the general arrangement of ducts.
 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."
- C. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 3. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
 4. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 5. Inspect casing insulation for integrity, moisture content, and adhesion.
 6. Verify that clearances have been provided for servicing.
 7. Verify that controls are connected and operable.
 8. Verify that filters are installed.
 9. Clean coils and inspect for construction debris.
 10. Inspect operation of power vents.
 11. Inspect and adjust vibration isolators and seismic restraints.
 12. Verify bearing lubrication.
 13. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 14. Adjust fan belts to proper alignment and tension.
 15. Start unit.
 16. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
 17. Operate unit for run-in period.
 18. Calibrate controls.
 19. Adjust and inspect high-temperature limits.
 20. Inspect outdoor-air dampers for proper stroke.
 21. Verify operational sequence of controls.
 22. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Outdoor-air flow.
- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (continued):

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION

- A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237433

SECTION 238126.11 - AIR-COOLED, SPLIT-SYSTEM AIR-CONDITIONERS (5 TONS AND SMALLER)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes small capacity, air-cooled, split-system air-conditioning and heat-pump units (5 tons and smaller) consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each air-handling unit.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

SECTION 238126.11 - AIR-COOLED, SPLIT-SYSTEM AIR-CONDITIONERS (5 TONS AND SMALLER)
(continued):

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.7 **COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 **WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 **MANUFACTURERS**

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Carrier Corporation; a unit of United Technologies Corp.
 2. Daikin Industries, Ltd.
 3. Lennox Industries, Inc.; Lennox International.
 4. Mitsubishi Electric & Electronics USA, Inc.
 5. Trane.
 6. YORK; a Johnson Controls company.

2.2 **INDOOR UNITS (5 TONS (18 kW) OR LESS)**

- A. Floor-Mounted, Evaporator-Fan Components:
 1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Engineer.
 - a. Insulation: Faced, glass-fiber duct liner.
 - b. Drain Pans: Galvanized steel, with connection for drain; insulated.

SECTION 238126.11 - AIR-COOLED, SPLIT-SYSTEM AIR-CONDITIONERS (5 TONS AND SMALLER)
(continued):

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
6. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Comply with Section 234100 "Particulate Air Filtration" for filters
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation. Filters shall be removable from one side.
 - 4) Provide external filter housing.

B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Totally enclosed, fan cooled.
 - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - f. Mount unit-mounted disconnect switches on interior of unit.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

SECTION 238126.11 - AIR-COOLED, SPLIT-SYSTEM AIR-CONDITIONERS (5 TONS AND SMALLER)
(continued):

- 2) Depth: A minimum of 1 inch (25 mm) deep.
- b. Single-wall, galvanized-steel sheet.
- c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
- 1) Minimum Connection Size: NPS 3/4 (DN 19).
- d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
- 8. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Comply with Section 234100 "Particulate Air Filtration" for filters.
 - 3) Filter-Holding Frames: Arranged for flat. Filters shall be removable from one side.
 - b. Extended-Surface, Disposable Panel Filters:
 - 1) Factory-fabricated, dry, extended-surface type.
 - 2) Thickness: 1 inch (25 mm).
 - 3) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

2.3 OUTDOOR UNITS (5 TONS (18 kW) OR LESS)

- A. Air-Cooled, Compressor-Condenser Components:
 - 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 - 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Single-stage or two-stage compressor motor (as indicated on Drawings) with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant: R-32.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with ARI 206/110.
 - 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
 - 4. Fan: Aluminum-propeller type, directly connected to motor.
 - 5. Motor: Permanently lubricated, with integral thermal-overload protection.

2.4 ACCESSORIES

- A. Control equipment are specified in Division 25.

SECTION 238126.11 - AIR-COOLED, SPLIT-SYSTEM AIR-CONDITIONERS (5 TONS AND SMALLER)
(continued):

- B. Thermostat/Humidistat: Low voltage with subbase to control compressor and evaporator fan. 7-day programmable combination thermostat/humidistat.
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, humidity, set-point temperature, set-point humidity, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- C. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- D. Automatic-reset timer to prevent rapid cycling of compressor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on 6-inch (100-mm) cast-in-place concrete equipment base(s) that is 6 inches (100 mm) larger, on each side, than unit. Comply with requirements for equipment bases and foundations specified in Division 03.
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113.11 "Metal Ducts for General HVAC." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

SECTION 238126.11 - AIR-COOLED, SPLIT-SYSTEM AIR-CONDITIONERS (5 TONS AND SMALLER)
(continued):

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.4 **STARTUP SERVICE**

- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 **DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126.11

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions of this Section apply to all Division 25 Specification Sections.

1.2 SUMMARY

- A. Section includes basic requirements for Instrumentation and Control systems.
- B. Related Work:
 - 1. Division 03 – Concrete
 - a. Refer to Division 03 for all concrete work.
 - 2. Division 05 – Metals
 - a. Refer to Division 05 for framed openings for equipment.
 - b. Comply with the requirements of Division 05 for supports for work.
 - 3. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 4. Division 07 – Thermal and Moisture Protection
 - a. Refer to Division 07 for installation of roof curbs and roof supports and for caulking and waterproofing of wall- and roof-mounted work.
 - b. Comply with the requirements of Division 07 for penetration firestopping and furnishing roof curbs and roof supports for equipment and piping.
 - 5. Division 08 – Openings
 - a. Refer to Division 08 for installation of access doors and frames.
 - b. Comply with the requirements of Division 08 for access doors and frames, unless otherwise included in the Contract Documents.
 - 6. Division 09 – Finishes
 - a. Refer to Division 09 for paint products and applications in finished spaces.
 - b. Comply with the requirements of Division 09 for paint products and applications identified in the Contract Documents.
 - 7. Division 10 – Specialties

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
- 8. Division 22 – Plumbing
 - a. Refer to Division 22 for all plumbing work.
 - b. Coordinate with Division 22 for related equipment and components and for connections to systems.
- 9. Division 23 – Heating, Ventilation, and Air-Conditioning
 - a. Refer to Division 23 for all heating, ventilation, and air-conditioning work.
 - b. Coordinate with Division 23 for related equipment and components and for connections to systems.
- 10. Division 26 – Electrical
 - a. Refer to Division 26 for all electrical work.
 - b. Comply with requirements of Division 26 for related equipment and components and for connections to systems.
- 11. Division 27 – Communications
 - a. Refer to Division 27 for all communications work.
 - b. Coordinate with Division 27 for related equipment and components and for connections to systems.
- 12. Division 28 – Electronic Safety and Security
 - a. Refer to Division 28 for all electronic safety and security work.
 - b. Coordinate with Division 28 for integration with security systems.
- 13. Division 29 – Fire Safety and Emergency Communications
 - a. Refer to Division 29 for all fire safety and emergency communications work.
 - b. Coordinate with Division 29 for integration with fire safety and emergency communications systems.
- 14. Division 31 – Earthwork
 - a. Refer to Division 31 for all site related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 31 for site clearing, earth moving, and dewatering within five feet outside the building and otherwise as indicated in the Contract Documents.
- 15. Division 33 – Utilities
 - a. Refer to Division 33 for all utility related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 33 for utility work within five feet outside the building and otherwise as indicated in the Contract Documents.

1.3 **DEFINITIONS**

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- A. Experienced: When used with an entity or individual, “experienced” unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Furnish: Supply and deliver to project site, ready for subsequent requirements.
- C. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
- D. Provide: Furnish and install, complete and ready for intended use.
- E. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- F. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.
- G. Concealed Work: Work hidden from view, including inside chases, furred spaces, **or above ceilings**.
- H. Exposed Work: Work open to view, including inside mechanical and equipment rooms.

1.4 QUALITY ASSURANCE

- A. General:
 - 1. It is the intent of the plans and specifications to obtain a complete, operable and satisfactory installation.
 - 2. All materials shall be new, be properly labeled and/or identified and be in full compliance with the contract documents.
 - 3. All work shall comply with applicable Codes and Standards.
 - 4. Manufacturer's model names and numbers used in these specifications are subject to change per manufacturer's action. Contractor shall therefore verify them with manufacturer's representative before ordering any product or equipment
- B. Furnish new and unused materials and equipment manufactured in the U.S.A. Where two or more units of the same type or class of equipment are required provide units of a single manufacturer.

1.5 CODES AND STANDARDS

- A. Perform work in accordance with the following codes and any applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
 - 1. ASHRAE
 - a. Standard 15 Safety Standard for Refrigeration Systems - 2019
 - b. Standard 55 Thermal Environmental Conditions for Human Occupancy – 2017
 - c. Standard 62.1 Ventilation Standard for Acceptable Indoor air Quality - 2019
 - d. Standard 90.1 Energy Standard for Buildings Except Low Rise Residential Buildings - 2019
 - 2. Occupational Safety and Health Regulations (OSHA).

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

3. National Fire Codes
 - a. NFPA 1 Fire Code – 2021 (Florida Edition)
 - b. NFPA 70 National Electrical Code – 2020
 - c. NFPA 72 National Fire Alarm and Signaling Code - 2019
 - d. NFPA 90A Standard for the Installation of Air Conditioning and Ventilation Systems - 2021
 - e. NFPA 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems - 2021
 - f. NFPA 91 Standard for the Installation of Blower and Exhaust Systems - 2020
 - g. NFPA 101 Life Safety Code – 2021 (Florida Edition)
 4. Florida Building Code, 2023 Edition
 - a. Building Code
 - b. Energy Conservation Code
 - c. Mechanical Code
 - d. Plumbing Code
 - e. Accessibility Code
 5. Florida Statutes
 - a. Chapter 471 Engineering
 - b. Chapter 533.80 Building Construction Standards; Florida Building Code - Enforcement
 6. Florida Administrative Code
 - a. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - b. Chapter 61G15-34 Responsibility Rules of Professional Engineers Concerning the Design of Mechanical Systems
 - c. Chapter 69A-3 Fire Prevention – General Provisions
 - d. Chapter 69A-60 The Florida Fire Prevention Code
- B. Resolve, in writing, any code violation discovered in contract documents with the Engineer prior to bidding. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. The Contractor shall include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and drawings required to comply with all applicable laws, ordinances, rules, and regulations.
- D. Where there is conflict between the Contract Documents and the applicable Codes, the Codes shall govern, except where the requirements of the Contract Documents are more stringent.

1.6 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments, or supplements in effect on date bids are received. Specifications and standards are minimum requirements for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
- B. Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition of the standard at the time project is bid unless otherwise specified herein

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

1.7 DELEGATED-DESIGN SERVICES

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

1.8 PERMITS FEES AND INSPECTIONS

- A. Obtain and pay for all permits, fees, tap fees, connection charges, demand charges, systems charges, impact fees, and inspections.
- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.9 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
 - 1. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer in writing prior to bid date; however, the most stringent requirement shall govern.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.10 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 - 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Prepare RFIs as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 - 1. The following Contractor-generated RFIs will be returned without action:

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.

1.11 SUBMITTALS

- A. Submittals (including Product Data, Shop Drawings, and any other Action Submittal or Information Submittal) will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions, Division 01, and the following:
1. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are approved by the Engineer.
 3. Submittals shall only contain relevant product data. Remove or strikeout irrelevant product data.
 4. Prepare submittals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
 5. Options: Identify options requiring selection by Engineer.
 6. Deviations: Clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 7. Revisions: Include relevant additional information and revisions, other than those specifically requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached submittal sheet.
 8. Contractor's Review:
 - a. Submittals shall have been reviewed and approved by the General Contractor / Construction Manager. Include approval stamp, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - b. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.
 9. Electrical Modifications:
 - a. The electrical design indicated on the plans supports the Basis of Design specifications for the Instrumentation and Control systems at the time of design.
 - b. If Instrumentation and Control equipment is submitted with different electrical requirements, it is the responsibility of the Contractor to resolve all required electrical design changes, including, but not limited to: wire and conduit size, type or size of disconnect or overload protection, breaker coordination, point(s) of connection, etc. Any corrections required shall be provided at no additional cost.
 - c. Submittal shall clearly show the electrical design revisions with a written statement that this change will be provided at no additional cost. Submittals made with no written reference to the electrical design revisions will be presumed to work with the electrical design.

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- B. Processing Time: Time of review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of the failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Allow not less than 15 days for submittal review. Allow not less than 21 days for review of large or complex submittals. Submittals received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 2. If Contractor transmits more than five submittals over two consecutive business days, review time shall increase by no less than 7 days for submittal review.
 3. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 4. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received. Time of review shall commence on receipt of all other related submittals.
- C. The Contractor shall not be relieved of responsibility for deviations from requirements of the contract documents by the Engineer's approval of shop drawings, product data, samples, or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal, and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in shop drawings, product data, samples, or similar submittals by the Engineer's approval thereof.
- D. Submittal Review Fees:
1. Additional Reviews: Submittals on any particular phase of Work will receive only one review and one re-review (if required). If additional reviews are required beyond these two, the Contractor will be charged \$200.00 per hour for review time, in addition to any expedited review charges. This fee shall be paid to the Engineer prior to Submittal release.
 2. Expedited Reviews: If General Contractor / Construction Manager requests for an expedited review, whether by official request or unofficially by assigning a review time less than required above, the General Contractor / Construction Manager will be charged \$1,000.00 per Submittal, in addition to any charges for additional reviews. This fee shall be paid to the Engineer prior to Submittal release.

1.12 COORDINATION DRAWINGS NOT REQUIRED

- A. Should the Contractor elect to provide Coordination Drawings when not expressly required by the Engineer, such Drawings shall be considered for informational purposes only. The Engineer will not conduct a review of these Drawings, and their submission or any implied approval shall not relieve the Contractor of the obligation to fully comply with the requirements set forth in the Construction Documents. The Contractor remains solely responsible for ensuring that all work meets the contract specifications and standards, regardless of the content or status of the Coordination Drawings.

1.13 SUBSTITUTIONS

- A. By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Substitution Requests shall include, at a minimum:

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

1. Statement indicating why specified material, equipment, or installation method cannot be provided, if applicable.
 2. Coordination of information, including a list of changes and revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 3. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include an annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 5. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 6. Cost information, including a proposal of change, if any, in the Contract Sum.
 7. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 8. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- C. Procurement Substitution Requests submitted prior to receipt of bids will be received and considered by Owner when the following conditions are satisfied, as determined by Engineer; otherwise, requests will be returned without action:
1. Requests for substitution of materials and equipment are received no later than 10 days prior to date of bid opening.
 2. Extensive revisions to the Contract Documents are not required.
 3. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
 4. The request is fully documented and properly submitted.
- D. Substitutions for Cause, as required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms will be received and considered by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 2. Substitution request is fully documented and properly submitted.
 3. Requested substitution has received necessary approvals of authorities having jurisdiction.
 4. Requested substitution is compatible with other portions of the Work.
 5. Requested substitution has been coordinated with other portions of the Work.
 6. Requested substitution provides specified warranty.
 7. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- E. Substitutions for Convenience, not required in order to meet other Project requirements but may offer advantage to Contractor or Owner, will be received and considered by Owner, as determined by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

1. Requested substitution is received within 60 days after the Notice of Award.
2. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
3. Requested substitution does not require extensive revisions to the Contract Documents.
4. Requested substitution is consistent with the Contract Documents and will produce indicated results.
5. Substitution request is fully documented and properly submitted.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.
10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

- F. If a requested substitution is approved but contains differences or omissions not specifically identified to the attention of the Engineer in the substitution request, the Owner reserves the right to require equal or similar features to be added to the substituted products or to have the substituted products replaced at the Contractor's expense.

1.14 PROJECT RECORD DOCUMENTS

- A. Recording: Maintain one copy of the Contract Documents and Shop Drawings during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation:
1. Contract Drawings and Shop Drawings:
 - a. Mark revisions to show where the actual installation varies from that shown originally.
 - b. Mark record sets completely and accurately, including important information that was either shown schematically or omitted from original Drawings.
 - c. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - d. Record underground and under-slab piping installed, dimensioning exact location and elevation of piping.
 2. Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 3. Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
- C. Deliver: Prior to Final Completion, provide record documents to Owner as indicated below:
1. Record Drawings: Submit PDF electronic files of scanned record prints and one set of prints.
 2. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
 3. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 4. Miscellaneous Record Submittals: Submit annotated PDF electronic files directories of each submittal.

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

1.15 OPERATION AND MAINTENANCE MANUALS

- A. Prepare and submit a comprehensive manual of emergency, operation, and maintenance data and materials in full accordance with the General and Supplementary Conditions, Division 01, and the following:
 - 1. Operations and Maintenance Manuals: Assemble a complete set of data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system, including:
 - a. Information required for daily operation and management, operating standards, and routine and special operating procedures.
 - b. Manufacturers' maintenance documentation, preventative maintenance procedures and frequency, repair procedures, wiring and systems diagrams, list of spare parts, and warranty information.
 - 2. Submit manuals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. Submittals shall be in searchable PDF format and not a scanned copy.

1.16 DEMONSTRATION AND TRAINING

- A. Prepare and provide services of qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system in accordance with the General and Supplementary Conditions, Division 01, individual Specification Sections, and the following:
 - 1. Demonstration and training shall occur upon completion of the Work and at a time designated by the Owner's representative.
 - 2. Provide a high-resolution, digital video recording of each training session to the Owner.

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

1.18 WARRANTY

- A. Warranty work and equipment within specified warranty period. During the warranty period, provide labor and materials to make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship without expense to the Owner.
 - 1. Warranty Period: One year from date of Substantial Completion.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
- C. Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving the Contractor of responsibilities during the warranty period.

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

PART 2 - PRODUCTS (NONE)

PART 3 - EXECUTION

3.1 CONTRACT DOCUMENTS

- A. Examine all drawings and specifications carefully before submitting a bid. **Architectural drawings take precedence over mechanical or electrical drawings with reference to building construction.**
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.
- C. The drawings indicate required size and points of termination of pipes, conduits, and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the responsibility of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.
- E. Any and all questions about a subcontractor's scope of work responsibility shall be addressed to and answered by the General Contractor / Construction Manager.
- F. Questions About Construction Documents: Any and all questions shall be submitted through the proper channels IN WRITING and, in turn, shall be answered by the Engineer in writing. All telephone conversations shall be considered unofficial and, as such, shall not be considered official or binding responses to Contractor's questions.
- G. Drawings, specifications, or other documents issued by the Engineer in electronic format and/or electronic media are provided for convenience only and are not intended for use as Contract Documents.
 - 1. The electronic files are provided merely as a convenience to the Recipient.
 - 2. The electronic files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.
 - 3. The Engineer makes no representation, warranty, or guarantee that electronic files:
 - a. Are suitable for any other usage or purpose.
 - b. Have any particular durability.
 - c. Will not damage or impair the Recipient's computer or software.
 - d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.
 - 4. Due to the unsecured nature of the electronic files and the inability of Engineer or the Recipient to establish controls over their use, the Engineer assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained therein. The Recipient shall at all times refer to the signed and sealed drawings, specification or other documents for the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of the electronic files.

3.2 SUPERVISION OF WORK

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- A. Perform all work under the direct supervision of an experienced, qualified superintendent. The Engineer has the right to remove a superintendent who, in the Engineer's opinion, is not satisfactory.

3.3 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.4 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.
- E. Interruption of Service: Before any existing equipment or system is shut down for disconnecting or tie-ins, coordinate with Engineer and Owner regarding acceptable dates and times for this Work to be performed. Work shall be performed at the time best suited for the Owner, which typically is either on weekends, holidays, and/or after normal working hours. Services shall be restored the same day unless prior arrangements are made. All overtime or premium costs associated with this Work shall be included in the Contractor's bid.

3.5 INSTALLATION

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- A. Install materials and equipment in a professional manner. The Engineer may direct replacement of items which, in the Engineer's opinion, do not present a professional appearance or do not allow adequate space for maintenance. Replace or reinstall items at the expense of the Contractor.
- B. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- C. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- D. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- G. Obstructions
 - 1. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
 - 2. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
 - 3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
 - 4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.
- H. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof, or ceiling to the satisfaction of the authority having jurisdiction.
- I. Structural Elements: Do not cut structural elements without written approval from Engineer. Notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. If approved by Engineer:
 - 1. Shore, brace, and support structural elements during cutting and patching.
 - 2. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- J. Space Requirements: Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- K. Tools and Equipment: Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.
- L. Phasing: Provide all temporary valves, piping, ductwork, equipment, and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.6 OWNER-INSTALLED PRODUCTS

- A. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

3.7 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- F. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
- G. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- H. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- I. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- J. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable or with in-place materials.
1. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 2. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.
- K. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.8 PAINTING

- A. Comply with requirements with General and Supplementary Conditions, Division 01, Division 09, and individual Specification Sections.
- B. Touch-up factory finishes on equipment provided under Division 25. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.
- C. Paint the following work where exposed to view:
1. Metal conduit
 2. Plastic conduit
- D. Paint the following work where exposed in occupied spaces:
1. Other items as directed by Engineer.

3.9 REPAIR OF WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

3.10 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Furnish a letter from the control manufacturer stating that all controls have been checked for operation and calibration, and the system is operating as designed.
- C. Furnish a letter from an authorized factory representative of the air conditioning unit manufacturer stating that the complete refrigeration installation including pipe sizing and routing and operating and safety controls has been checked and is operating properly.
- D. Tests
 - 1. Include all tests specified and/or required under laws, rules and regulations of all departments having jurisdiction. Tests shall also be performed as indicated herein and other sections of the specifications.
 - 2. After all systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems.
 - 3. All parts of the work and associated equipment shall be tested and adjusted to work properly and be left in perfect operating condition.
 - 4. Correct defects disclosed by these tests without any additional cost to the Owner. Repeat tests on repaired or replaced work.
 - 5. Maintain a log of all tests being conducted and have it available for review by the Engineer. Log to indicate date, type of tests, duration, and defects noted and when corrected.
 - 6. Special tests on individual systems are specified under individual Specification Sections.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

3.11 CLEANING

- A. Progress Cleaning: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

SECTION 250100 - GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROL (continued):

2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Final Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove labels that are not permanent.
 - c. Wipe surfaces of equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

END OF SECTION 250100

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SECTION 250529 - HANGERS AND SUPPORTS FOR CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems for control raceways.
 - 2. Aluminum slotted support systems for control raceways.
 - 3. Conduit and cable support devices.
 - 4. Support for conductors in vertical conduit.
 - 5. Structural steel for fabricated supports and restraints.
 - 6. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 - 7. Fabricated metal equipment support assemblies.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 3. Channel Width: Selected for applicable load criteria.
 - 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 7. Channel Dimensions: Selected for applicable load criteria.

SECTION 250529 - HANGERS AND SUPPORTS FOR CONTROL SYSTEMS (continued):

- B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Channel Material: 6063-T6 aluminum alloy.
 - 3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 7. Channel Dimensions: Selected for applicable load criteria.
- C. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125/F 3125M, Grade A325 (Grade A325M).
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

SECTION 250529 - HANGERS AND SUPPORTS FOR CONTROL SYSTEMS (continued):

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101.
 - 5. NECA 102.
 - 6. NECA 105.
 - 7. NECA 111.
- B. Comply with requirements in Division 07 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Division 26 and Division 27.
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.

SECTION 250529 - HANGERS AND SUPPORTS FOR CONTROL SYSTEMS (continued):

- 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel-boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 250529

SECTION 250901 – STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Stand-alone control system for monitoring and controlling of HVAC systems.
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

1.3 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control.
- E. COV: Changes of value.
- F. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- G. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- H. RF: Radio frequency.
- I. UPS: Uninterruptible power supply.
- J. USB: Universal Serial Bus.
- K. WLED: White light emitting diode.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

1.4 ACTION SUBMITTALS

A. Multiple Submissions:

1. Submit Product Data and Shop Drawings in separate submittals. Incorporate approved Product Data into Shop Drawings.

B. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. Shop Drawings:

1. General Requirements:

- a. Include cover drawing with Project name, location, Owner, Engineer, Contractor and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
 - c. Drawings Size: 11"x17".
2. Include plans, elevations, sections, and mounting details where applicable.
 3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 4. Detail means of vibration isolation and show attachments to rotating equipment.
 5. Schematic drawings for each controlled system indicating the following:
 - a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
 - c. A graphic showing location of control I/O in proper relationship to system.
 - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
 - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
 - f. Elementary wiring diagrams of controls for equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
 - g. Narrative sequence of operation.
 - h. Graphic sequence of operation, showing all inputs and output logical blocks.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

6. Electrical power riser diagram indicating the following:
 - a. Each point of connection to field power with requirements (volts / phase / hertz / amperes / connection type) listed for each.
 - b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression, DC power supplies, and UPS units with unique identification for each.
 - c. Each product requiring power with requirements (volts / phase / hertz / amperes / connection type) listed for each.
 - d. Power wiring type and size, race type, and size for each.
 7. Monitoring and control signal diagrams indicating the following:
 - a. Control signal cable and wiring between controllers and I/O.
 - b. Point-to-point schematic wiring diagrams for each product.
 - c. Control signal tubing to sensors, switches and transmitters.
- D. System Description:
1. Description of testing plans and procedures.
 2. Description of Owner training.
- E. Delegated-Design Submittal: For system products and installation indicated as being delegated.
1. Supporting documentation showing system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
 2. Schedule for control-damper actuators.
 - a. Actuator selection indicating torque provided.
 - b. Actuator signal to control damper (on, close or modulate).
 - c. Actuator position on loss of power.
 - d. Actuator position on loss of control signal.
 3. Schedule and design calculations for control valves and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Pressure-differential drop across valve at Project design flow condition.
 - c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
 - d. Design and minimum control valve coefficient with corresponding valve position.
 - e. Maximum close-off pressure.
 - f. Actuator selection indicating torque provided.
 - g. Actuator signal to control damper (on, close or modulate).
 - h. Actuator position on loss of power.
 - i. Actuator position on loss of control signal.
 4. Schedule and design calculations for selecting flow instruments.
 - a. Instrument flow range.
 - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - d. Pressure-differential loss across instrument at Project design flow conditions.
 - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For system to include in emergency, operation and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Engineering, installation, and maintenance manuals that explain how to:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
 - e. List of recommended spare parts with part numbers and suppliers.
 - f. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - g. Licenses, guarantees, and warranty documents.
 - h. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 - i. Owner training materials.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer warrants system free from defects within specified warranty period.
 - 1. Warranties include, but are not limited to, the following:
 - a. Recalibration of sensors.
 - b. Tuning of PID control loops.
 - c. Labor and materials.
 - 2. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
 - 3. Warranty service shall occur during normal business hours by qualified trained technician(s) and commence within 24 hours of Owner's verbal or written warranty service request, 24 hours a day, 7 days a week, 365 days a year, including holidays and weekends.
 - 4. Warranty Period: One year(s) from date of Final Completion, or as listed below, whichever comes first.
 - a. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Control system shall consist of stand-alone microprocessor-based controllers, sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- B. Control Stability: Control variables indicated within the following limits:
 - 1. Flow:
 - a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
 - b. Air, Terminal Units: Within 5 percent of design flow rate.
 - c. Water: Within 5 percent of design flow rate.
 - d. Steam: Within 5 percent of design flow rate.
 - 2. Moisture (Relative Humidity):
 - a. Air: Within 5 percent RH.
 - b. Space: Within 5 percent RH.
 - c. Outdoor: Within 5 percent RH.
 - 3. Level: Within 5 percent of reading.
 - 4. Pressure:
 - a. Air, Ducts and Equipment: Within 0.2 inch wg (50 Pa).
 - b. Space: Within 0.01 inch wg (2.5 Pa).
 - c. Water: Within 1.5 psi (10.3 kPa).
 - d. Steam: Within 2 psi (13.8 kPa).
 - 5. Temperature, Dew Point:
 - a. Air: Within 1 deg F (0.5 deg C).
 - b. Space: Within 1 deg F (0.5 deg C).
 - 6. Temperature, Dry Bulb:
 - a. Air: Within 2 deg F (1 deg C).

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- b. Space: Within 2 deg F (1 deg C).
 - c. Energy Recovery Runaround Liquid: Within 1 deg F (0.5 deg C).
- 7. Temperature, Wet Bulb:
 - a. Air: Within 1 deg F (0.5 deg C).
 - b. Space: Within 1 deg F (0.5 deg C).
- C. Environmental Conditions for Controllers:
 - 1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
 - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
 - 2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors, Non-Corrosive Environment: Type 4.
 - b. Outdoors, Corrosive Environment: Type 4X.
 - c. Indoors, Heated with Filtered Ventilation: Type 1.
 - d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
 - e. Indoors, Heated and Air Conditioned: Type 1.
 - f. Mechanical Equipment Rooms:
 - 1)
 - 2) Air-Moving Equipment Rooms: Type 1.
 - g. Localized Areas Exposed to Washdown: Type 4.
 - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 12.
 - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X.
 - j. Hazardous Locations: Explosion-proof rating for condition.
- D. Environmental Conditions for Instruments and Actuators:
 - 1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and ventilated as required by instrument and application.
 - 2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

- a. Outdoors, Non-Corrosive Environment: Type 4.
- b. Outdoors, Corrosive Environment: Type 4X.
- c. Indoors, Heated with Filtered Ventilation: Type 1.
- d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
- e. Indoors, Heated and Air-conditioned: Type 1.
- f. Mechanical Equipment Rooms:
 - 1) Air-Moving Equipment Rooms: Type 1.
- g. Localized Areas Exposed to Washdown: Type 4.
- h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 12.
- i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4X.
- j. Hazardous Locations: Explosion-proof rating for condition.

E. Electric Power Quality:

1. Power-Line Surges:

- a. Protect susceptible DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
- b. Do not use fuses for surge protection.
- c. Test protection in the normal mode and in the common mode, using the following two waveforms:
 - 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
 - 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

- a. Protect susceptible DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
 - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
 - 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
 - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
 - 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

- 3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

F. Backup Power Source:

- 1. Controlled systems and equipment served by a backup power source shall have associated controlled system products that control such systems and equipment also served from a backup power source.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

G. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.3 STAND-ALONE CONTROLLERS

A. Controllers shall perform monitoring, control, energy optimization and other requirements indicated.

B. Environment Requirements:

1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F (Zero to 50 deg C).
3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F (40 to 65 deg C).

C. Power and Noise Immunity:

1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches (900 mm) of enclosure.

D. Remote Temperature Controller:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Honeywell; T775 Series or comparable product.
2. Description: Stand-alone, multi-point and multi-loop electronic temperature controller.
3. Operating Voltage: 24 Vac or 120 Vac.
4. Backlit digital display.
5. Integral seven-day time clock for night setback or shutdown.
6. Sensors (as required for application):
 - a. Room: Wall-mounted, space temperature RTD sensor.
 - b. Duct: 8-inch duct temperature RTD sensor with box.
 - c. Coils: 12-foot averaging temperature RTD sensor with box.
7. Signal Input (model specific as required for application):
 - a. Digital: Dry contact.
 - b. Analog: 0 – 10 Vdc or 4 – 20 mA
8. Signal Output (model specific as required for application):
 - a. Relays: 24 Vac.
 - b. Modulating: 0 – 10 Vdc, 2 – 10 Vdc, or 4 – 20 mA.
9. Control Type (model specific as required for application):
 - a. Relay On/Off: Differential control, adjustable.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- b. Modulating: PI or PID, with adjustable tuning.

2.4 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in an enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Individual wall-mounted single-door enclosures shall not exceed 36 inches (900 mm) wide and 48 inches (1200 mm) high.
5. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or free-standing support stand as indicated.
6. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect electric and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch- (6-mm-) high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
- D. Wall-Mounted, NEMA 250, Type 1:
1. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
 2. Construct enclosure of steel, not less than:
 - a. Enclosure size less than 24 in. (600 mm): 0.053 in. (1.35 mm) or 0.067 in. (1.7 mm) thick.
 - b. Enclosure size 24 in. (600 mm) and larger: 0.067 in. (1.7 mm) thick.
 3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior color shall be manufacturer's standard.
 - b. Interior color shall be manufacturer's standard.
 4. Hinged door full size of front face of enclosure and supported using:
 - a. Enclosures sizes less than 36 in. (900 mm) tall: Multiple butt hinges.
 - b. Enclosures sizes 36 in. (900 mm) tall and larger: Continuous piano hinges.
 5. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Size less than 24 in. (600 mm): Solid or Perforated steel, 0.053 in. (1.35 mm) thick.
 - b. Size 24 in. (600 mm) and larger: Solid aluminum, 0.10 in. (3 mm) or steel, 0.093 in. (2.36 mm) thick.
 6. Internal panel mounting hardware, grounding hardware and sealing washers.
 7. Grounding stud on enclosure body.
 8. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- E. Wall Mounted NEMA 250, Types 4 and 12:
1. Enclosure shall be NRTL listed according to UL 508A.
 2. Seam and joints are continuously welded and ground smooth.
 3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
 4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seam-less gasket door seal.
 5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide (1500 mm tall by 900 mm wide).
 6. Construct enclosure of steel, not less than the following:
 - a. Size Less Than 24 Inches (600 mm): 0.053 inch (1.35 mm) or 0.067 inch (1.7 mm) thick.
 - b. Size 24 Inches (600 mm) and Larger: 0.067 inch (1.7 mm) thick.
 7. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior color shall be manufacturer's standard.
 - b. Interior color shall be manufacturer's standard.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

8. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
 - a. Sizes through **24 Inches (600 mm)** Tall: Two hinges.
 - b. Sizes between **24 Inches (600 mm)** through **48 Inches (1200 mm)** Tall: Three hinges.
 - c. Sizes Larger **48 Inches (1200 mm)** Tall: Four hinges.
 9. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Size Less Than **24 Inches (600 mm)**: Solid or perforated steel, **0.053 inch (1.35 mm)** thick.
 - b. Size **24 Inches (600 mm)** and Larger: Solid aluminum, **0.10 inch (3 mm)** or steel, **0.093 inch (2.36 mm)** thick.
 10. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
 11. Grounding stud on enclosure body.
 12. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- F. Wall-Mounted, NEMA 250, Type 4X SS:
1. Enclosure shall be NRTL listed according to UL 508A.
 2. Seam and joints are continuously welded and ground smooth.
 3. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 4. Construct enclosure of Type 316L stainless steel, not less than the following:
 - a. Size Less Than **24 Inches (600 mm)**: **0.053 inch (1.35 mm)** thick.
 - b. Size **24 Inches (600 mm)** and Larger: **0.067 inch (1.7 mm)** thick.
 5. Outside body and door of enclosure with brushed No. 4 finish.
 6. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
 - a. Sizes through **24 Inches (600 mm)** Tall: Two hinges.
 - b. Sizes between **24 Inches (600 mm)** through **48 Inches (1200 mm)** Tall: Three hinges.
 - c. Sizes Larger **48 Inches (1200 mm)** Tall: Four hinges.
 7. Corner-formed door, full size of enclosure face, supported using continuous piano hinge full length of door.
 8. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquid-tight Type 316 stainless-steel handle with integral locking mechanism.
 9. Removable internal panel shall be **0.093-inch (2.36-mm)** solid steel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 10. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
 11. Install corrosion-resistant polyester vent drain in a stainless-steel sleeve at the bottom of enclosure.
 12. Include enclosure with stainless-steel mounting brackets.
- G. Accessories:
1. Electric Heater:
 - a. Aluminum housing with brushed finish.
 - b. Thermostatic control with adjustable set point from **zero to 100 deg F (Minus 18 to 38 deg C)**.
 - c. Capacity: 100, 200, 400, and 800 W as required by application.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.
- 2. Ventilation Fans, Filtered Intake and Exhaust Grilles:
 - a. Number and size of fans, filters and grilles as required by application.
 - b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
 - c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
 - d. Thermostatic control with adjustable set point from 32 to 140 deg F (Zero to 60 deg C).
 - e. Maximum operating temperature of 158 deg F (70 deg C).
 - f. 4-inch (100-mm) fan thermally protected and provided with permanently lubricated ball-bearings.
 - g. 6- and 10-inch (150- and 250-mm) fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
 - h. Dynamically balanced impellers molded from polycarbonate material.
 - i. Fan furnished with power cord and polarized plug for power connection.
 - j. Fan brackets, finger guards and mounting hardware provided with fans to complete installation.
 - k. Removable Intake and Exhaust Grilles: ABS plastic or stainless steel of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
 - l. Filters for NEMA 250, Type 1 Enclosures: Washable aluminum, of a size to match intake grille.
 - m. Filters for NEMA 250, Type 12 Enclosures: Disposable, of a size to match intake grille.
- 3. Bar handle with keyed cylinder lock set.

2.5 RELAYS

- A. Current Sensing Relay:
 - 1. Monitors ac current.
 - 2. Independent adjustable controls for pickup and dropout current.
 - 3. Energized when supply voltage is present and current is above pickup setting.
 - 4. De-energizes when monitored current is below dropout current.
 - 5. Dropout current is adjustable from 50 to 95 percent of pickup current.
 - 6. Include a current transformer, if required for application.
 - 7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.
 - 8. Positive indication of belt failure.
- B. Control Relay:
 - 1. Description:
 - a. LED status indication of activated relay and current trigger.
 - b. Closed-Open-Auto override switch located on the load side of the relay.
 - 2. Performance:
 - a. Ambient Temperature: Minus 30 to 140 deg F (Minus 34 to 60 deg C).
 - b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

3. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
4. Enclosure: NEMA 250, Type 1 enclosure (plenum rated) for indoors and NEMA 250, Type 4X for outdoors.

2.6 ELECTRICAL POWER DEVICES

A. Transformers:

1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
2. Transformer shall be at least 40 VA.
3. Transformer shall have both primary and secondary fuses.

B. Transient Voltage Suppression:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. **Current Technology Inc.**
 - b. Liebert Corporation.
 - c. Surge Suppression, Inc.
2. The maximum continuous operating voltage shall be at least 125 percent.
3. The operating frequency range shall be 47 to 63 Hz.
4. Protection modes according to NEMA LS-1.
5. The rated single-pulse surge current capacity, for each mode of protection, shall be no less than the following:
 - a. Line to Neutral: 45,000 A.
 - b. Neutral to Ground: 45,000 A.
 - c. Line to Ground: 45,000 A.
 - d. Per Phase: 90,000 A.
6. Clamping voltages shall be in compliance with test and evaluation procedures defined in NEMA LS-1. Maximum clamping voltage shall be as follows:
 - a. Line to Neutral: 360 V.
 - b. Line to Ground: 360 V.
 - c. Neutral to Ground: 360 V.
7. Unit shall have LED status indicator that extinguishes to indicate a failure.
8. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449.
9. Unit shall not generate any appreciable magnetic field.
10. Unit shall not generate an audible noise.
11. Applications:
 - a. Control Power:
 - 1) Description: Series connected, Type 2 SPD. (Type 1 and Type 4 are NOT permitted).
 - 2) Connections: 3-position screw terminal strips.
 - 3) Current Rating: 30 A.
 - 4) Basis of Design: Surge Suppression, Inc.; S-SPT###-30.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

b. Hardwired Points:

- 1) Description: Series connected SPD.
- 2) Connections: Screw terminal strips.
- 3) Current Rating: 500 mA.
- 4) Maximum Data Rate: 2 Mbps.
- 5) Basis of Design: Surge Suppression, Inc.; CLP24Ax-B.

C. DC Power Supply:

1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
2. Enclose circuitry in a housing.
3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
4. Performance:
 - a. Output voltage nominally 25-V dc within 5 percent.
 - b. Output current up to 100 mA.
 - c. Input voltage nominally 120-V ac, 60 Hz.
 - d. Load regulation within 0.5 percent from zero- to 100-mA load.
 - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
 - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

2.7 PIPING AND TUBING

A. Pressure Instrument Signal Air, Tubing and Piping:

1. Products in this paragraph are intended for use with the following:
 - a. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers and accessories.
2. Copper Tubing:
 - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
 - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
 - c. Diameter, as required by application, not less than nominal **0.25 inch (6 mm)**.
 - d. Wall thickness, as required by the application, but not less than **0.030 inch (0.8 mm)**.
3. Copper Tubing Connectors and Fittings:
 - a. Brass, solder-joint type.
4. Polyethylene Tubing:
 - a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1, Class C and Grade 5.
 - b. Tubing shall comply with stress crack test according to ASTM D 1693.
 - c. Diameter, as required by application, of not less than nominal **0.25 inch (6 mm)**.
5. Polyethylene Tubing Connectors and Fittings:

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- a. Brass, barbed fittings.
 - b. Brass, compression type.
- B. Process Tubing:
 1. Products in this paragraph are intended for signals to instruments connected to liquid and steam systems.
 2. Copper Tubing:
 - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered with chemical and physical properties according to ASTM B 75.
 - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
 - c. Diameter, as required by application, of not less than nominal **0.25 inch (6 mm)**.
 - d. Wall thickness, as required by application, but not less than **0.030 inch (0.8 mm)**.
 3. Copper Tubing Connectors and Fittings:
 - a. Brass, solder-joint type.
 4. Stainless-Steel Tubing:
 - a. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, free from scale.
 - b. Chemical and physical properties according to ASTM A 269.
 - c. Diameter, as required by application, of not less than nominal **0.25 inch (6 mm)**.
 - d. Wall thickness, as required by application, but not less than **0.035 inch (0.9 mm)**.
 - e. Furnish stainless-steel tubing in [**20-foot (6-mm)**] straight random lengths.
 5. Stainless-Steel Tubing Connectors and Fittings:
 - a. Connectors and fittings shall be stainless steel, with stainless-steel collets, flareless type.
 - b. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.

2.8 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
 1. Wire size shall be at least No. 18 AWG.
 2. Conductor shall be 7/24 soft annealed copper strand with **2- to 2.5-inch (50- to 65-mm)** lay.
 3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
 4. Conductor colors shall be black (hot), white (neutral), and green (ground).
 5. Furnish wire on spools.
- B. Single Twisted Shielded Instrumentation Cable above 24 V:
 1. Wire size shall be a minimum No. 18 AWG.
 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a **2- to 2.5-inch (50- to 65-mm)** lay.
 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
1. Wire size shall be a minimum No. 18 AWG.
 2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch (50- to 65-mm) lay.
 3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
 4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.

2.9 RACEWAYS

- A. Comply with requirements in Division 26 for electrical power raceways and boxes.
- B. Comply with requirements in Division 26 and Division 27 for raceways for balanced twisted pair cables and optical fiber cables.

2.10 IDENTIFICATION

- A. Control Equipment, Instruments, and Control Devices:
1. Self-adhesive label and Laminated acrylic or melamine plastic sign bearing unique identification.
 - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
 2. Legend shall consist of white lettering on black background.
 3. Laminated acrylic or melamine plastic sign shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer and shall be fastened with drive pins.
 4. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.
- B. Valve Tags:
1. Brass tags and brass chains attached to valve.
 2. Tags shall be at least 1.5 inches (38 mm) in diameter.
 3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
 4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.
- C. Raceway and Boxes:

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "Controls," using an engraved phenolic tag.
 3. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."
- D. Equipment Warning Labels:
1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
 2. Lettering size shall be at least 14-point type with white lettering on red background.
 3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
 4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least **0.25 inch (6 mm)** beyond white border.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
1. Airflow sensors and switches, which are specified in Section 250923.14 "Flow Instruments."
 2. Pressure sensors, which are specified in Section 250923.23 "Pressure Instruments."
- C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

1. DDC control valves, which are specified in Section 250923.11 "Control Valves."
 2. Pipe-mounted flow meters, which are specified in Section 250923.14 "Flow Instruments."
 3. Pipe-mounted sensors, switches and transmitters. Flow meters are specified in Section 250923.14 "Flow Instruments." Liquid and steam temperature sensors, switches, and transmitters are specified in Section 250923.27 "Temperature Instruments."
- D. Deliver the following to electrical installers for installation in electrical circuits. Include installation instructions to Installer and supervise installation for compliance with requirements.
1. Relays and/or motor-rated contactors required for operation of single-phase motors, 1 hp and smaller. (Motor starters for three-phase motors and single-phase motors larger than 1 hp shall be furnished and installed by Division 26 contractor).

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Division 07.
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Division 07.
- H. Welding Requirements:
1. Restrict welding and burning to supports and bracing.
 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

3.4 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
 - 1. Provide a separate controller for each major HVAC system.
 - 2. Controller shall be located within the same room as equipment.
- B. Connect controllers to field power supply and to UPS units where indicated.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Application-Specific Controllers:
 - 1. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.5 PROGRAMMING

- A. Provide software programming for the system as per specifications and adhere to the sequences of operation provided on the Drawings.

3.6 ENCLOSURES INSTALLATION

- A. Install the following items in enclosures, to comply with indicated requirements:
 - 1. Controllers.
 - 2. Electrical power devices.
 - 3. Accessories.
- B. Attach wall-mounted enclosures to wall using the following types of steel struts:
 - 1. For NEMA 250, Type 1 Enclosures: Use galvanized-steel or corrosion-resistant-coated steel strut and hardware.
 - 2. For NEMA 250, Type 4 Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
 - 3. Install plastic caps on exposed cut edges of strut.
- C. Align top of adjacent enclosures.
- D. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

3.7 SURGE PROTECTIVE DEVICES INSTALLATION

- A. Install surge protective devices as close as practical to the electrical panel or dedicated electronic equipment to be protected. The SPD shall be close-connected to the panel in a position near the panel board neutral bus bar or positioned so that the overall lead length will be minimal.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- B. Install surge protection devices in a manner consistent with proper and acceptable industry wiring practice. Install connection leads as short and straight as possible while avoiding sharp bends. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- C. Surge protective devices shall be installed at the following locations:
 - 1. VFD communication interfaces.
 - 2. Exterior hardwired terminations. Provide multiple SPDs to accommodate quantity of hardwired terminations specified.
 - 3. Control transformers.

3.8 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Division 26.

3.9 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Division 26 for identification products and installation.
- B. Install self-adhesive labels with unique instrument identification on face of each instrument connected to a DDC controller.
- C. Install self-adhesive labels with unique identification on face of each control damper and valve actuator connected to a DDC controller.
- D. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.
- E. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.
- F. Warning Labels and Signs:
 - 1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
 - 2. Shall be located in highly visible location near power service entry points.

3.10 PIPING AND TUBING INSTALLATION

- A. Above-Grade Air Signal Piping and Tubing Installation:
 - 1. Material Application:
 - a. Install copper tubing, except as follows:

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- 1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
 - 2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when concealed behind accessible ceilings.
 - b. Install copper tubing, unless other accessible materials are indicated, for air signals to instruments including, but not limited to, the following:
 - 1) Sensors.
 - 2) Switches.
 - 3) Transmitters.
 - c. Install drawn-temper copper tubing, except within 36 inches (900 mm) of device terminations tubing shall be annealed-tempered copper tubing.
 - d. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
 - e. Install barbed fittings to connect polyethylene tubing to instruments, control devices, and accessories.
2. Routing:
 - a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
 - b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling or behind architectural enclosures or covers.
 - c. Install piping and tubing plumb and parallel to and at right angles with building construction.
 - d. Install multiple runs of tubing or piping in equally spaced parallel lines.
 - e. Piping and tubing shall not interfere with access to valves, equipment, duct and equipment access doors, or obstruct personnel access and passageways of any kind.
 - f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on record Drawings.
 - g. Install vibration loops in copper tubing when connecting to instrument and actuators that vibrate.
3. Support:
 - a. According to MSS SP-69, Table 3, except support spacing shall not exceed 60 inches (1500 mm).
 - b. Support copper tubing with copper hangers, clips, and tube trays.
 - c. Do not use tape for support or dielectric isolation.
 - d. Install supports at each change in direction and at each branch take off.
 - e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
 - f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
 - g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
 - h. Brace supports to prevent lateral movement.
 - i. Paint steel support members that are not galvanized or zinc coated.
 - j. Support polyethylene tubing same as copper tubing.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
5. Protect exposed tubing in mechanical equipment rooms from mechanical damage within **84 inches (2100 mm)** above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
6. Joining and Makeup:
 - a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
 - b. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on other end.
 - c. Make tubing bends with a tube-bending tool. Hard bends, wrinkled or flattened bends are unacceptable.
 - d. Install tube fittings according to manufacturer's written instructions.
 - e. Do not make tubing connections to a fitting before completing makeup of the connection.
 - f. Align tubing with the fitting. Avoid springing tube into position, as this may result in excessive stress on both tubing and fitting with possible resulting leaks.
 - g. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
 - h. Check tubing for correct diameter and wall thickness.
 - i. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.
 - j. Thread pipe on a threading machine. Ream inner edges of pipe ends, file and grind to remove burrs.
 - k. Wrap pipe threads of fittings on pneumatic lines with a single wrap of PTFE tape.
 - l. Protect piping and tubing from entrance of foreign matter.
7. Conduit in which nonmetallic tubing is installed shall not exceed 50 percent fill. Support conduit according to NFPA 70 unless otherwise indicated.

B. Identify piping and tubing as follows:

1. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
2. Mark each instrument tube connection with a number-coded identification. Each unique tube shall have same unique number at instrument connection and termination at opposite end of tube.

3.11 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Division 26.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Terminate wiring in a junction box.
 - a. Clamp cable over jacket in junction box.
 - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

4. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
5. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
6. Use shielded cable to transmitters.
7. Use shielded cable to temperature sensors.
8. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Division 26 for control-voltage conductors.
2. Comply with Division 26 and Division 27 for balanced twisted pair cabling and optical fiber installation.

3.12 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Testing of Air-Signal Tubing:
 - a. Test for leaks and obstructions.
 - b. Disconnect each pipe and tubing line before a test is performed, and blowout dust, dirt, trash, condensate and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Air from an oil-free compressor with an air dryer is an acceptable alternative for the test.
 - c. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
 - d. Connect a pressure source to near end of run with a needle valve between air supply and tubing run.
 - e. Connect a pressure gage accurate to within 0.5 percent of test between the shutoff needle valve and tubing run under test.
 - f. For system pressures above 30 psig (207 kPa), apply a pressure of 1.5 times operating pressure. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 1 psig (6.9 kPa).
 - g. For system pressures 30 psig (207 kPa) and below, apply a pressure of 2.0 times operating pressure to piping and tubing run. Record pressure in tubing run every 5 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 0.5 psig (3.5 kPa).

B. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.13 SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
- E. Control Damper Checkout:
 1. Verify that control dampers are installed correctly for flow direction.
 2. Verify that proper blade alignment, either parallel or opposed, has been provided.
 3. Verify that damper frame attachment is properly secured and sealed.
 4. Verify that damper actuator and linkage attachment is secure.
 5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
 6. Verify that damper blade travel is unobstructed.
- F. Control Valve Checkout:
 1. Verify that control valves are installed correctly for flow direction.
 2. Verify that valve body attachment is properly secured and sealed.
 3. Verify that valve actuator and linkage attachment is secure.
 4. Verify that actuator wiring is complete, enclosed and connected to correct power source.
 5. Verify that valve ball, disc or plug travel is unobstructed.
 6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
- G. Instrument Checkout:
 1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
 2. Verify that attachment is properly secured and sealed.
 3. Verify that conduit connections are properly secured and sealed.
 4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
 5. Inspect instrument tag against approved submittal.
 6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
 7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
 8. For temperature instruments:

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- a. Verify sensing element type and proper material.
- b. Verify length and insertion.

3.14 SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
 - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 - 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 - 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
 - 1. Check digital signals using a jumper wire.
 - 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
 - 1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
 - 3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
 - 4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.15 SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.16 CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
 - a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
8. Exercise each binary point.

3.17 SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 1. Detailed explanation for any items that are not completed or verified.
 2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
 3. HVAC equipment motors operate below full-load amperage ratings.
 4. Required system components, wiring, and accessories are installed.
 5. Installed system architecture matches approved Drawings.
 6. Control electric power circuits operate at proper voltage and are free from faults.
 7. Required surge protection is installed.
 8. system network communications function properly, including uploading and downloading programming changes.
 9. Each controller's programming is backed up.
 10. Equipment, products, tubing, wiring cable and conduits are properly labeled.
 11. All I/O points are programmed into controllers.
 12. Testing, adjusting and balancing work affecting controls is complete.
 13. Dampers and actuators zero and span adjustments are set properly.
 14. Each control damper and actuator goes to failed position on loss of power.
 15. Valves and actuators zero and span adjustments are set properly.
 16. Each control valve and actuator goes to failed position on loss of power.
 17. Meter, sensor and transmitter readings are accurate and calibrated.
 18. Control loops are tuned for smooth and stable operation.
 19. View trend data where applicable.
 20. Each controller works properly in standalone mode.
 21. Safety controls and devices function properly.
 22. Interfaces with fire-alarm system function properly.
 23. Electrical interlocks function properly.
 24. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
 25. Record Drawings are completed.
- E. Test Plan:
 1. Prepare and submit a validation test plan including test procedures for performance validation tests.
 2. Test plan shall address all specified functions of system and sequences of operation.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
 - a. Verify analog I/O points at operating value.
 - b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
 - a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

3.18 FINAL REVIEW

- A. Submit written request to Engineer and Construction Manager when system is ready for final review. Written request shall state the following:
 1. System has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
 2. System has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
 3. System control of HVAC systems results in operation according to sequences of operation indicated.
 4. System is complete and ready for final review.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- B. Review by Engineer and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should additional reviews be required due to a specific start-up or checkout test item, reported to have been successfully completed, but determined during review to be faulty, Construction Manager shall compensate entity performing review for total costs, labor and expenses, associated with subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review. Construction Manager shall be responsible for any cost recovery for retesting costs from the party responsible for executing the faulty start-up or checkout test item.
- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of system final review shall include a demonstration to parties participating in final review.
 - 1. Provide staff familiar with system installed to demonstrate operation of system during final review.
 - 2. Provide testing equipment to demonstrate accuracy and other performance requirements of system that is requested by reviewers during final review.
 - 3. Demonstration shall include, but not be limited to, the following:
 - a. Accuracy and calibration of 20 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
 - b. Controlled equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 20 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
 - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
 - d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.

3.19 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.20 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.21 DEMONSTRATION

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide not less than one days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
 - c. Total days of training shall be broken into not more than four separate training classes.
- C. Training Schedule:
 - 1. Schedule training to provide Owner with at least 20 business days of notice in advance of training.
 - 2. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions.
 - 3. Provide staggered training schedule as requested by Owner.
- D. Training Attendee List and Sign-in Sheet:
 - 1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
 - 2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
 - 3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
 - 4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
 - 5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.
- E. Organization of Training Sessions:
 - 1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system.
 - 2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.
- F. Training Outline:
 - 1. Submit training outline for Owner review at least 20 business days before scheduling training.
 - 2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.
- G. On-Site Training:

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

1. Provide as much of training located on-site as deemed feasible and practical by Owner.
2. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
3. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

H. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide a workstation for use by each attendee.

I. Training Content for Daily Operators:

1. Basic System Understanding
 - a. Basic operation of system.
 - b. Understanding each unique product type installed including performance and service requirements for each.
 - c. Understanding operation of each system and equipment controlled by system including sequences of operation.
 - d. Adjusting and changing set points and time schedules.
 - e. Understanding content of operation and maintenance manuals including control drawings.
 - f. Understanding physical location and placement of controllers and I/O hardware.
 - g. Review of testing results to establish basic understanding of system operating performance and HVAC system limitations as of Substantial Completion.
2. Operations:
 - a. All equipment and/or system start-up procedures.
 - b. All equipment and/or systems shut-down procedures.
 - c. Routine and normal operating sequences for all systems.
 - d. Special operating instructions and procedures.
 - e. Seasonal and weekend operating instructions.
 - f. Demonstrating the following for systems and equipment controlled by system:
 - 1) Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
 - 2) Hardware interlocks and safeties function properly and system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
3. Emergencies:
 - a. Instructions on meanings of warnings, trouble indications, and error messages.
 - b. Instructions on stopping, manual overrides, and BAS override procedures.
 - c. Safety device procedures and actions.
 - d. Operating procedures for system, sub-system, or equipment failures.
 - e. Shut-down instructions for each type of emergency.
 - f. Operating instructions for conditions outside of normal limits.
 - g. Special operating instructions and procedures.
 - h. Adjustments:
 - 1) Proper adjustment procedures and points intended to be adjusted.

SECTION 250901 - STAND-ALONE CONTROLS FOR NON-DDC SYSTEMS (continued):

- 2) Economy and efficiency adjustments.
 - 3) Adjustments for efficient energy use.
- 4. Troubleshooting:
 - a. Diagnostic instruction procedures for each typical system installed.
 - b. Test and inspection procedures for each typical system installed.
 - c. Maintenance.
 - d. Inspection procedures.
 - e. Procedures for preventative maintenance.
 - f. Procedures for routine maintenance.

END OF SECTION 250901

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions of this Section apply to all Division 26 Specification Sections.

1.2 SUMMARY

- A. Section includes basic requirements for electrical systems.
- B. Related Work:
 - 1. Division 03 – Concrete
 - a. Refer to Division 03 for rough grouting in and around work, patching concrete cut to accommodate work, and sumps for work.
 - b. Comply with the requirements of Division 03 for curbs, foundations, and equipment pads for equipment.
 - 2. Division 05 – Metals
 - a. Refer to Division 05 for framed openings for equipment.
 - b. Comply with the requirements of Division 05 for supports for work.
 - 3. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 4. Division 07 – Thermal and Moisture Protection
 - a. Refer to Division 07 for installation of roof curbs and roof supports and for caulking and waterproofing of wall- and roof-mounted work.
 - b. Comply with the requirements of Division 07 for penetration firestopping and furnishing roof curbs and roof supports for equipment and conduit.
 - 5. Division 08 – Openings
 - a. Refer to Division 08 for installation of access doors and frames.
 - b. Comply with the requirements of Division 08 for access doors and frames, unless otherwise included in the Contract Documents.
 - 6. Division 09 – Finishes
 - a. Refer to Division 09 for paint products and applications in finished spaces.
 - b. Comply with the requirements of Division 09 for paint products and applications identified in the Contract Documents.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

7. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
8. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
9. Division 22 – Plumbing
 - a. Refer to Division 22 for all plumbing work.
 - b. Comply with requirements of Division 22 for related equipment and components and for connections to systems.
10. Division 23 – Heating, Ventilation, and Air-Conditioning
 - a. Refer to Division 23 for all heating, ventilation, and air-conditioning work.
 - b. Comply with requirements of Division 23 for related equipment and components and for connections to systems.
11. Division 25 – Instrumentation and Control
 - a. Refer to Division 25 for instrumentation and control systems.
 - b. Comply with the requirements of Division 25 for installation of and integration with instrumentation and control components.
12. Division 27 – Communications
 - a. Refer to Division 27 for all communications work.
13. Division 28 – Electronic Safety and Security
 - a. Refer to Division 28 for all electronic safety and security work.
 - b. Coordinate with Division 28 for integration with security systems.
14. Division 29 – Fire Safety and Emergency Communications
 - a. Refer to Division 29 for all fire safety and emergency communications work.
 - b. Coordinate with Division 29 for integration with fire safety and emergency communications systems.
15. Division 31 – Earthwork
 - a. Refer to Division 31 for all site related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 31 for site clearing, earth moving, and dewatering within five feet outside the building and otherwise as indicated in the Contract Documents.
16. Division 33 – Utilities
 - a. Refer to Division 33 for all utility related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 33 for utility work within five feet outside the building and otherwise as indicated in the Contract Documents.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, “experienced” unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Furnish: Supply and deliver to project site, ready for subsequent requirements.
- C. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
- D. Provide: Furnish and install, complete and ready for intended use.
- E. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- F. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.
- G. Concealed Work: Work hidden from view, including inside chases, furred spaces, or above ceilings.
- H. Exposed Work: Work open to view, including inside mechanical and equipment rooms .

1.4 QUALITY ASSURANCE

- A. General:
 - 1. It is the intent of the plans and specifications to obtain a complete, operable and satisfactory installation.
 - 2. All materials shall be new, be properly labeled and/or identified and be in full compliance with the contract documents.
 - 3. All work shall comply with applicable Codes and Standards.
 - 4. Manufacturer's model names and numbers used in these specifications are subject to change per manufacturer's action. Contractor shall therefore verify them with manufacturer's representative before ordering any product or equipment
- B. Furnish new and unused materials and equipment manufactured in the U.S.A. Where two or more units of the same type or class of equipment are required provide units of a single manufacturer.

1.5 CODES AND STANDARDS

- A. Perform work in accordance with the following codes and any applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
 - 1. ASHRAE
 - a. Standard 90.1 Energy Standard for Buildings Except Low Rise Residential Buildings - 2019
 - 2. Occupational Safety and Health Regulations (OSHA).
 - 3. National Fire Codes

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

- a. NFPA 1 Fire Code – 2021 (Florida Edition)
 - b. NFPA 70 National Electrical Code – 2020
 - c. NFPA 72 National Fire Alarm and Signaling Code - 2019
 - d. NFPA 101 Life Safety Code – 2021 (Florida Edition)
 - 4. Florida Building Code, 2023 Edition
 - a. Building Code
 - b. Energy Conservation Code
 - c. Mechanical Code
 - d. Plumbing Code
 - e. Fuel Gas Code
 - f. Accessibility Code
 - 5. Florida Statutes
 - a. Chapter 471 Engineering
 - b. Chapter 533.80 Building Construction Standards; Florida Building Code - Enforcement
 - 6. Florida Administrative Code
 - a. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - b. Chapter 61G15-33 Responsibility Rules of Professional Engineers Concerning the Design of Electrical Systems
 - c. Chapter 69A-3 Fire Prevention – General Provisions
 - d. Chapter 69A-60 The Florida Fire Prevention Code
 - 7. ADA Accessibility Guidelines for Buildings (ADAAG)
- B. Resolve, in writing, any code violation discovered in contract documents with the Engineer prior to bidding. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. The Contractor shall include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and drawings required to comply with all applicable laws, ordinances, rules, and regulations.
- D. Where there is conflict between the Contract Documents and the applicable Codes, the Codes shall govern, except where the requirements of the Contract Documents are more stringent.

1.6 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or NEC Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments, or supplements in effect on date bids are received. Specifications and standards are minimum requirements for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
- B. Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition of the standard at the time project is bid unless otherwise specified herein

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

1.7 DELEGATED-DESIGN SERVICES

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

1.8 PERMITS FEES AND INSPECTIONS

- A. Obtain and pay for all permits, fees, tap fees, connection charges, demand charges, systems charges, impact fees, and inspections.
- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.9 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
 - 1. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer in writing prior to bid date; however, the most stringent requirement shall govern.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.10 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 - 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Prepare RFIs as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 - 1. The following Contractor-generated RFIs will be returned without action:

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

- a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.

1.11 SUBMITTALS

- A. Submittals (including Product Data, Shop Drawings, and any other Action Submittal or Information Submittal) will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions, Division 01, and the following:
1. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are approved by the Engineer.
 3. Submittals shall only contain relevant product data. Remove or strikeout irrelevant product data.
 4. Prepare submittals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
 5. Options: Identify options requiring selection by Engineer.
 6. Deviations: Clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 7. Revisions: Include relevant additional information and revisions, other than those specifically requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached submittal sheet.
 8. Contractor's Review:
 - a. Submittals shall have been reviewed and approved by the General Contractor / Construction Manager. Include approval stamp, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - b. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.
 9. Electrical Modifications:
 - a. The electrical design indicated on the plans supports the Basis of Design specifications for the HVAC, plumbing, and fire-suppression systems at the time of design.
 - b. If HVAC, plumbing, or fire-suppression equipment is submitted with different electrical requirements, it is the responsibility of the Contractor to resolve all required electrical design changes, including, but not limited to: wire and conduit size, type or size of disconnect or overload protection, breaker coordination, point(s) of connection, etc. Any corrections required shall be provided at no additional cost.
 - c. Submittal shall clearly show the electrical design revisions with a written statement that this change will be provided at no additional cost. Submittals made with no written reference to the electrical design revisions will be presumed to work with the electrical design.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

- B. Processing Time: Time of review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of the failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Allow not less than 15 days for submittal review. Allow not less than 21 days for review of large or complex submittals. Submittals received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 - 2. If Contractor transmits more than five submittals over two consecutive business days, review time shall increase by no less than 7 days for submittal review.
 - 3. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 - 4. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received. Time of review shall commence on receipt of all other related submittals.
- C. The Contractor shall not be relieved of responsibility for deviations from requirements of the contract documents by the Engineer's approval of shop drawings, product data, samples, or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal, and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in shop drawings, product data, samples, or similar submittals by the Engineer's approval thereof.
- D. Submittal Review Fees:
 - 1. Additional Reviews: Submittals on any particular phase of Work will receive only one review and one re-review (if required). If additional reviews are required beyond these two, the Contractor will be charged \$200.00 per hour for review time, in addition to any expedited review charges. This fee shall be paid to the Engineer prior to Submittal release.
 - 2. Expedited Reviews: If General Contractor / Construction Manager requests for an expedited review, whether by official request or unofficially by assigning a review time less than required above, the General Contractor / Construction Manager will be charged \$1,000.00 per Submittal, in addition to any charges for additional reviews. This fee shall be paid to the Engineer prior to Submittal release.

1.12 COORDINATION DRAWINGS (NOT REQUIRED)

- A. Should the Contractor elect to provide Coordination Drawings when not expressly required by the Engineer, such Drawings shall be considered for informational purposes only. The Engineer will not conduct a review of these Drawings, and their submission or any implied approval shall not relieve the Contractor of the obligation to fully comply with the requirements set forth in the Construction Documents. The Contractor remains solely responsible for ensuring that all work meets the contract specifications and standards, regardless of the content or status of the Coordination Drawings.

1.13 SUBSTITUTIONS

- A. By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Substitution Requests shall include, at a minimum:

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

1. Statement indicating why specified material, equipment, or installation method cannot be provided, if applicable.
 2. Coordination of information, including a list of changes and revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 3. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include an annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 5. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 6. Cost information, including a proposal of change, if any, in the Contract Sum.
 7. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 8. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- C. Procurement Substitution Requests submitted prior to receipt of bids will be received and considered by Owner when the following conditions are satisfied, as determined by Engineer; otherwise, requests will be returned without action:
1. Requests for substitution of materials and equipment are received no later than 10 days prior to date of bid opening.
 2. Extensive revisions to the Contract Documents are not required.
 3. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
 4. The request is fully documented and properly submitted.
- D. Substitutions for Cause, as required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms will be received and considered by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 2. Substitution request is fully documented and properly submitted.
 3. Requested substitution has received necessary approvals of authorities having jurisdiction.
 4. Requested substitution is compatible with other portions of the Work.
 5. Requested substitution has been coordinated with other portions of the Work.
 6. Requested substitution provides specified warranty.
 7. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- E. Substitutions for Convenience, not required in order to meet other Project requirements but may offer advantage to Contractor or Owner, will be received and considered by Owner, as determined by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

1. Requested substitution is received within 60 days after the Notice of Award.
 2. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 3. Requested substitution does not require extensive revisions to the Contract Documents.
 4. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 5. Substitution request is fully documented and properly submitted.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. Requested substitution is compatible with other portions of the Work.
 8. Requested substitution has been coordinated with other portions of the Work.
 9. Requested substitution provides specified warranty.
 10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- F. If a requested substitution is approved but contains differences or omissions not specifically identified to the attention of the Engineer in the substitution request, the Owner reserves the right to require equal or similar features to be added to the substituted products or to have the substituted products replaced at the Contractor's expense.

1.14 PROJECT RECORD DOCUMENTS

- A. Recording: Maintain one copy of the Contract Documents and Shop Drawings during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation:
1. Contract Drawings and Shop Drawings:
 - a. Mark revisions to show where the actual installation varies from that shown originally.
 - b. Mark record sets completely and accurately, including important information that was either shown schematically or omitted from original Drawings.
 - c. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - d. Record underground and under-slab piping installed, dimensioning exact location and elevation of piping.
 2. Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 3. Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
- C. Deliver: Prior to Final Completion, provide record documents to Owner as indicated below:
1. Record Drawings: Submit PDF electronic files of scanned record prints and one set of prints.
 2. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
 3. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 4. Miscellaneous Record Submittals: Submit annotated PDF electronic files directories of each submittal.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

1.15 OPERATION AND MAINTENANCE MANUALS

- A. Prepare and submit a comprehensive manual of emergency, operation, and maintenance data and materials in full accordance with the General and Supplementary Conditions, Division 01, and the following:
 - 1. Operations and Maintenance Manuals: Assemble a complete set of data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system, including:
 - a. Information required for daily operation and management, operating standards, and routine and special operating procedures.
 - b. Manufacturers' maintenance documentation, preventative maintenance procedures and frequency, repair procedures, wiring and systems diagrams, list of spare parts, and warranty information.
 - 2. Submit manuals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. Submittals shall be in searchable PDF format and not a scanned copy.

1.16 DEMONSTRATION AND TRAINING

- A. Prepare and provide services of qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system in accordance with the General and Supplementary Conditions, Division 01, individual Specification Sections, and the following:
 - 1. Demonstration and training shall occur upon completion of the Work and at a time designated by the Owner's representative.

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

1.18 WARRANTY

- A. Warranty work and equipment within specified warranty period. During the warranty period, provide labor and materials to make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship without expense to the Owner.
 - 1. Warranty Period: One year from date of Substantial Completion.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
- C. Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving the Contractor of responsibilities during the warranty period.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

PART 2 - PRODUCTS (NONE)

PART 3 - EXECUTION

3.1 CONTRACT DOCUMENTS

- A. Examine all drawings and specifications carefully before submitting a bid. Architectural drawings take precedence over mechanical or electrical drawings with reference to building construction.
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.
- C. The drawings indicate required size and points of termination of pipes, conduits, and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the responsibility of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.
- E. Any and all questions about a subcontractor's scope of work responsibility shall be addressed to and answered by the General Contractor / Construction Manager.
- F. Questions About Construction Documents: Any and all questions shall be submitted through the proper channels IN WRITING and, in turn, shall be answered by the Engineer in writing. All telephone conversations shall be considered unofficial and, as such, shall not be considered official or binding responses to Contractor's questions.
- G. Drawings, specifications, or other documents issued by the Engineer in electronic format and/or electronic media are provided for convenience only and are not intended for use as Contract Documents.
 - 1. The electronic files are provided merely as a convenience to the Recipient.
 - 2. The electronic files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.
 - 3. The Engineer makes no representation, warranty, or guarantee that electronic files:
 - a. Are suitable for any other usage or purpose.
 - b. Have any particular durability.
 - c. Will not damage or impair the Recipient's computer or software.
 - d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.
 - 4. Due to the unsecured nature of the electronic files and the inability of Engineer or the Recipient to establish controls over their use, the Engineer assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained therein. The Recipient shall at all times refer to the signed and sealed drawings, specification or other documents for the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of the electronic files.

3.2 SUPERVISION OF WORK

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

- A. Perform all work under the direct supervision of an experienced, qualified superintendent. The Engineer has the right to remove a superintendent who, in the Engineer's opinion, is not satisfactory.

3.3 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.4 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.

3.5 INSTALLATION

- A. Install materials and equipment in a professional manner. The Engineer may direct replacement of items which, in the Engineer's opinion, do not present a professional appearance or do not allow adequate space for maintenance. Replace or reinstall items at the expense of the Contractor.
- B. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- C. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- D. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- G. Obstructions
1. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
 2. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
 3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
 4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.
- H. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof, or ceiling to the satisfaction of the authority having jurisdiction.
- I. Structural Elements: Do not cut structural elements without written approval from Engineer. Notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. If approved by Engineer:
1. Shore, brace, and support structural elements during cutting and patching.
 2. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- J. Space Requirements: Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
- K. Tools and Equipment: Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.
- L. Phasing: Provide all temporary valves, piping, ductwork, equipment, and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.6 OWNER-INSTALLED PRODUCTS

- A. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

3.7 UTILITY SERVICES AND ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

3.8 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- F. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
- G. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- H. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- I. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- J. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable or with in-place materials.
1. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 2. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.
- K. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.9 PAINTING

- A. Comply with requirements with General and Supplementary Conditions, Division 01, Division 09, and individual Specification Sections.
- B. Touch-up factory finishes on equipment provided under Division 26. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.
- C. Paint the following work where exposed to view:
1. Metal conduit
 2. Plastic conduit
- D. Paint the following work where exposed in occupied spaces:
1. Other items as directed by Engineer.

3.10 REPAIR OF WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

3.11 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests
 - 1. Include all tests specified and/or required under laws, rules and regulations of all departments having jurisdiction. Tests shall also be performed as indicated herein and other sections of the specifications.
 - 2. After all systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems.
 - 3. All parts of the work and associated equipment shall be tested and adjusted to work properly and be left in perfect operating condition.
 - 4. Correct defects disclosed by these tests without any additional cost to the Owner. Repeat tests on repaired or replaced work.
 - 5. Maintain a log of all tests being conducted and have it available for review by the Engineer. Log to indicate date, type of tests, duration, and defects noted and when corrected.
 - 6. Special tests on individual systems are specified under individual Specification Sections.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

3.12 CLEANING

- A. Progress Cleaning: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

- B. Final Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove labels that are not permanent.
 - c. Wipe surfaces of equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

END OF SECTION 260100

SECTION 260100 - GENERAL PROVISIONS FOR ELECTRICAL (continued):

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Aluminum building wire.
3. Connectors and splices.

B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (continued):

2.2 ALUMINUM BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.
- D. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83.

2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper or aluminum to match wire.
 - 2. Type: Two hole with long barrels.
 - 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 - 1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - 2. Aluminum for feeders No. 6 AWG and larger. Copper for all other feeders. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
 - 1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (continued):

- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch (150 mm) of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (continued):

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07.

3.8 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category 6 balanced twisted pair cable.
 - 2. Balanced twisted pair cable hardware.
 - 3. Control cable.
 - 4. Control-circuit conductors.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inch (1520 mm) or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 CATEGORY 6 BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100 ohm, No. 23 AWG solid copper.
- D. Shielding/Screening: Unshielded twisted pairs (UTP).

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES (continued):

- E. Cable Rating: Plenum.
- F. Jacket: Yellow thermoplastic.

2.3 BALANCED TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
- B. General Requirements for Balanced Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables must be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.
- D. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
 - 2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.

2.4 CONTROL CABLE

- A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - 1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with NFPA 262.

2.5 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES (continued):

1. Outlet boxes for cables must be no smaller than 4 inch (102 mm) square by 2-1/8 inch (53 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
 2. Flexible metal conduit must not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
 2. Secure conduits to backboard if entering the room from overhead.
 3. Extend conduits 4 inch (75 mm) above finished floor.
 4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
1. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 2. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
 3. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
 4. Secure and support cables at intervals not exceeding 30 inch (760 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 5. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
 6. Support: Do not allow cables to lie on removable ceiling tiles.
 7. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
 8. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
 9. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.
- C. Balanced Twisted Pair Cable Installation:
1. Do not untwist balanced twisted pair cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.
- D. Installation of Control-Circuit Conductors:
1. Install wiring in raceways.

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES (continued):

2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of **8 inch (200 mm)** above ceilings by cable supports not more than **48 inch (760 mm)** apart.
2. Cable must not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

3.3 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.5 FIRESTOPPING

- A. Comply with requirements in Division 07.

3.6 GROUNDING

- A. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.
 - 3. Foundation steel electrodes.

1.2 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. TGB: Telecommunications grounding busbar.
- C. TMGB: Telecommunications main grounding busbar.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
 - 1. Cable Tray Equipment Grounding Wire: No. 6 AWG.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (continued):

B. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than **12 inches (300 mm)**. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

C. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, **1/4 inch (6 mm)** in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; **1-5/8 inch (41 mm)** wide and **1/16 inch (1.6 mm)** thick.

D. PGB and TGB Grounding Bus: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, **1/4 by 4 inches (6.3 by 100 mm) in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.**

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a **4-inch (100-mm)** clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Mechanical-Type Bus-Bar Connectors: Cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (continued):

- J. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- K. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on **5/8- or 1-inch (15.8- or 25.4-mm)** centers for a two-bolt connection to the busbar.
- L. Straps: Solid copper, copper lugs. Rated for 600 A.
- M. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- N. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with stainless steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; **3/4 inch by 10 ft. (19 mm by 3 m)**.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least **30 inch (750 mm)** below grade.
 - 2. Duct-Bank Grounding Conductor: Bury **12 inch (300 mm)** above duct bank when indicated as part of duct-bank installation.
- C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers **2 inch (50 mm)** minimum from wall, **6 inch (150 mm)** above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
 - 3. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- E. Telecommunications Grounding:
 - 1. The BCT between the TGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (continued):

2. Primary Protector: Bond to the TMGB with insulated bonding conductor.
3. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than **2 kcmils/linear foot (1 sq. mm/linear meter)** of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
4. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
5. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

F. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors must be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Transformer: Install grounding electrode(s) at the transformer location. The electrode must be connected to the equipment grounding conductor and to the frame of the transformer.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so **4 inch (100 mm)** will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from **2 inch (50 mm)** above to **6 inch (150 mm)** below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than **6 inch (150 mm)** from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (continued):

- B. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- C. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.6 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are **2 inch (50 mm)** below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. Use exothermic welds for all below-grade connections.
 - 3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least **12 inch (300 mm)** deep, with cover.
 - 1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (continued):

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than **60 ft. (18 m)** apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building area or item indicated.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than **24 inch (600 mm)** from building's foundation.
- J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least **20 ft. (6.0 m)** long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- K. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Grounding system will be considered defective if it does not pass tests and inspections.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (continued):

- C. Prepare test and inspection reports.
- D. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 - 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 - 5. Substations and Pad-Mounted Equipment: 5 ohms.
 - 6. Manhole Grounds: 10 ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS (continued):

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Support, anchorage, and attachment components.
 - 2. Fabricated metal equipment support assemblies.
- B. Related Requirements:

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 3. Channel Width: 1-5/8 inch (41.25 mm).
 - 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS (continued):

must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.

- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, **Grade A325** (**Grade A325M**).
 - 6. Toggle Bolts: All steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA NEIS 101
 - 2. NECA NEIS 105.
- B. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as required by NFPA 70. Minimum rod size must be **1/4 inch (6 mm)** in diameter.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS (continued):

- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus **200 lb (90 kg)**.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete **4 inch (100 mm)** thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than **4 inch (100 mm)** thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel-boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than **4 inch (100 mm)** larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS (continued):

- B. Use 3000 psi (20.7 MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup:
 - 1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Type ERMCS raceways, elbows, couplings, and nipples.
3. Type FMC-S raceways.
4. Type LFMC raceways.
5. Type PVC raceways and fittings.
6. Fittings for conduit, tubing, and cable.
7. Threaded metal joint compound.
8. Solvent cements.
9. Wireways and auxiliary gutters.
10. Metallic outlet boxes, device boxes, rings, and covers.
11. Termination boxes.
12. Cabinets, cutout boxes, junction boxes, pull boxes, and miscellaneous enclosures.
13. Cover plates for device boxes.
14. Hoods for outlet boxes.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Floor boxes.
4. Cabinets, cutout boxes, and miscellaneous enclosures.

PART 2 - PRODUCTS

2.1 TYPE EMT-S RACEWAYS AND ELBOWS

A. Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 797 and UL Category Control Number FJMX.
 - 2) Material: Steel.
 - 3) Exterior Coating: Zinc.
 - 4) Interior Coating: Zinc with organic top coating.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

c. Options:

- 1) Minimum Trade Size: **3/4 inch (21 mm)**.
- 2) Colors: Critical operations power system (COPS) feeders: Orange.

2.2 TYPE ERM-C-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Galvanized-Steel Electrical Rigid Metal Conduit (ERM-C-S-G), Elbows, Couplings, and Nipples:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 6 and UL Category Control Number DYIX.
 - 2) Exterior Coating: Zinc.
 - 3) Interior Coating: Zinc with organic top coating.

c. Options:

- 1) Minimum Trade Size: **3/4 inch (21 mm)**.
- 2) Critical operations power system (COPS) feeders: Orange.

2.3 TYPE FMC-S RACEWAYS

A. Steel Flexible Metal Conduit (FMC-S):

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standard: UL 1 and UL Category Control Number DXUZ.
 - 2) Material: Steel.

c. Options:

- 1) Minimum Trade Size: **3/4 inch (21 mm)**.
- 2) Colors: As indicated on Drawings.

2.4 TYPE LFMC RACEWAYS

A. Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

- 1) Reference Standard: UL 360 and UL Category Control Number DXHR.
- 2) Material: Steel.

c. Options:

- 1) Minimum Trade Size: 3/4 inch (21 mm).

2.5 TYPE PVC RACEWAYS AND FITTINGS

A. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 651 and UL Category Control Number DZYR.
 - 2) Dimensional Specifications: Schedule 40.
- c. Options:
 - 1) Minimum Trade Size: 3/4 inch (21 mm).
 - 2) Markings: For use with maximum 90 deg C wire. and for directional boring applications.

2.6 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Fittings for Type ERM, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 514B and UL Category Control Number DWTT.
 - 2) Material: Steel.
 - 3) Coupling Method: Compression coupling.
- c. Options:
 - 1) Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - 2) Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

B. Fittings for Type EMT Raceways:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

- 1) Reference Standards: UL 514B and UL Category Control Number FKAV.
 - 2) Material: Steel.
 - 3) Coupling Method: Compression coupling.
 - c. Options:
 - 1) Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - 2) Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
- C. Fittings for Type FMC Raceways:
 1. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514B and UL Category Control Number ILNR.
- D. Fittings for Type LFMC and Type LFNC Raceways:
 1. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514B and UL Category Control Number DXAS.

2.7 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

- A. Applicable Standards:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and approved by authorities having jurisdiction for application to threaded conduit assemblies.
 2. General Characteristics:
 - a. Reference Standards: UL 2419 and UL Category Control Number FOIZ.

2.8 SOLVENT CEMENTS

- A. Solvent Cements for Type PVC Raceways and Fittings:
 1. Applicable Standards:
 - a. General Characteristics:
 - 1) Reference Standards: As recommended by conduit manufacturer in accordance with UL 514B and UL Category Control Number DWTT.
 - b. Sustainability Characteristics:

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

2.9 WIREWAYS AND AUXILIARY GUTTERS

A. Metal Wireways and Auxiliary Gutters:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 870 and UL Category Control Number ZOYX.
 - 2) Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - 3) Finish: Manufacturer's standard enamel finish.
- c. Options:
 - 1) Degree of Protection: Type 1 inside; Type 3R outside unless otherwise indicated.
 - 2) Wireway Covers: Screw-cover type unless otherwise indicated.

2.10 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Metallic Outlet Boxes:

- 1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
- 2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.
 - c. Options:
 - 1) Material: Sheet steel.
 - 2) Sheet Metal Depth: Minimum 2.5 inch (65 mm).
 - 3) Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb (23 kg).
 - 4) Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb (32 kg).

B. Metallic Conduit Bodies:

- 1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
- 2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

b. General Characteristics:

- 1) Reference Standards: UL 514A and UL Category Control Number QCIT.

C. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.
 - c. Options:
 - 1) Material: Sheet steel.
 - 2) Sheet Metal Depth: minimum 2.5 inch (65 mm).
 - 3) Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb (23 kg).
 - 4) Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb (32 kg).

D. Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.

E. Metallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.

F. Metallic Concrete Boxes and Covers:

1. Description: Box intended for use in poured concrete.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

b. General Characteristics:

- 1) Reference Standards: UL 514A and UL Category Control Number QCIT.

2.11 **TERMINATION BOXES**

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 1773 and UL Category Control Number XCKT.
 - 2) Listed and labeled for installation on line side of service equipment.

C. Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 1773 and UL Category Control Number XCKT.
 - 2) Listed and labeled for installation on load side of service equipment.

2.12 **CABINETS, CUTOOT BOXES, JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES**

A. Indoor Sheet Metal Cabinets:

1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.

2. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number CYIV.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
- c. Options:
 - 1) Degree of Protection: Type 1.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

B. Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number BGUZ.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 1.

C. Indoor Sheet Metal Miscellaneous Enclosures:

1. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards:
 - a) UL 1773 and UL Category Control Number XCKT.
 - b) Non-Environmental Characteristics: UL 50.
 - c) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 1.

D. Outdoor Sheet Metal Cabinets:

1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number CYIV.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 3R.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

E. Outdoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number BGUZ.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 3R.

F. Outdoor Sheet Metal Miscellaneous Enclosures:

1. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards:
 - a) UL 1773 and UL Category Control Number XCKT.
 - b) Non-Environmental Characteristics: UL 50.
 - c) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 3R.

2.13 COVER PLATES FOR DEVICES BOXES

A. Metallic Cover Plates for Device Boxes:

1. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - 2) Wallplate-Securing Screws: Metal with head color to match wallplate finish.
 - c. Options:
 - 1) Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

- 2) Wallplate Material: **0.032 inch (0.8 mm)** thick Type 302/304 non-magnetic stainless steel with brushed finish.

B. Nonmetallic Cover Plates for Device Boxes:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - 2) Wallplate-Securing Screws: Metal with head color to match wallplate finish.
- c. Options:
 - 1) Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - 2) Wallplate Material: **0.060 inch (1.5 mm)** thick high-impact thermoplastic (nylon) with smooth finish and color matching wiring device.
 - 3) Color: White.

2.14 HOODS FOR OUTLET BOXES

A. Extra-Duty, While-in-Use Hoods for Outlet Boxes:

1. Applicable Standards:

- a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- b. General Characteristics:
 - 1) Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - 2) Marked "Extra-Duty" in accordance with UL 514D.
 - 3) Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
 - 4) Mounts to box using fasteners different from wiring device.
- c. Options:
 - 1) Provides clear, weatherproof, "while-in-use" cover.
 - 2) Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.1 SELECTION OF RACEWAYS

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
 - 1. Exposed Conduit: ERM C.
 - 2. Concealed Conduit, Aboveground: ERM C.
 - 3. Direct-Buried Conduit: PVC-40.
 - 4. Concrete-Encased Conduit Not in Trench: PVC-40.
 - 5. Concrete-Encased Conduit in Trench: PVC-40.
 - 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFM C.
- C. Indoors:
 - 1. Hazardous Classified Locations: ERM C.
 - 2. Exposed and Subject to Physical Damage: ERM C. Raceway locations include the following:
 - a. Loading docks.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums.
 - 3. Exposed, Not Subject to Physical Damage: EMT.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Damp or Wet Locations: ERM C.
 - 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC.
- D. Stub-ups to Above Recessed Ceilings: Provide EMT, IMC, or ERM C for raceways.
- E. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
 - 1. ERM C and IMC: Provide threaded type fittings unless otherwise indicated.

3.2 SELECTION OF BOXES AND ENCLOSURES

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
 - 1. Outdoors:
 - a. Type 3R unless otherwise indicated.
 - 2. Indoors:
 - a. Type 1 unless otherwise indicated.
- C. Exposed Boxes Installed Less Than 6.5 ft. (2 m) Above Floor:

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

1. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.3 INSTALLATION OF RACEWAYS

A. Installation Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.
2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
3. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
4. Comply with NECA NEIS 101 for installation of steel raceways.
5. Comply with NECA NEIS 111 for installation of nonmetallic raceways.
6. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
7. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4 inch (35 mm) trade size and insulated throat metal bushings on 1-1/2 inch (41 mm) trade size and larger conduits terminated with lock-nuts. Install insulated throat metal grounding bushings on service conduits.
8. Raceway Terminations at Locations Subject to Moisture or Vibration:
 - a. Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG. Install insulated throat metal grounding bushings on service conduits.

B. General Requirements for Installation of Raceways:

1. Complete raceway installation before starting conductor installation.
2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft. (0.6 m) above finished floor.
3. Install no more than equivalent of three 90-degree bends in conduit run. Support within 12 inch (300 mm) of changes in direction.
4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
6. Support conduit within 12 inch (300 mm) of enclosures to which attached.
7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
8. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - b. Where an underground service raceway enters a building or structure.
 - c. Conduit extending from interior to exterior of building.
 - d. Conduit extending into pressurized duct and equipment.
 - e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

- f. Where otherwise required by NFPA 70.
 - 9. Do not install conduits within **2 inch (50 mm)** of the bottom side of a metal deck roof.
 - 10. Keep raceways at least **6 inch (150 mm)** away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
 - 11. Cut conduit perpendicular to the length. For conduits **2 inch (53 mm)** trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 - 12. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than **200 lb (90 kg)** tensile strength. Leave at least **12 inch (300 mm)** of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- C. Requirements for Installation of Specific Raceway Types:
- 1. Types ERMCM and IMC:
 - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
 - 2. Types FMC, LFMC, and LFNC:
 - a. Comply with NEMA RV 3. Provide a maximum of **72 inch (1830 mm)** of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 3. Types PVC and EPEC:
 - a. Do not install Type PVC or Type EPEC conduit where ambient temperature exceeds **122 deg F (50 deg C)**. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
 - b. Comply with manufacturer's written instructions for solvent welding and fittings.
- D. Raceways Embedded in Slabs:
- 1. Run raceways larger than **1 inch (27 mm)** trade size below concrete slab..
 - 2. Arrange raceways to cross building expansion joints with expansion fittings at right angles to the joint.
 - 3. Arrange raceways to ensure that each is surrounded by a minimum of **1 inch (25 mm)** of concrete without voids.
 - 4. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
 - 5. Change from ENT to ERMCM before rising above floor.
- E. Stub-ups to Above Recessed Ceilings:
- 1. Provide EMT, IMC, or ERMCM for raceways.
 - 2. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- F. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
- 1. EMT: Provide compression, steel fittings. Comply with NEMA FB 2.10.
 - 2. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

G. Expansion-Joint Fittings:

1. Install in runs of aboveground PVC that are located where environmental temperature change may exceed **30 deg F (17 deg C)** and that have straight-run length that exceeds **25 ft. (7.6 m)**. Install in runs of aboveground ERM and EMT conduit that are located where environmental temperature change may exceed **100 deg F (55 deg C)** and that have straight-run length that exceeds **100 ft. (30 m)**.
2. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: **125 deg F (70 deg C)** temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: **155 deg F (86 deg C)** temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: **125 deg F (70 deg C)** temperature change.
 - d. Attics: **135 deg F (75 deg C)** temperature change.
3. Install fitting(s) that provide expansion and contraction for at least **0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C)** of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least **0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C)** of temperature change for metal conduits.
4. Install expansion fittings at locations where conduits cross building or structure expansion joints.
5. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

H. Raceways Penetrating Rooms or Walls with Acoustical Requirements:

1. Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestop-ping.

3.4 INSTALLATION OF DIRECT BURIED RACEWAYS

- A. Install direct buried raceway with a minimum **36 inch (50 mm)** of well tramped earth above the top of the raceway.
- B. Install underground warning tape per requirements in Section 260553 "Identification for Electrical Systems".

3.5 INSTALLATION OF BOXES AND ENCLOSURES

- A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
- B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

- D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- E. Locate boxes so that cover or plate will not span different building finishes.
- F. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
- G. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
- H. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
- I. Set metal floor boxes level and flush with finished floor surface.
- J. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- K. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
- L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
- M. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - 1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - 2. Provide gaskets for wallplates and covers.

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07.

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.8 CLEANING

- A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION 260533

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS (continued):

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SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
 - 2. Rigid nonmetallic duct.
 - 3. Flexible nonmetallic duct.
 - 4. Duct accessories.
 - 5. Polymer concrete handholes and boxes with polymer concrete cover.
 - 6. Precast manholes.
 - 7. Utility structure accessories.
 - 8. Flowable fill.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
- D. GRC: Galvanized rigid (steel) conduit
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct-bank materials, including spacers and miscellaneous components.
 - 2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Include accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Include underground-line warning tape.
 - 5. Flowable fill.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

1.5 FIELD CONDITIONS

- A. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- C. Solvents and Adhesives: As recommended by conduit manufacturer.

2.2 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC-40 HDPE, complying with NEMA TC 7 and UL 651A.
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.4 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armorcast Products Company.
 - 2. NewBasis.
 - 3. Oldcastle Enclosure Solutions.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC." or as indicated for each service.
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.5 FLOWABLE FILL

- A. Description: Low-strength-concrete, flowable-slurry mix.
 - 1. Cement: ASTM C150, Type I, portland.
 - 2. Density: **115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m).**
 - 3. Aggregates:
 - a. ASTM C33, natural sand, fine and crushed gravel or stone, coarse.
 - 4. Admixture: ASTM C618, fly-ash mineral.
 - 5. Water: Comply with ASTM C94/C94M.
 - 6. Strength: **100 to 200 psig (690 to 1380 kPa)** at 28 days.
 - 7. Color:
 - a. Electrical Power Lines and Cables: Red.
 - b. Fiber Optics, Communications, Alarms: Orange.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- D. Bored Underground Duct: Type EPEC-40-HDPE unless otherwise indicated.
- E. Underground Ducts Crossing Driveways, Roadways, and Railroads: Type EPC-40 PVC RNC, encased in reinforced concrete.
- F. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 3. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures.

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
 - 1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell, without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch (19 mm).
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet (3 m) from the terminator, without reducing duct line slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch (19 mm).
- I. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- J. Pulling Cord: Install 200-lbf- (1000-N-) test nylon cord in empty ducts.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

K. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Division 31 for pipes less than 6 inches (150 mm) in nominal diameter.
2. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
3. Depth: Install so top of duct envelope is at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Where cover over top of piping is less than required depth, cover with flowable fill up to 6 inches below finished grade.
4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
6. Minimum Space between Duct: 3 inches (75 mm) between edge of duct and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and communications ducts.
7. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches (100 mm) above finished floor and minimum 3 inches (75 mm) from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches (100 mm) above finished floor and no less than 3 inches (75 mm) from conduit side to edge of slab.
8. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
10. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between duct of like services, and 4 inches (100 mm) between power and communications ducts.
11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

- b. If more than one pour is necessary, terminate each pour in a vertical plane and install **3/4-inch (15-mm)** reinforcing-rod dowels extending a minimum of **18 inches (450 mm)** into concrete on both sides of joint near corners of envelope.
 - 12. Pouring Concrete: Comply with requirements in Division 03. Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- L. Direct-Buried Duct and Duct Bank:
- 1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than **6 inches (150 mm)** in nominal diameter.
 - 2. Width: Excavate trench **3 inches (75 mm)** wider than duct on each side.
 - 3. Depth: Install top of duct at least **36 inches (900 mm)** below finished grade unless otherwise indicated. Where cover over top of piping is less than required depth, cover with flowable fill up to 6 inches below finished grade.
 - 4. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - 5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per **20 feet (6 m)** of duct. Place spacers within **24 inches (600 mm)** of duct ends. Stagger spacers approximately **6 inches (150 mm)** between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 6. Install duct with a minimum of **3 inches (75 mm)** between ducts for like services and **6 inches (150 mm)** between power and communications duct.
 - 7. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of **60 inches (1500 mm)** from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum **4 inches (100 mm)** above finished floor and minimum **3 inches (75 mm)** from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of **60 inches (1500 mm)** from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum **4 inches (100 mm)** above finished floor and no less than **3 inches (75 mm)** from conduit side to edge of slab.
 - 8. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to **4 inches (100 mm)** over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

- a. Place minimum **3 inches (75 mm)** of sand as a bed for duct. Place sand to a minimum of **6 inches (150 mm)** above top level of duct.
 - b. Place minimum **6 inches (150 mm)** of engineered fill above the encasement of duct.
- M. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than **12 inches (300 mm)** above all concrete-encased duct and duct banks and approximately **12 inches (300 mm)** below grade. Align tape parallel to and within **3 inches (75 mm)** of centerline of duct bank. Provide an additional warning tape for each **12-inch (300-mm)** increment of duct-bank width over a nominal **18 inches (450 mm)**. Space additional tapes **12 inches (300 mm)** apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1-inch (25-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
1. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes **1 inch (25 mm)** above finished grade.
 2. Where indicated, cast handhole cover frame integrally with handhole structure.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- E. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than **3-7/8 inches (97 mm)** for manholes and **2 inches (50 mm)** for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
- C. Sweep floor, removing dirt and debris.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

- D. Remove foreign material.

END OF SECTION 260543

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS (continued):

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Grout.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Wall Sleeves, Steel:

1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

2.2 RECTANGULAR SLEEVES

A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:

1. Description:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inch (1270 mm) and with no side larger than 16 inch (400 mm), thickness must be 0.052 inch (1.3 mm).
 - 2) For sleeve cross-section rectangle perimeter not less than 50 inch (1270 mm) or with one or more sides larger than 16 inch (400 mm), thickness must be 0.138 inch (3.5 mm).

2.3 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
(continued):

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
 - 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 - 2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between sleeve and raceway or cable, unless sleeve seal system is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- B. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- C. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
(continued):

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 260544

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
(continued):

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels.
 - 3. Tapes and stencils.
 - 4. Signs.
 - 5. Paint for identification.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS (continued):

- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Color for Neutral: White or gray.
 - 4. Color for Equipment Grounds: Green.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
- F. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

- A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
- B. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
 - c. As required by authorities having jurisdiction.

2.4 TAPES AND STENCILS

- A. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS (continued):

- B. Tape and Stencil: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers placed diagonally over orange background and are 12 inches (300 mm) wide. Stop stripes at legends.
- C. Underground-Line Warning Tape:
 - 1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
 - 3. Description:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, compounded for direct-burial service.
 - b. Width: 3 inches (75 mm).
 - c. Overall Thickness: 5 mils (0.125 mm).
 - d. Foil Core Thickness: 0.35 mil (0.00889 mm).
 - e. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
 - f. Tensile according to ASTM D 882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).

2.5 SIGNS

- A. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch (6.4-mm) grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS (continued):

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum **3/8-inch- (10-mm-)** high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS (continued):

- M. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.
- O. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of **6 inches (150 mm)** where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- P. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- Q. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at **6 to 8 inches (150 to 200 mm)** below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds **16 inches (400 mm)** overall.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- R. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using plenum-rated cable ties.
- S. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high sign; where two lines of text are required, use labels **2 inches (50 mm)** high.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 50 A and 120 V to Ground: Identify with self-adhesive wraparound labels.

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS (continued):

1. Locate identification at changes in direction, at penetrations of walls and floors, at **50-foot (15-m)** maximum intervals in straight runs, and at **25-foot (7.6-m)** maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend, circuit designation, and system voltage. System legends shall be as follows:
 1. "EMERGENCY POWER."
 2. "POWER."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify the phase.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at **50-foot (15-m)** maximum intervals in straight runs, and at **25-foot (7.6-m)** maximum intervals in congested areas.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- H. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- I. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- J. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 1. Apply to exterior of door, cover, or other access.
 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- L. Arc Flash Warning Labeling: Self-adhesive labels.
- M. Operating Instruction Signs: Self-adhesive labels.
- N. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum **3/8-inch- (10-mm-)** high letters for emergency instructions at equipment used for power transfer.
- O. Equipment Identification Labels:

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS (continued):

1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - f. Emergency system boxes and enclosures.
 - g. Enclosed switches.
 - h. Enclosed circuit breakers.
 - i. Enclosed controllers.
 - j. Variable-speed controllers.
 - k. Battery-inverter units.
 - l. Monitoring and control equipment.

END OF SECTION 260553

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS (continued):

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

SECTION 262416 - PANELBOARDS (continued):

2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Keys: Two spares for each type of panelboard cabinet lock.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboard.
- B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.9 FIELD CONDITIONS

- A. Environmental Limitations:
 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete.
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding **minus 22 deg F (minus 30 deg C)** to **plus 104 deg F (plus 40 deg C)**.
 - b. Altitude: Not exceeding **6600 feet (2000 m)**.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding **6600 feet (2000 m)**.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS CENTERS COMMON REQUIREMENTS

SECTION 262416 - PANELBOARDS (continued):

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Height: **84 inches (2.13 m)** maximum.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Finishes:
 - a. Panels and Trim: Steel , factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
- G. Incoming Mains:
 - 1. Location: As indicated on plans.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

SECTION 262416 - PANELBOARDS (continued):

4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panel-board.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- J. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton.](#)
 2. [SIEMENS Industry, Inc.; Energy Management Division.](#)
 3. [Square D; by Schneider Electric.](#)
 4. [ABB Inc](#)
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than **36 inches (914 mm)** high, provide two latches, keyed alike.
- D. Mains: Circuit breaker Fused switch or Lugs only.
- E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers or fused switches as indicated.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Eaton.](#)
 2. [SIEMENS Industry, Inc.; Energy Management Division.](#)
 3. [Square D; by Schneider Electric.](#)

SECTION 262416 - PANELBOARDS (continued):

4. [ABB Inc](#)
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only, as indicated.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:
 1. [Eaton](#).
 2. [SIEMENS Industry, Inc.: Energy Management Division](#).
 3. [Square D; by Schneider Electric](#).
 4. [ABB Inc](#)
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 5. Subfeed Circuit Breakers: Vertically mounted.
 6. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.

SECTION 262416 - PANELBOARDS (continued):

- c. UL listed for reverse connection without restrictive line or load ratings.
- d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- e. Ground-Fault Protection: Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- f. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
- g. Rating Plugs: Three-pole breakers with ampere ratings greater than 110 amperes shall have electronic adjustable trip units.
- h. Multipole units enclosed in a single housing with a single handle.

2.5 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.

SECTION 262416 - PANELBOARDS (continued):

- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Mount panelboard cabinet plumb and rigid without distortion of box.
- F. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Mount surface-mounted panelboards to steel slotted supports **5/8 inch (16 mm)** in depth. Orient steel slotted supports vertically.
- H. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- I. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- J. Install filler plates in unused spaces.
- K. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

SECTION 262416 - PANELBOARDS (continued):

b. Instruments and Equipment:

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

- B. Panelboards will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 **ADJUSTING**

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches.
2. General-grade duplex straight-blade receptacles.
3. Receptacles with arc-fault and ground-fault protective devices.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Toggle switches.
2. Duplex straight-blade receptacles.
3. Receptacles with GFCI device.
4. USB Receptacles

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Devices for Owner-Furnished Equipment:
1. Receptacles: Match plug configurations.
 2. Cord and Plug Sets: Match equipment requirements.
- C. Device Color:
1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.

2.2 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch:

1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:

SECTION 262726 - WIRING DEVICES (continued):

- a. Reference Standards: UL CCN WMUZ and UL 20.
- 3. Options:
 - a. Configuration:
 - 1) General-duty, 120-277 V, 20 A.

2.3 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

- 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
- 3. Options:
 - a. Configuration:
 - 1) General-duty, NEMA 5-20R.
 - 2) General-duty, NEMA 6-20R.
 - 3) Heavy-duty, NEMA 7-15R.

B. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment:

- 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
- 3. Options:
 - a. Configuration:
 - 1) General-duty, NEMA 5-20R; one USB-A port; one USB-C ports. 5V DC, 6 A.

2.4 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

SECTION 262726 - WIRING DEVICES (continued):

1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
3. Options:
 - a. Configuration: Heavy-duty, NEMA 5-20R.

2.5 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material: Smooth, high-impact thermoplastic.
 3. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receptacles:
 1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION

- A. Coordination with Other Trades:
 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- B. Conductors:

SECTION 262726 - WIRING DEVICES (continued):

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

C. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than **6 inches (152 mm)** in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

D. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.3 SELECTION OF GFCI RECEPTACLES

A. Provide non-feed-through GFCI receptacles.

3.4 INSTALLATION OF SWITCHES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Consult Architect for resolution of conflicting requirements.

SECTION 262726 - WIRING DEVICES (continued):

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering and provide durable wire markers or tags inside device box or outlet box.

3.5 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

A. Comply with manufacturer's instructions.

B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
4. Consult Architect for resolution of conflicting requirements.

C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering and provide durable wire markers or tags inside device box or outlet box.

3.6 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

3.7 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

SECTION 262726 - WIRING DEVICES (continued):

2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and CAPTOR, Systems Analysis, Inc. electronic format.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 FIELD CONDITIONS

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS (continued):

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than **minus 22 deg F (minus 30 deg C)** and not exceeding **104 deg F (40 deg C)**.
 - 2. Altitude: Not exceeding **6600 feet (2010 m)**.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **ABB Inc.**
 - 2. **Eaton.**
 - 3. **SIEMENS Industry, Inc.: Energy Management Division.**
 - 4. **Square D.**
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses and lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS (continued):

4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. ABB Inc.
 3. SIEMENS Industry, Inc.; Energy Management Division.
 4. Square D.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac.
 5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1), gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12) or a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel), copper-free cast aluminum alloy (NEMA 250 Types 7, 9) , as indicated.
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1), directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R) or externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS (continued):

- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.

3.3 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS (continued):

- A. Perform tests and inspections.
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- C. Tests and Inspections for Molded Case Circuit Breakers:
 - 1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS (continued):

- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
 - 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interruptible (fast-transfer) central battery equipment.
 - 2. Enclosures.
 - 3. Optional and accessory features.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. IBC: International Building Code.
- C. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time can be "slow" (up to approximately 1 second) or "fast" (2-4 ms or 40-50 ms, depending on manufacturer).
- D. LED: Light-emitting diode.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. NiCd: Nickel cadmium.
- G. OCPD: Overcurrent protective device.
- H. PC: Personal computer.
- I. PWM: Pulse-width modulated.
- J. TDD: Total demand (harmonic current) distortion (also listed as "THD" in catalog data by manufacturers).
- K. THD(V): Total harmonic voltage demand.
- L. VRLA: Valve-regulated lead acid.

1.4 ACTION SUBMITTALS

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

- A. Product Data: For each type and rating of central battery equipment unit.
 - 1. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.
- B. Shop Drawings: For each type and rating of central battery equipment unit.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection.
 - 3. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring.
 - 4. Include elevation, details, and legends of control and indication displays.
 - 5. Include -circuit current (withstand) rating of unit.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. Output Circuit Breaker Open/Tripped Alarm Contacts: One for every 10 supplied, but no fewer than 1 of each type.
 - 2. Cabinet Ventilation Filters: One complete set.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Member company of NETA or an NRTL acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles.
- B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
 - 3. Humidity: More than 95 percent (condensing).

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

4. Altitude: Exceeding 3300 feet (1000 m).
 - B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for central battery equipment, including clearances between central battery equipment and adjacent surfaces and other items.
- 1.9 COORDINATION
- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
- 1.10 WARRANTY
- A. Special Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
 1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
 - a. Central Battery Equipment (excluding Batteries): One year(s).
 - b. Standard VRLA Batteries:
 - 1) Full Warranty: One year(s).
 - 2) Pro Rata: Nine years.
 - c. Premium VRLA Batteries:
 - 1) Full Warranty: One year(s).
 - 2) Pro Rata: 19 years.

PART 2 - PRODUCTS

- 2.1 PERFORMANCE REQUIREMENTS
- 2.2 INTERRUPTIBLE (FAST-TRANSFER) CENTRAL BATTERY EQUIPMENT
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB, Electrification Business.
 2. Controlled Power Company; an Emerson company.
 3. Cooper Industries, Inc.
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. LVS Controls.
 6. Myers Emergency Power Systems.
 7. Signify North America Corporation (formerly Philips Lighting).
 - B. General Requirements for Interruptible (Fast-Transfer) Central Battery Equipment:
 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924.
 3. Comply with the IBC, NFPA 70, and NFPA 101.

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

4. Comply with NEMA PE 1.
- C. Performance Requirements:
1. Fast-Transfer Central Battery Equipment: Line-interactive (on-line) system. Automatically sense loss of normal ac supply and use a solid-state static switch to transfer load. Transfer in 2-4 ms or less from normal supply to battery-inverter supply.
 2. Automatic Operation:
 - a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
 - b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
 - c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
 - d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
 - e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
 - f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
 - g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
 - h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.
- D. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
 2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
 3. Synchronizing Slew Rate: 1 Hz per second, maximum.
 4. Minimum Off-Line Efficiency: 99 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or operating condition.
 6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F (20 deg C) and not exceeding 86 deg F (30 deg C).
 7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F (minus 20 deg C) and not exceeding 158 deg F (70 deg C).
 8. Ambient Temperature Rating (Batteries): Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
 9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C).
 10. Humidity Rating: Less than 95 percent (noncondensing).
 11. Altitude Rating: Not exceeding 3300 feet (1005 m).
 12. Off-Line Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

- E. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.
- F. Controls and Indication:
 - 1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:
 - a. Normal power available.
 - b. Status of system.
 - c. Battery charging status.
 - d. On battery power.
 - e. System fault.
 - f. External fault.
 - 2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - a. Keypad: In addition to required programming and control keys, include the following:
 - 1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
 - 2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.
 - 3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.
 - b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:
 - 1) Real-time clock with current time and date.
 - 2) Tests and Events Logs: Record and store up to 50 tests and events.
 - a) Dates.
 - b) Times.
 - c) Durations.
 - d) Output voltage and currents.
 - 3) Alarm Logs: Record and store up to 50 alarms.
 - a) Dates.
 - b) Times.
 - c) Alarm type.
 - 4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:
 - a) Input and output voltage (V ac) and output current (A ac).
 - b) Battery voltage (V dc) and current (A ac).
 - c) Fault or alarming status (code).
 - d) Power output (VA).
 - e) Inverter load (W).
 - f) Ambient temperature (deg F).
 - g) System run time (cumulative days).

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

- h) Inverter run time (cumulative minutes).
 - 5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:
 - a) High/low battery charge voltage.
 - b) High/low input voltage.
 - c) Battery nearing low-voltage condition.
 - d) Battery low voltage.
 - e) High ambient temperature.
 - f) Inverter fault.
 - g) Output fault.
 - h) Output overload.
- G. Self-Protection and Reliability Features:
 - 1. Input transient protection by means of surge suppressors to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
 - 2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
 - 3. Battery deep-discharge and self-discharge protection; with alarms.
 - 4. Battery self-test circuitry; with alarms and logging.
- H. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489 .
 - 1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 22 kA, or as indicated on drawings.
- I. Inverter:
 - 1. Description: Solid-state, high-frequency, PWM type, with the following operational features:
 - a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
 - b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
 - c. Output Voltage Waveform: Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
 - d. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
 - e. Load Power Factor: 0.5 lead to 0.5 lag.
 - f. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.
- J. Rectifier/Battery Charger:
 - 1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
 - 2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
 - 3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

K. Batteries:

1. Description: Standard VRLA batteries.
 - a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes .
2. Battery Disconnect and OCPD: Manufacturer's standard.

L. Maintenance Bypass Systems:

1. Maintenance Bypass Mode:
 - a. Internal; manual operation only; bypasses central battery equipment power circuits (inverter and static transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be break-before-make, with temporary disrupting power to the load.
2. Bypass Overload Capability: 1.5 times the base load current.

M. Integral Output Disconnecting Means and OCPD:

1. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.
 - a. As indicated on drawings.

2.3 ENCLOSURES

- A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
 2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment .

2.4 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate central battery equipment fabricator's quality-control and testing methods.
- B. Testing: Test and inspect central battery equipment according to UL 924.
- C. Factory Tests: Test and inspect assembled central battery equipment, by a qualified testing agency, according to UL 924 . Affix standards organization's label. Include the following:
1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 2. Full-load test.
 3. Transient-load response test.
 4. Overload test.
 5. Power failure test.
- D. Central battery equipment will be considered defective if it does not pass tests and inspections.

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store central battery equipment according to NECA 411.
- B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.
- D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install central battery equipment and accessories according to NECA 411.
- C. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Comply with NECA 1.
- F. Wiring Methods:
 - 1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters.
 - 2. Install cables in raceways and cable trays except within consoles, cabinets, desks, counters, accessible ceiling spaces, and gypsum board partitions where unenclosed wiring method may be used.
 - 3. Install conductors and cables concealed in accessible ceilings, walls, and floors where possible.
 - 4. Conceal raceway and cables except in unfinished spaces.
 - 5. Provide plenum-rated cable, where installed exposed or in open cable tray, within environmental airspaces, including plenum ceilings.

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

- 6. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
- 7. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

- A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 INSTALLATION OF CONTROL WIRING

- A. Install wiring between central battery equipment and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.

3.5 IDENTIFICATION

- A. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label central battery equipment with engraved nameplates.
 - 3. Label each separate cabinet, for multicabinet units.
 - 4. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for central battery equipment, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of central battery equipment units.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

D. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

- a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
- b. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
- c. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect central battery equipment, wiring, components, connections, and equipment installation.
2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
3. Test continuity of each circuit.
4. Verify that input voltages and frequencies at central battery equipment locations are within voltage and frequency limits specified in Part 2. If outside this range, notify Architect before closing input OCPDs.
5. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.
6. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Central battery equipment will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, and other adjustable parts.

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

- C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.
- D. Set the automatic system test parameters.

3.9 **PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace central battery equipment whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 **DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION 263323.11

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING (continued):

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SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes lightning protection system for ordinary structures.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
 - 2. Include raceway locations needed for the installation of conductors.
 - 3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
 - 4. Include roof attachment details, coordinated with roof installation.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For lightning protection system to include in maintenance manuals.
 - 1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:
 - a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Division 01 "Project Record Documents."
- B. Completion Certificate:
 - 1. UL Master Label Certificate.

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES (continued):

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: UL-listed installer, category OWAY.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL Lightning Protection Standard: Comply with UL 96A requirements for [Class I] [Class II] buildings.
- B. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.2 MATERIALS

- A. Air Terminals:
 - 1. Copper or Aluminum unless otherwise indicated.
 - 2. 1/2-inch (12.7-mm) diameter by 18 inches (450 mm) long.
 - 3. Pointed tip.
 - 4. Integral base support.
- B. Class 1 Main Conductors:
 - 1. Stranded Copper: 57,400 circular mils in diameter.
 - 2. Aluminum: 98,600 circular mils in diameter.
- C. Class II Main Conductors:
 - 1. Stranded Copper: 115,000 circular mils in diameter.
 - 2. Aluminum: 192,000 circular mils in diameter.
- D. Secondary Conductors:
 - 1. Stranded Copper: 26,240 circular mils in diameter.
 - 2. Aluminum: 41,400 circular mils in diameter.
- A. Ground Loop Conductor: Tinned copper.
- B. Ground Rods:
 - 1. Material: Copper-clad steel.
 - 2. Diameter: 3/4 inch (19 mm).
 - 3. Rods shall be not less than 120 inches (3050 mm) long.
 - 4. Sectional type, with integral threads.
- C. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES (continued):

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and **8 inches (203 mm)** in radius and narrow loops.
- C. Conceal conductors within normal view from exterior locations at grade within **200 feet (60 m)** of building. Comply with requirements for concealed installations in UL 96A.
 - 1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
 - 2. Install conduit where necessary to comply with conductor concealment requirements.
 - 3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.
- D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

- A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.
- B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Perform inspections as required to obtain a UL Master Label for system.
- B. Prepare test and inspection reports and certificates.

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES (continued):

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type 2 surge protective devices.
 - 2. Enclosures.
 - 3. Conductors and cables.

1.2 DEFINITIONS

- A. I_n : Nominal discharge current.
- B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.
- C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.
- D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).
- E. SCCR: Short-circuit current rating.
- F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- H. Type 3 SPDs: Point of utilization SPDs.
- I. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.
- J. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.
- K. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

- A. Product Data:

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS (continued):

1. For each type of product.
 - a. Include electrical characteristics, specialties, and accessories for SPDs.
 - b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:
 - 1) Tested values for VPRs.
 - 2) I_n ratings.
 - 3) MCOV, type designations.
 - 4) OCPD requirements.
 - 5) Manufacturer's model number.
 - 6) System voltage.
 - 7) Modes of protection.

B. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.5 WARRANTY

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

1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

B. The manufacturer shall provide unlimited free replacement of the entire SPD (not just modules, components or sub-assemblies) for all inoperable SPDs during the warranty period. Acceptable manufacturers listed that do not meet the warranty as standard shall submit a letter extending the warranty with the product submittal.

1. Manufacturer's Replacement Policy

PART 2 - PRODUCTS

2.1 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB, Electrification Business.
2. Advanced Protection Technologies Inc. (APT).
3. Eaton.
4. Liebert; Vertiv Holdings Co.
5. Mersen USA.
6. SSI, an ILSCO Company.
7. Schneider Electric USA, Inc.
8. Siemens Industry, Inc., Energy Management Division.

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS (continued):

- B. Source Limitations: Obtain devices from single source from single manufacturer.
- C. General Characteristics:
 - 1. Reference Standards: UL 1449, Type 2; UL 1283.
 - 2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
 - 3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 160 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
 - 4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.
- D. Options:
 - 1. Include LED indicator lights for power and protection status.
 - 2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
 - 4. Include surge counter.

2.2 **TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDs)**

- A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.

2.3 **ENCLOSURES**

- A. Indoor Enclosures: Type 1.
- B. Outdoor Enclosures: Type 4X.

2.4 **CONDUCTORS AND CABLES**

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 **INSTALLATION**

- A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

SECTION 264313 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS (continued):

- B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
 - 2. Do not exceed manufacturer's recommended lead length.
 - 3. Do not bond neutral and ground.
- C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

3.3 STARTUP SERVICE

- A. Complete startup checks in accordance with manufacturer's instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following types of LED luminaires:
 - 1. Materials.
 - 2. Finishes.
 - 3. Luminaire support.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

SECTION 265119 - LED INTERIOR LIGHTING (continued):

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI.

SECTION 265119 - LED INTERIOR LIGHTING (continued):

2.2 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A 36/A 36M for carbon structural steel.
2. ASTM A 568/A 568M for sheet steel.

C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A 240/240 M.

D. Galvanized Steel: ASTM A 653/A 653M.

E. Aluminum: ASTM B 209.

2.3 METAL FINISHES

- #### **A.**
- Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT

- #### **A.**
- Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- #### **B.**
- Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- #### **C.**
- Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- #### **D.**
- Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- #### **E.**
- Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

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

SECTION 265119 - LED INTERIOR LIGHTING (continued):

- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaires:
 - 1. Attached to a minimum 20 gauge backing plate attached to wall structural members .
 - 2. Do not attach luminaires directly to gypsum board.
- G. Suspended Luminaires:
 - 1. Ceiling Mount:
 - a. Two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length .
 - b. Pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length .
 - c. Hook mount.
 - 2. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

SECTION 265119 - LED INTERIOR LIGHTING (continued):

4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265119

SECTION 265119 - LED INTERIOR LIGHTING (continued):

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SECTION 265613 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Poles and accessories for support of luminaires.

1.3 DEFINITIONS

- A. EPA: Equivalent projected area.
- B. Luminaire: Complete luminaire.
- C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
- D. Standard: See "Pole."

1.4 ACTION SUBMITTALS

- A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
 - 1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
 - 2. Include finishes for lighting poles and luminaire-supporting devices.
 - 3. Anchor bolts.
 - 4. Manufactured pole foundations.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store poles on decay-resistant skids at least **12 inches (300 mm)** above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

PART 2 - PRODUCTS

SECTION 265613 - LIGHTING POLES AND STANDARDS (continued):

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-6-M.
- B. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
- C. Live Load: Single load of **500 lbf (2200 N)** distributed according to AASHTO LTS-6-M.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
 - 1. Basic wind speed for calculating wind load for poles **50 feet (15 m)** high or less is **150 mph (67 m/s)**.
 - a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 25 years.
 - c. Velocity Conversion Factor: 1.0.
- E. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.3 to obtain the EPA to be used in pole selection strength analysis.
- F. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 STEEL POLES

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. **Cooper Lighting Solutions; Signify North America Corp.**
 - 2. **Lithonia Lighting; Acuity Brands Lighting, Inc.**
 - 3. **LSI Industries.**
- B. Source Limitations: Obtain poles from single manufacturer or producer.
- C. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.
- D. Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of **46,000 psig (317 MPa)**; one-piece construction up to **40 feet (12 m)** in height with access handhole in pole wall.
 - 1. Shape: Round, straight.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- E. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - 1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with galvanized-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.
- F. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

SECTION 265613 - LIGHTING POLES AND STANDARDS (continued):

- G. Fasteners: Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
 - 1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- H. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.
- I. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.
- J. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- K. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2. Powder Coat: Comply with AAMA 2604.
 - a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils dry film thickness. Coat interior and exterior of pole for equal corrosion protection.
 - b. Color: As selected by Architect from manufacturer's full range.
 - 3. Corrosion Coating: Apply non-porous, automotive grade corrosion coating to exterior of powder coated pole.

2.3 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

2.4 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi (380,000 kPa).
 - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
- B. Nuts: ASTM A 563, Grade A, Heavy-Hex
 - 1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
 - 2. Two nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.
- C. Washers: ASTM F 436, Type 1.

SECTION 265613 - LIGHTING POLES AND STANDARDS (continued):

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. One washers provided per anchor bolt.

2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- C. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

- A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Anchor Bolts: Install plumb using manufacturer-supplied steel template, uniformly spaced.

3.3 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
 1. Fire Hydrants and Water Piping: 60 inches (1520 mm).
 2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet (3 m).
 3. Trees: 15 feet (5 m) from tree trunk.

SECTION 265613 - LIGHTING POLES AND STANDARDS (continued):

- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."
- D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers unless otherwise indicated.
 - 4. Use a short piece of 1/2 -inch (13-mm) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch (25 mm) below top of concrete slab.
- F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.4 CORROSION PREVENTION

- A. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.5 GROUNDING

- A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION 265613

SECTION 265613 - LIGHTING POLES AND STANDARDS (continued):

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SECTION 265619 – LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
 - 2. Luminaire supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - 6. Wiring diagrams for power, control, and signal wiring.
 - 7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

SECTION 265619 - LED EXTERIOR LIGHTING (continued):

- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.8 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

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

SECTION 265619 - LED EXTERIOR LIGHTING (continued):

- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. UL Compliance: Comply with UL 1598 and listed for wet location.
- D. Lamp base complying with ANSI C81.61 or IEC 60061-1.
- E. Bulb shape complying with ANSI C79.1.
- F. CRI of 80. CCT of 4100 K.
- G. L70 lamp life of 50,000 hours.
- H. Internal driver.
- I. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.
- J. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum Epoxy-coated steel or as indicated on drawings. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least **0.125 inch (3.175 mm)** minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
 - 1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 - 2. Provide filter/breather for enclosed luminaires.

SECTION 265619 - LED EXTERIOR LIGHTING (continued):

- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.3 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Architect from manufacturer's full range.

2.4 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

SECTION 265619 - LED EXTERIOR LIGHTING (continued):

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
- G. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.
- I. Coordinate layout and installation of luminaires with other construction.
- J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

SECTION 265619 - LED EXTERIOR LIGHTING (continued):

- K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with **0.010-inch-** (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-64.
 - d. IES LM-72.
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265619

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions of this Section apply to all Division 27 Specification Sections.

1.2 SUMMARY

- A. Section includes basic requirements for communication systems.
- B. Related Work:
 - 1. Division 03 – Concrete
 - a. Refer to Division 03 for rough grouting in and around work, patching concrete cut to accommodate work, and sumps for work.
 - b. Comply with the requirements of Division 03 for curbs, foundations, and equipment pads for equipment.
 - 2. Division 05 – Metals
 - a. Refer to Division 05 for framed openings for equipment.
 - b. Comply with the requirements of Division 05 for supports for work.
 - 3. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 4. Division 07 – Thermal and Moisture Protection
 - a. Refer to Division 07 for installation of roof curbs and roof supports and for caulking and waterproofing of wall- and roof-mounted work.
 - b. Comply with the requirements of Division 07 for penetration firestopping and furnishing roof curbs and roof supports for equipment and conduit.
 - 5. Division 08 – Openings
 - a. Refer to Division 08 for installation of access doors and frames.
 - b. Comply with the requirements of Division 08 for access doors and frames, unless otherwise included in the Contract Documents.
 - 6. Division 09 – Finishes
 - a. Refer to Division 09 for paint products and applications in finished spaces.
 - b. Comply with the requirements of Division 09 for paint products and applications identified in the Contract Documents.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

7. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
8. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
9. Division 22 – Plumbing
 - a. Refer to Division 22 for all plumbing work.
10. Division 23 – Heating, Ventilation, and Air-Conditioning
 - a. Refer to Division 23 for all heating, ventilation, and air-conditioning work.
11. Division 25 – Instrumentation and Control
 - a. Refer to Division 25 for instrumentation and control systems.
 - b. Comply with the requirements of Division 25 for installation of and integration with instrumentation and control components.
12. Division 26 – Electrical
 - a. Refer to Division 26 for all electrical work.
13. Division 28 – Electronic Safety and Security
 - a. Refer to Division 28 for all electronic safety and security work.
 - b. Coordinate with Division 28 for integration with security systems.
14. Division 29 – Fire Safety and Emergency Communications
 - a. Refer to Division 29 for all fire safety and emergency communications work.
 - b. Coordinate with Division 29 for integration with fire safety and emergency communications systems.
15. Division 31 – Earthwork
 - a. Refer to Division 31 for all site related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 31 for site clearing, earth moving, and dewatering within five feet outside the building and otherwise as indicated in the Contract Documents.
16. Division 33 – Utilities
 - a. Refer to Division 33 for all utility related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 33 for utility work within five feet outside the building and otherwise as indicated in the Contract Documents.

1.3 **DEFINITIONS**

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

- A. Experienced: When used with an entity or individual, “experienced” unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Furnish: Supply and deliver to project site, ready for subsequent requirements.
- C. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
- D. Provide: Furnish and install, complete and ready for intended use.
- E. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- F. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.
- G. Concealed Work: Work hidden from view, including inside chases, furred spaces, or above ceilings.
- H. Exposed Work: Work open to view, including inside mechanical and equipment rooms .

1.4 QUALITY ASSURANCE

- A. General:
 - 1. It is the intent of the plans and specifications to obtain a complete, operable and satisfactory installation.
 - 2. All materials shall be new, be properly labeled and/or identified and be in full compliance with the contract documents.
 - 3. All work shall comply with applicable Codes and Standards.
 - 4. Manufacturer's model names and numbers used in these specifications are subject to change per manufacturer's action. Contractor shall therefore verify them with manufacturer's representative before ordering any product or equipment
- B. Furnish new and unused materials and equipment manufactured in the U.S.A. Where two or more units of the same type or class of equipment are required provide units of a single manufacturer.

1.5 CODES AND STANDARDS

- A. Perform work in accordance with the following codes and any applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
 - 1. Occupational Safety and Health Regulations (OSHA).
 - 2. National Fire Codes
 - a. NFPA 1 Fire Code – 2021 (Florida Edition)
 - b. NFPA 70 National Electrical Code – 2020
 - c. NFPA 72 National Fire Alarm and Signaling Code - 2019
 - d. NFPA 101 Life Safety Code – 2021 (Florida Edition)
 - 3. Florida Building Code, 2023 Edition

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

- a. Building Code
 - b. Energy Conservation Code
 - c. Mechanical Code
 - d. Plumbing Code
 - e. Fuel Gas Code
 - f. Accessibility Code
 - 4. Florida Statutes
 - a. Chapter 471 Engineering
 - b. Chapter 533.80 Building Construction Standards; Florida Building Code - Enforcement
 - 5. Florida Administrative Code
 - a. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - b. Chapter 61G15-33 Responsibility Rules of Professional Engineers Concerning the Design of Electrical Systems
 - c. Chapter 69A-3 Fire Prevention – General Provisions
 - d. Chapter 69A-60 The Florida Fire Prevention Code
 - 6. ADA Accessibility Guidelines for Buildings (ADAAG)
- B. Resolve, in writing, any code violation discovered in contract documents with the Engineer prior to bidding. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
- C. The Contractor shall include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and drawings required to comply with all applicable laws, ordinances, rules, and regulations.
- D. Where there is conflict between the Contract Documents and the applicable Codes, the Codes shall govern, except where the requirements of the Contract Documents are more stringent.

1.6 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or NEC Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments, or supplements in effect on date bids are received. Specifications and standards are minimum requirements for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
- B. Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition of the standard at the time project is bid unless otherwise specified herein

1.7 DELEGATED-DESIGN SERVICES

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

1.8 PERMITS FEES AND INSPECTIONS

- A. Obtain and pay for all permits, fees, tap fees, connection charges, demand charges, systems charges, impact fees, and inspections.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.9 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
 - 1. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer in writing prior to bid date; however, the most stringent requirement shall govern.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.10 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 - 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Prepare RFIs as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 - 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 - 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

1.11 SUBMITTALS

- A. Submittals (including Product Data, Shop Drawings, and any other Action Submittal or Information Submittal) will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions, Division 01, and the following:
1. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are approved by the Engineer.
 3. Submittals shall only contain relevant product data. Remove or strikeout irrelevant product data.
 4. Prepare submittals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
 5. Options: Identify options requiring selection by Engineer.
 6. Deviations: Clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 7. Revisions: Include relevant additional information and revisions, other than those specifically requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached submittal sheet.
 8. Contractor's Review:
 - a. Submittals shall have been reviewed and approved by the General Contractor / Construction Manager. Include approval stamp, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - b. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.
 9. Electrical Modifications:
 - a. The electrical design indicated on the plans supports the Basis of Design specifications for the Communications systems at the time of design.
 - b. If Communications equipment is submitted with different electrical requirements, it is the responsibility of the Contractor to resolve all required electrical design changes, including, but not limited to: wire and conduit size, type or size of disconnect or overload protection, breaker coordination, point(s) of connection, etc. Any corrections required shall be provided at no additional cost.
 - c. Submittal shall clearly show the electrical design revisions with a written statement that this change will be provided at no additional cost. Submittals made with no written reference to the electrical design revisions will be presumed to work with the electrical design.
- B. Processing Time: Time of review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of the failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Allow not less than 15 days for submittal review. Allow not less than 21 days for review of large or complex submittals. Submittals received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 2. If Contractor transmits more than five submittals over two consecutive business days, review time shall increase by no less than 7 days for submittal review.
 3. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

4. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received. Time of review shall commence on receipt of all other related submittals.
- C. The Contractor shall not be relieved of responsibility for deviations from requirements of the contract documents by the Engineer's approval of shop drawings, product data, samples, or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal, and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in shop drawings, product data, samples, or similar submittals by the Engineer's approval thereof.
- D. Submittal Review Fees:
 1. Additional Reviews: Submittals on any particular phase of Work will receive only one review and one re-review (if required). If additional reviews are required beyond these two, the Contractor will be charged \$200.00 per hour for review time, in addition to any expedited review charges. This fee shall be paid to the Engineer prior to Submittal release.
 2. Expedited Reviews: If General Contractor / Construction Manager requests for an expedited review, whether by official request or unofficially by assigning a review time less than required above, the General Contractor / Construction Manager will be charged \$1,000.00 per Submittal, in addition to any charges for additional reviews. This fee shall be paid to the Engineer prior to Submittal release.

1.12 COORDINATION DRAWINGS (NOT REQUIRED)

- A. Should the Contractor elect to provide Coordination Drawings when not expressly required by the Engineer, such Drawings shall be considered for informational purposes only. The Engineer will not conduct a review of these Drawings, and their submission or any implied approval shall not relieve the Contractor of the obligation to fully comply with the requirements set forth in the Construction Documents. The Contractor remains solely responsible for ensuring that all work meets the contract specifications and standards, regardless of the content or status of the Coordination Drawings.

1.13 SUBSTITUTIONS

- A. By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Substitution Requests shall include, at a minimum:
 1. Statement indicating why specified material, equipment, or installation method cannot be provided, if applicable.
 2. Coordination of information, including a list of changes and revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 3. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include an annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

5. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 6. Cost information, including a proposal of change, if any, in the Contract Sum.
 7. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 8. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- C. Procurement Substitution Requests submitted prior to receipt of bids will be received and considered by Owner when the following conditions are satisfied, as determined by Engineer; otherwise, requests will be returned without action:
1. Requests for substitution of materials and equipment are received no later than 10 days prior to date of bid opening.
 2. Extensive revisions to the Contract Documents are not required.
 3. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
 4. The request is fully documented and properly submitted.
- D. Substitutions for Cause, as required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms will be received and considered by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 2. Substitution request is fully documented and properly submitted.
 3. Requested substitution has received necessary approvals of authorities having jurisdiction.
 4. Requested substitution is compatible with other portions of the Work.
 5. Requested substitution has been coordinated with other portions of the Work.
 6. Requested substitution provides specified warranty.
 7. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- E. Substitutions for Convenience, not required in order to meet other Project requirements but may offer advantage to Contractor or Owner, will be received and considered by Owner, as determined by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is received within 60 days after the Notice of Award.
 2. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 3. Requested substitution does not require extensive revisions to the Contract Documents.
 4. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 5. Substitution request is fully documented and properly submitted.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

7. Requested substitution is compatible with other portions of the Work.
 8. Requested substitution has been coordinated with other portions of the Work.
 9. Requested substitution provides specified warranty.
 10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- F. If a requested substitution is approved but contains differences or omissions not specifically identified to the attention of the Engineer in the substitution request, the Owner reserves the right to require equal or similar features to be added to the substituted products or to have the substituted products replaced at the Contractor's expense.

1.14 PROJECT RECORD DOCUMENTS

- A. Recording: Maintain one copy of the Contract Documents and Shop Drawings during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation:
1. Contract Drawings and Shop Drawings:
 - a. Mark revisions to show where the actual installation varies from that shown originally.
 - b. Mark record sets completely and accurately, including important information that was either shown schematically or omitted from original Drawings.
 - c. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - d. Record underground and under-slab piping installed, dimensioning exact location and elevation of piping.
 2. Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 3. Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
- C. Deliver: Prior to Final Completion, provide record documents to Owner as indicated below:
1. Record Drawings: Submit PDF electronic files of scanned record prints and one set of prints.
 2. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
 3. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 4. Miscellaneous Record Submittals: Submit annotated PDF electronic files directories of each submittal.

1.15 OPERATION AND MAINTENANCE MANUALS

- A. Prepare and submit a comprehensive manual of emergency, operation, and maintenance data and materials in full accordance with the General and Supplementary Conditions, Division 01, and the following:
1. Operations and Maintenance Manuals: Assemble a complete set of data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system, including:

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

- a. Information required for daily operation and management, operating standards, and routine and special operating procedures.
 - b. Manufacturers' maintenance documentation, preventative maintenance procedures and frequency, repair procedures, wiring and systems diagrams, list of spare parts, and warranty information.
2. Submit manuals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. Submittals shall be in searchable PDF format and not a scanned copy.

1.16 DEMONSTRATION AND TRAINING

- A. Prepare and provide services of qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system in accordance with the General and Supplementary Conditions, Division 01, individual Specification Sections, and the following:
 1. Demonstration and training shall occur upon completion of the Work and at a time designated by the Owner's representative.

1.17 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

1.18 WARRANTY

- A. Warranty work and equipment within specified warranty period. During the warranty period, provide labor and materials to make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship without expense to the Owner.
 1. Warranty Period: One year from date of Substantial Completion.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
- C. Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving the Contractor of responsibilities during the warranty period.

PART 2 - PRODUCTS (NONE)

PART 3 - EXECUTION

3.1 CONTRACT DOCUMENTS

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

- A. Examine all drawings and specifications carefully before submitting a bid. Architectural drawings take precedence over mechanical or electrical drawings with reference to building construction.
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.
- C. The drawings indicate required size and points of termination of pipes, conduits, and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the responsibility of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.
- E. Any and all questions about a subcontractor's scope of work responsibility shall be addressed to and answered by the General Contractor / Construction Manager.
- F. Questions About Construction Documents: Any and all questions shall be submitted through the proper channels IN WRITING and, in turn, shall be answered by the Engineer in writing. All telephone conversations shall be considered unofficial and, as such, shall not be considered official or binding responses to Contractor's questions.
- G. Drawings, specifications, or other documents issued by the Engineer in electronic format and/or electronic media are provided for convenience only and are not intended for use as Contract Documents.
 - 1. The electronic files are provided merely as a convenience to the Recipient.
 - 2. The electronic files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.
 - 3. The Engineer makes no representation, warranty, or guarantee that electronic files:
 - a. Are suitable for any other usage or purpose.
 - b. Have any particular durability.
 - c. Will not damage or impair the Recipient's computer or software.
 - d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.
 - 4. Due to the unsecured nature of the electronic files and the inability of Engineer or the Recipient to establish controls over their use, the Engineer assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained therein. The Recipient shall at all times refer to the signed and sealed drawings, specification or other documents for the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of the electronic files.

3.2 SUPERVISION OF WORK

- A. Perform all work under the direct supervision of an experienced, qualified superintendent. The Engineer has the right to remove a superintendent who, in the Engineer's opinion, is not satisfactory.

3.3 EXAMINATION

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.4 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.

3.5 INSTALLATION

- A. Install materials and equipment in a professional manner. The Engineer may direct replacement of items which, in the Engineer's opinion, do not present a professional appearance or do not allow adequate space for maintenance. Replace or reinstall items at the expense of the Contractor.
- B. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

- C. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- D. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- G. Obstructions
 - 1. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
 - 2. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
 - 3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
 - 4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.
- H. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof, or ceiling to the satisfaction of the authority having jurisdiction.
- I. Structural Elements: Do not cut structural elements without written approval from Engineer. Notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. If approved by Engineer:
 - 1. Shore, brace, and support structural elements during cutting and patching.
 - 2. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- J. Space Requirements: Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
- K. Tools and Equipment: Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.
- L. Phasing: Provide all temporary valves, piping, ductwork, equipment, and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

3.6 OWNER-INSTALLED PRODUCTS

- A. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

3.7 UTILITY SERVICES AND COMMUNICATION SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

3.8 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- F. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
- G. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- H. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- I. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- J. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable or with in-place materials.
1. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 2. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.
- K. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.9 PAINTING

- A. Comply with requirements with General and Supplementary Conditions, Division 01, Division 09, and individual Specification Sections.
- B. Touch-up factory finishes on equipment provided under Division 27. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.
- C. Paint the following work where exposed to view:
1. Metal conduit
 2. Plastic conduit
- D. Paint the following work where exposed in occupied spaces:
1. Other items as directed by Engineer.

3.10 REPAIR OF WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

3.11 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests
 1. Include all tests specified and/or required under laws, rules and regulations of all departments having jurisdiction. Tests shall also be performed as indicated herein and other sections of the specifications.
 2. After all systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems.
 3. All parts of the work and associated equipment shall be tested and adjusted to work properly and be left in perfect operating condition.
 4. Correct defects disclosed by these tests without any additional cost to the Owner. Repeat tests on repaired or replaced work.
 5. Maintain a log of all tests being conducted and have it available for review by the Engineer. Log to indicate date, type of tests, duration, and defects noted and when corrected.
 6. Special tests on individual systems are specified under individual Specification Sections.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

3.12 CLEANING

- A. Progress Cleaning: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Final Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove labels that are not permanent.
 - c. Wipe surfaces of equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

END OF SECTION 270100

SECTION 270100 - GENERAL PROVISIONS FOR COMMUNICATIONS (continued):

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SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Selection and installation of communications busbars.
2. Selection and installation of communications bonding conductors.

1.2 DEFINITIONS

- A. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
- B. PBB: Primary bonding busbar, located in main distribution frame room, ideally near electrical service entrance.
- C. RBB: Rack bonding busbar, located in equipment cabinets and racks.
- D. SBB: Secondary bonding busbar, located in intermediate distribution frame rooms.
- E. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
- F. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
- G. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
- H. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of TBC connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of TBC only after unsatisfactory conditions have been corrected.

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS (continued):

3.2 SELECTION OF COMMUNICATIONS BUSBARS

- A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. PBB:
 - 1. Dimensions: 1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high).
 - 2. Stand-Off Distance: 4 inch (100 mm).

3.3 SELECTION OF COMMUNICATIONS BONDING CONDUCTORS

- A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Communications Busbar Connections:
 - 1. TBC: Not smaller than 3/0 AWG and no smaller than largest TBB.
 - 2. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
 - 3. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
 - 4. TEBC: Not smaller than 2 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
 - 5. Bonding Conductors to Structural Steel: Not smaller than 4 AWG unless otherwise indicated on Drawings. Provide bolted clamp connectors.
- C. Cable Tray Connections:
 - 1. Cable Tray Equipment Grounding Conductor: 6 AWG.
 - 2. Cable Tray Bonding Jumper: If not supplied by cable manufacturer, provide bonding jumper not smaller than 6 AWG and not longer than 12 inch (300 mm). If jumper is wire, it must be terminated with lug having one hole and standard barrel for one crimp. If jumper is flexible braid, it must be terminated with one- or two-hole ferrule. Attach with bonding screw or connector provided by cable tray manufacturer.
- D. Underground Connections: Not smaller than 2 AWG. Provide welded connectors, except bolted connectors may be used in handholes or manholes and as otherwise indicated on Drawings.

3.4 INSTALLATION OF BONDING FOR COMMUNICATIONS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Busbars:

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS (continued):

- a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers **12 inch (300 mm)** above finished floor unless otherwise indicated.
2. Conductors:
 - a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
 - b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:
 - 1) Use crimping tool and die specific to connector.
 - 2) Pre-twist conductor.
 - 3) Apply antioxidant compound to bolted and compression connections.
 - c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
 - d. Install without splices.
 - e. Support conductors at not more than **36 inch (900 mm)** intervals.
 - f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room. Install bonding conductors in EMT-A or EMT-SS when routed through plenum. Do not install bonding conductors in EMT-S unless otherwise indicated on Drawings.
 - 1) If bonding conductor must be installed in EMT-S or other ferrous metallic raceway, bond conductor to raceway using grounding bushing that complies with Section 270528 "Pathways for Communications Systems," and bond both ends of raceway to SBB.
3. Provide TBC and terminate ends to PBB and intersystem bonding busbar at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
4. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together BBCs where required by TIA-607.
5. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.
6. Communications Enclosures: Bond metallic enclosures of telecommunications equipment with UBCs to nearest SBB or PBB.
7. Equipment Racks: Bond metallic components of enclosures to RBB using UBCs. Provide top-mounted RBB if not provided by enclosure or rack manufacturer. Bond RBB to SBB with TEBC. Power connection must comply with NFPA 70; equipment grounding conductor in power cord of cord- and plug-connected equipment must be considered supplemental to bonding requirements in this Section.
8. Shielded Cable: Bond shield of shielded cable to SBB in communications rooms and spaces. Comply with TIA-568.1 and TIA-568.2 when grounding shielded balanced twisted-pair cables.
9. Primary Protector: Bond to PBB with insulated bonding conductor.
10. Electrical Power Panelboards: Where electrical panelboards for communications equipment are located in same room or space, bond each ground bar of panelboard to SBB.
11. Cable Trays: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.
12. Ladder Racks: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.

3.5 IDENTIFICATION

- A. Comply with Section 270553 "Identification for Communications Systems."

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS (continued):

- B. Labels must be preprinted or computer-printed type.
 - 1. Label PBB(s) with "ts-PBB," where "ts" is telecommunications space identifier for location of PBB.
 - 2. Label SBB(s) with "ts-SBB," where "ts" is telecommunications space identifier for location of SBB.
 - 3. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.
 - 2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.
 - a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 m Ω .
 - 1) If measured resistance from electrical service equipment to ground exceeds 5 Ω , notify Architect and include recommendations to reduce resistance to ground.
 - b. Measure resistance between SBBs and PBB. Maximum acceptable value is 100 m Ω .
 - 3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.
 - a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB and to SBBs. Maximum acceptable AC current level is 1 A.
- B. Nonconforming Work:
 - 1. Communications bonding will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- C. Collect, assemble, and submit test and inspection reports.

3.7 PROTECTION

- A. After installation, protect busbars and conductors from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Hooks.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Polymer-concrete handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Wireways and fittings.
 - 3. Boxes, enclosures, and cabinets.
 - 4. Underground handholes and boxes.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. EMT: Comply with ANSI C80.3 and UL 797.

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS (continued):

- E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
- F. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. Galvanized steel.
- E. J shape.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
 - 3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS (continued):

4. Device Box Dimensions: 4 11/16 inches square by 3-1/4 inches deep (102 mm square by 83 mm deep).
 5. Gangable boxes are prohibited.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Metal Floor Boxes:
1. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4, with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- G. Cabinets:
1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.
 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 POLYMER-CONCRETE HANDHOLES

- A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.
- B. General Requirements for Polymer Concrete Handholes:
1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 3. Comply with TIA-569-D.
- C. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
- D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 2. Cover Legend: Molded lettering, "COMMUNICATIONS".
- E. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS (continued):

- F. Handholes **12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long)** and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4 stainless steel.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Damp or Wet Locations: GRC.
 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
 7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: **1 inch (25 mm)**.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
- E. Do not install nonmetallic conduit where ambient temperature exceeds **120 deg F (49 deg C)**.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS (continued):

- 5. NECA 105.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS (continued):

- P. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the lock-nut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- S. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- T. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
 - 2. 1-Inch (25-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- U. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- V. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- W. Hooks:
 - 1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 - 2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 - 3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 - 4. Space hooks no more than 4 feet (1.2 m) o.c.
 - 5. Provide a hook at each change in direction.
- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS (continued):

- Z. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- CC. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe of less than **6 inches (150 mm)** in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within **12 inches (300 mm)** of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete around conduit for a minimum of **12 inches (300 mm)** on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of **60 inches (1500 mm)** from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1/2-inch (12.5-mm)** sieve to **No. 4 (4.75-mm)** sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures **1 inch (25 mm)** above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS (continued):

- E. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 **SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 **FIRESTOPPING**

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07.

3.7 **PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 270528

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems for communication raceways.
 - 2. Conduit and cable support devices.
 - 3. Support for conductors in vertical conduit.
 - 4. Structural steel for fabricated supports and restraints.
 - 5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 - 6. Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum **13/32-inch- (10-mm-)** diameter holes at a maximum of **8 inches (200 mm)** o.c. in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 3. Channel Width: **1-5/8 inches (41.25 mm)**.
 - 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS (continued):

- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type [**zinc-coated steel**] [**stainless steel**] for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, **Grade A325** (**Grade A325M**).
 - 5. Toggle Bolts: Stainless-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA/BICSI 568.
 - 3. TIA-569-D.
 - 4. NECA 101.
 - 5. NECA 105.
- B. Comply with requirements in Division 07 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be **1/4 inch** (**6 mm**) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS (continued):

1. Secure raceways and cables to these supports with single-bolt conduit clamps, using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

- A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus **200 lb (90 kg)**.
- B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Use expansion anchor fasteners.
 5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- C. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of **2.0 mils (0.05 mm)**.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 270529

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS (continued):

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SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Ladder cable tray.
 - 2. Wire-mesh cable tray.
 - 3. Cable tray accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAY

- A. Description:

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS (continued):

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: **18 inches (450 mm)** unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: **4 inches (100 mm)**.
4. Straight Section Lengths: **10 feet (3.0 m)**, except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: **9 inches (225 mm)** o.c.
6. Radius-Fitting Rung Spacing: **9 inches (225 mm)** at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: **7/8-inch (22-mm)** width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a **200-lb (90-kg)** concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: **24 inches (600 mm)**.
11. Class Designation: Comply with NEMA VE 1, Class 8A.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

B. Materials and Finishes:

1. Steel:
 - a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Epoxy-resin paint.
 - 1) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
 - 2) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
 - 3) Hardware: Chromium-zinc plated, ASTM F 1136.

2.3 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS (continued):

- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Fasten cable tray supports to building structure.
- F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems."
- G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- I. Support bus assembly to prevent twisting from eccentric loading.
- J. Do not install more than one cable tray splice between supports.
- K. Support trapeze hangers for cable trays with 1/4-inch- (6-mm-) diameter rods.
- L. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended. Space connectors and set gaps according to applicable standard.
- N. Make changes in direction and elevation using manufacturer's recommended fittings.
- O. Make cable tray connections using manufacturer's recommended fittings.
- P. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07.
- Q. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- R. Install cable trays with enough workspace to permit access for installing cables.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS (continued):

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every **18 inches (450 mm)**.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than **72 inches (1800 mm)**.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 PROTECTION

- A. Protect installed cable trays and cables.
 - 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
 - 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 - 3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduit and fittings, including GRC and PVC-coated GRC.
 - 2. Rigid nonmetallic duct.
 - 3. Duct accessories, including rigid innerduct and fabric innerduct.
 - 4. Polymer concrete handholes and boxes with polymer concrete cover.

1.3 DEFINITIONS

- A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.
- D. GRC: Galvanized rigid conduit.
- E. IMC: Intermediate metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include duct-bank materials, including spacers and miscellaneous components.
 - 2. Include duct and conduits and their accessories, including elbows, end bells, bends, fittings, duct spacers and solvent cement.
 - 3. Include accessories for handholes, and boxes.
 - 4. Include underground-line warning tape.

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS (continued):

1.5 INFORMATIONAL SUBMITTALS

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 RIGID NONMETALLIC DUCTS

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. General Requirements for Nonmetallic Ducts and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-C and TIA-758-C.
- C. Solvents and Adhesives: As recommended by duct manufacturer.

2.2 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC 40-HDPE complying with NEMA TC 7 and UL 651A.
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-C and TIA-758-C.

2.3 DUCT ACCESSORIES

- A. Fabric Innerduct: Continuous, polyester, multi -pocket fabric innerduct, with internal pull tape and tracer wire.
- B. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS (continued):

- C. Underground-Line Warning Tape: Underground-line warning tape specified in Section 270553 "Identification for Communications Systems."

2.4 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- C. Color: Gray .
- D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- G. Cover Legend: Molded lettering, "COMMUNICATIONS ."
- H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- J. Handholes **12 inches wide by 24 inches long (300 mm wide by 600 mm long)** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS (continued):

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Communications: Type EPC-40-PVC RNC, in direct-buried duct bank unless otherwise indicated.
- B. Underground Duct Crossing Paved Paths, Driveways, and Roadways: Type EPC-40-PVC RNC, encased in reinforced concrete.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for Communications:
 - 1. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 - 2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 3. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area after construction in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS (continued):

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.
- C. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of [48 inches (1200 mm)] [12.5 feet (4 m)] [25 feet (7.5 m)], both horizontally and vertically, at other locations unless otherwise indicated.
 - 1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings, and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End-Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line direct-buried duct and duct banks, with calculated expansion of more than 3/4 inch (19 mm).
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet (3 m) from the terminator without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct or duct bank, with calculated expansion of more than 3/4 inch (19 mm).
- I. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- J. Innerduct: Install immediately after mandreling duct. Size and type as indicated on Drawings.
- K. Pulling Cord: Install 200-lbf- (1000-N-m) test nylon cord in empty duct and innerduct.

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS (continued):

L. Direct-Buried Duct and Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct and duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for duct less than **6 inches (150 mm)** in nominal diameter.
2. Install duct with a minimum of **3 inches (75 mm)** between duct for like services and **6 inches (150 mm)** between power and signal duct.
3. Width: Excavate trench **12 inches (300 mm)** wider than duct or duct bank on each side.
4. Width: Excavate trench **3 inches (75 mm)** wider than duct or duct bank on each side.
5. Depth: Install top of duct or duct bank at least **36 inches (900 mm)** below finished grade unless otherwise indicated.
6. Set elevation of bottom of duct or duct bank below frost line.
7. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
8. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than **[four] [five]** spacers per **20 feet (6 m)** of duct. Place spacers within **24 inches (600 mm)** of duct ends. Stagger spacers approximately **6 inches (150 mm)** between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow. .
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - a. Couple GRC to duct with adapters designed for this purpose, and encase coupling with **3 inches (75 mm)** of concrete.
 - b. For equipment mounted on outdoor bases, extend GRC horizontally a minimum of **60 inches (1500 mm)** from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to **4 inches (100 mm)** over duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
 - a. Place minimum of **3 inches (75 mm)** of sand as a bed for duct and duct bank. Place sand to a minimum of **6 inches (150 mm)** above top level of duct and duct bank.
 - b. Place minimum of **6 inches (150 mm)** of engineered fill above concrete encasement of duct bank.

- M. Underground-Line Warning Tape: Bury **[nonconducting] [conducting]** underground-line warning tape specified in Section 270553 "Identification for Communication Systems" no less than **12 inches (300 mm)** above all concrete-encased duct and duct bank **[and approximately 12 inches (300 mm) below grade]**. Align tape parallel to and within **3 inches (75 mm)** of centerline of duct bank. Provide an additional warning tape for each **12-inch (300-mm)** increment of duct-bank width over a nominal **18 inches (450 mm)**. Space additional tapes **12 inches (300 mm)** apart, horizontally.

3.6 **INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE**

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS (continued):

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- E. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring, encircling, and in contact with, enclosure, and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

3.7 GROUNDING

- A. Ground underground duct, duct bank, and utility structures according to Section 270526 "Grounding and Bonding for Communications Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- (300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole[**and handhole**] grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.
- B. Clean internal surfaces of manholes, including sump.
 - 1. Remove foreign material.

**SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION
SYSTEMS (continued):**

END OF SECTION 270543

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Round sleeves.
 - 2. Rectangular sleeves.
 - 3. Sleeve seal systems.
 - 4. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

- A. Wall Sleeves, Steel:
 - 1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B. Molded Sleeves, PVC:
 - 1. Description: With nailing flange for attaching to wooden forms.

2.2 RECTANGULAR SLEEVES

- A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:
 - 1. Description:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness must be 0.052 inch (1.3 mm).

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING (continued):

- 2) For sleeve cross-section rectangle perimeter not less than **50 inches (1270 mm)** or with one or more sides larger than **16 inches (400 mm)**, thickness must be **0.138 inch (3.5 mm)**.

2.3 SLEEVE SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.
 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Stainless steel.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Design Mix: **5000-psi (34.5-MPa)**, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING (continued):

- C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- F. Underground, Exterior-Wall and Floor Penetrations:
 - 1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.
 - 2. Install steel pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE SEAL SYSTEMS

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 270544

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING (continued):

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SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Underground-line warning tape.
 - 2. Signs.
 - 3. Bands and tubes.
 - 4. Cable ties.
 - 5. Miscellaneous identification products.
 - 6. Labels.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS (continued):

- A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels:
 - a. Permanent, waterproof black ink marker recommended by tag manufacturer.
 - b. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- B. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
 - c. As required by authorities having jurisdiction.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
 - 2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE".
- C. Description:
 - 1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 2. Width: 3 inches (75 mm).
 - 3. Overall Thickness: 8 mils (0.2 mm).
 - 4. Foil Core Thickness: 0.35 mil (0.00889 mm).
 - 5. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).
 - 6. Tensile according to ASTM D882: 300 lbf (1334 N) and 12,500 psi (86.1 MPa).

2.5 SIGNS

- A. Laminated-Acrylic or Melamine-Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS (continued):

- a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
- b. For signs larger than 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick.
- c. Engraved legend with white letters on a dark gray background.
- d. Punched or drilled for mechanical fasteners with 1/4-inch (6.4-mm) grommets in corners for mounting.
- e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

- A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D638: 12,000 psi (82.7 MPa).
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black.
- B. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength at 73 deg F (23 deg C) according to ASTM D638: 7000 psi (48.2 MPa).
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS (continued):

- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label **6 inches (150 mm)** from cable end.
- I. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.
- J. Underground-Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at **6 to 8 inches (150 to 200 mm)** below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds **16 inches (400 mm)** overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
 - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- K. Cable Ties: General purpose, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
 - 1. System legends shall be as follows:
 - a. Telecommunications.

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS (continued):

- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
1. Telecommunications room designation.
 2. Period.
 3. Rack designation.
 4. Period.
 5. Patch panel rack U position.
 6. Period.
 7. Patch panel port number.
- E. Equipment Room Labeling:
1. Racks, Frames, and Enclosures: Identify front and rear of each with laminated-acrylic or melamine-plastic signs containing equipment designation.
 - a. Telecommunications room designation.
 - b. Period.
 - c. Rack or cabinet designation.
 2. Patch Panels: Label individual rows and outlets, starting at top left and working down, with self-adhesive labels.
 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Patch panel rack U position.
 - b. Period.
 - c. Patch panel port number.
- F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the first and second location of the far or other end of the backbone cable. Both terminations terminated should be labeled identically.
1. Telecommunications room designation (first location).
 2. Period.
 3. Rack designation.
 4. Period.
 5. Patch panel rack U position.
 6. Period.
 7. Patch panel port number.
 8. Slash.
 9. Telecommunications room designation (second location).
 10. Period.
 11. Rack designation.
 12. Period.
 13. Patch panel rack U position.
 14. Period.
 15. Patch panel port number.
- G. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
1. Telecommunications room designation.
 2. Period.
 3. Rack designation.

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS (continued):

4. Period.
 5. Patch panel rack U position.
 6. Period.
 7. Patch panel port number.
- H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- I. Instructional Signs: Self-adhesive labels.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
1. Apply to exterior of door, cover, or other access.
- K. Equipment Identification Labels:
1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.
 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
 3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.
 - c. Computer room air conditioners.
 - d. Power distribution components.

END OF SECTION 270553

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Backboards.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. TGB: Telecommunications grounding bus bar.
- F. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS (continued):

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).
- B. Backboard Paint: Light-colored fire-retardant paint.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Backboards:

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS (continued):

1. Install from 6 inches (150 mm) to 8 feet, 6 inches (2588 mm) above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Comply with requirements in Division 07.
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS (continued):

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SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. 19-inch equipment racks.
 - 2. 19-inch freestanding equipment cabinets.
 - 3. Grounding.
 - 4. Labeling.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. TGB: Telecommunications grounding bus bar.
- G. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES (continued):

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Technician to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL listed.
- B. RoHS compliant.

2.2 19-INCH EQUIPMENT RACKS

- A. Description: Two- and four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Chatsworth.
 2. Cooper B-line; brand of Eaton, Electrical Sector.
 3. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 4. Panduit Corp.
- C. General Requirements:
 1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 2. Material: Extruded steel.
 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 4. Color: Black.
- D. Floor-Mounted Racks:
 1. Overall Height: 84 inches (2133.6 mm).
 2. Overall Depth: 29 inches (736.6 mm).
 3. Upright Depth: 3 inches (76.2 mm).
 4. Two-Post Load Rating: 1000 lb (454 kg).
 5. Four-Post Load Rating: 2000 lb (907 kg).
 6. Number of Rack Units per Rack: 45.
 - a. Numbering: Every rack units, on interior of rack.
 7. Threads: 12-24.
 8. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
 9. Base shall have a minimum of four mounting holes for permanent attachment to floor.
 10. Top shall have provisions for attaching to cable tray or ceiling.
 11. Self-leveling.
- E. Wall-Mounted Racks:

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES (continued):

1. Height: As indicated on Drawings.
2. Depth: 23 inches (584.2 mm).
3. Load Rating: 150 lb (65 kg).
4. Number of Rack Units per Rack: As indicated on Drawings.
5. Threads: 12-24.
6. Wall Attachment: Four mounting holes.
7. Equipment Access: Integral swing.

F. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 19-INCH EQUIPMENT CABINETS

- A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72 inches (450 mm) between rails.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth Products, Inc.
2. Cooper B-line; brand of Eaton, Electrical Sector.
3. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
4. Panduit Corp.

C. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Modular Freestanding Cabinets:

1. Overall Height: 84 inches (2133.6 mm).
2. Overall Depth: 245.3 inches (1150mm).
3. Load Rating: 3000 lb (1362 kg).
4. Number of Rack Units: 45.
 - a. Numbering: Every rack units, on interior of rack.
5. Threads: Universal square.
6. Removable and lockable side and top panels.
7. Hinged and lockable front and rear doors.
8. Adjustable feet for leveling.
9. Screened ventilation openings in roof and rear door.
10. Cable access provisions in roof and base.
11. TGB.
12. Air dam.

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES (continued):

13. Bottom panel.
14. Ring cable manager.
15. Full height dual PDU bracket.
16. All cabinets keyed alike.

E. Cable Management:

1. Ring cable manager.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.

2.4 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
 2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch (482.6- or 584.2-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical TGB: 72 or 36 inches (1828.8 or 914.4 mm) long, with stainless-steel or copper-plated hardware for attachment to rack.

2.5 LABELING

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES (continued):

2. Record agreements reached in meetings and distribute them to other participants.
 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

- A. Comply with NECA/BICSI 607.
- B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.
- C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least **2 inches (50 mm)** of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.
1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

- A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."
- B. Comply with requirements in Division 09 for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration, including optional identification requirements of this standard.
- D. Labels shall be machine printed. Type shall be **1/4 inch (6 mm)** in height.

END OF SECTION 271116

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES (continued):

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SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Type OFNR optical fiber cable.
 - 2. Optical fiber cable hardware.

1.2 DEFINITIONS

- A. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.
- B. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.
- C. Type OFNR: Nonconductive cable for use as riser in vertical shafts or from floor to floor.
- D. Types OFN and OFNG: Nonconductive cable for general purpose use.

1.3 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Type OFNR optical fiber cable.
 - 2. Types OFN and OFNG optical fiber cable.
 - 3. Optical fiber cable hardware.
- B. Shop Drawings:
 - 1. System Labeling Schedules:
 - a. Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. Cabling administration drawings and printouts.
 - 3. Wiring diagrams showing typical schematic arrangement, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Cross-connects.

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING (continued):

- f. Patch panels.
 - g. Patch cords.
- 4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.
- C. Field Quality-Control Reports: Optical fiber cable testing plan.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet-work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.
- B. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine continuity of strand end to end. Use optical fiber flashlight or optical loss test set.

PART 2 - PRODUCTS

2.1 TYPE OFNR OPTICAL FIBER CABLE

- A. Type OFNR Optical Fiber Cable: This category covers jacketed optical fiber cable for use as risers in vertical runs in shaft or between floors within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.
- B. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 - 2. Listing Criteria: UL CCN QAYK; including UL 1651.
 - 3. General Characteristics:
 - a. Performance: TIA-568.3.
 - b. Inside Plant Mechanical Properties: ICEA S-83-596.
 - c. Jacket:
 - 1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
 - 2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch (1 m).
- C. Type OFNR, Designation OS2, Inside Plant, Single-Mode Optical Fiber Cable:
 - 1. Source Limitations: Obtain products from single manufacturer.
 - 2. Additional Characteristics:
 - a. Construction: TIA-492CAAA; 9 μ m core diameter, 250 μ m cladding diameter.
 - b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING (continued):

3. Options:
 - a. Configuration:
 - 1) 12-fiber and less: Tight buffered, non-unitized optical fiber cable.
 - 2) 24-fiber and greater: Tight buffered, unitized optical fiber cable.
 - b. Maximum Attenuation: <0.5 dB/km> at 1310 nm wavelength; 0.5 dB/km> at 1550 nm wavelength.
 - c. Jacket Color: Yellow.

2.2 TYPES OFN AND OFNG OPTICAL FIBER CABLE

- A. Types OFN and OFNG Optical Fiber Cable: This category covers jacketed optical fiber cable for general use within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.
- B. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
 2. Listing Criteria: UL CCN QAYK; including UL 1651.
 3. General Characteristics:
 - a. Performance: TIA-568.3.
 - b. Inside-Outside Plant Mechanical Properties: ICEA S-87-640.
 - c. Jacket:
 - 1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
 - 2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch (1 m).
- C. Types OFN and OFNG, Designation OS2, Outside Plant, Single-Mode Optical Fiber Cable:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Additional Characteristics:
 - a. Construction: TIA-492CAAB; 9 µm core diameter, 250 µm cladding diameter, gel-filled with low water peak.
 - b. Minimum Overfilled Modal Bandwidth-Length Product: 500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
 3. Options:
 - a. Configuration:
 - 1) 6 or 12-fiber, single loose tube, optical fiber cable.
 - 2) 24-fiber or greater, stranded loose tube, optical fiber cable.
 - b. Maximum Attenuation: 0.4 dB/km at 1310 nm wavelength; 0.3 dB/km at 1550 nm wavelength.
 - c. Jacket Color: Black.

2.3 OPTICAL FIBER CABLE HARDWARE

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING (continued):

- A. Performance Criteria:
 - 1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
 - 2. TIA-568.3.
- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - 1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- C. Patch Cords: Factory-made, dual-fiber cables in 36 inch (900 mm) lengths.
- D. Connector Type: Type LC complying with TIA-604-10, connectors.
- E. Plugs and Plug Assemblies:
 - 1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
 - 2. Insertion loss not more than 0.25 dB.
 - 3. Marked to indicate transmission performance.
- F. Jacks and Jack Assemblies:
 - 1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
 - 2. Insertion loss not more than 0.25 dB.
 - 3. Marked to indicate transmission performance.
 - 4. Designed to snap-in to patch panel or faceplate.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.2 SELECTION OF OPTICAL FIBER TYPE

- A. Installed in Vertical Shaft or Floor-to-Floor Riser:
 - 1. Nonconductive: Type OFNR in metallic conduit.
- B. Installed in Plenum, Duct, or Other Space Handling Environmental Air:
 - 1. Nonconductive: Type OFNP in metallic conduit.
- C. Installed in Location Other Than Riser or Plenum:
 - 1. Nonconductive: Type OFNP in metallic conduit.
- D. Installed in Below Grade Duct:

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING (continued):

1. Nonconductive: Type OFNG in non-metallic conduit.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.
- C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.
- D. Backbone cabling system must comply with transmission standards in TIA-568.1.
- E. Telecommunications Pathways and Spaces: Comply with TIA-569.
- F. Wiring Methods:
 1. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental airspaces, including plenum ceilings.
 - b. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
 2. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- G. Optical Fiber Cabling Installation:
 1. Comply with TIA-568.1 and TIA-568.3.
 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch (760 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
 9. In communications equipment room, provide 10 ft (3 m) long service loop on each end of cable.
 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING (continued):

H. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

I. Group connecting hardware for cables into separate logical fields.

3.4 **FIRESTOPPING**

- A. Comply with requirements in Division 07.
- B. Comply with TIA-569, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 **GROUNDING**

- A. Install grounding in accordance with BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607 and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize length of bonding conductors. Fasten to wall allowing at least **2 inch (50 mm)** clearance behind grounding bus bar. Connect grounding bus bar with minimum 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to grounding bus bar, using not smaller than 6 AWG equipment grounding conductor.

3.6 **IDENTIFICATION**

- A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 1. Administration Class: Class 1 .
 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.
- C. Cable Schedule: Install in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING (continued):

E. Cable and Wire Identification:

1. Label each cable within **4 inch (100 mm)** of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 ft (4.5 m)**.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use different color for jacks and plugs of each service.

F. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:
 - a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

C. Nonconforming Work:

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

D. Collect, assemble, and submit test and inspection reports.

1. Data for each measurement must be documented.
2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING (continued):

END OF SECTION 271323

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Provisions of this Section apply to all Division 28 Specification Sections.

1.2 SUMMARY

- A. Section includes basic requirements for electronic safety and security systems.
- B. Related Work:
 - 1. Division 03 – Concrete
 - a. Refer to Division 03 for rough grouting in and around work, patching concrete cut to accommodate work, and sumps for work.
 - b. Comply with the requirements of Division 03 for curbs, foundations, and equipment pads for equipment.
 - 2. Division 05 – Metals
 - a. Refer to Division 05 for framed openings for equipment.
 - b. Comply with the requirements of Division 05 for supports for work.
 - 3. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 4. Division 07 – Thermal and Moisture Protection
 - a. Refer to Division 07 for installation of roof curbs and roof supports and for caulking and waterproofing of wall- and roof-mounted work.
 - b. Comply with the requirements of Division 07 for penetration firestopping and furnishing roof curbs and roof supports for equipment and conduit.
 - 5. Division 08 – Openings
 - a. Refer to Division 08 for installation of access doors and frames.
 - b. Comply with the requirements of Division 08 for access doors and frames, unless otherwise included in the Contract Documents.
 - 6. Division 09 – Finishes
 - a. Refer to Division 09 for paint products and applications in finished spaces.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- b. Comply with the requirements of Division 09 for paint products and applications identified in the Contract Documents.
- 7. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
- 8. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
- 9. Division 22 – Plumbing
 - a. Refer to Division 22 for all plumbing work.
- 10. Division 23 – Heating, Ventilation, and Air-Conditioning
 - a. Refer to Division 23 for all heating, ventilation, and air-conditioning work.
- 11. Division 25 – Instrumentation and Control
 - a. Refer to Division 25 for instrumentation and control systems.
 - b. Comply with the requirements of Division 25 for installation of and integration with instrumentation and control components.
- 12. Division 26 – Electrical
 - a. Refer to Division 26 for all electrical work.
- 13. Division 27 – Communications
 - a. Refer to Division 27 for all communications work.
 - b. Coordinate with Division 27 for integration with communication systems.
- 14. Division 28 – Electronic Safety and Security
 - a. Refer to Division 28 for all electronic safety and security work.
 - b. Coordinate with Division 28 for integration with security systems.
- 15. Division 31 – Earthwork
 - a. Refer to Division 31 for all site related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 31 for site clearing, earth moving, and dewatering within five feet outside the building and otherwise as indicated in the Contract Documents.
- 16. Division 33 – Utilities
 - a. Refer to Division 33 for all utility related work greater than five feet outside the building, unless noted otherwise in the Contract Documents.
 - b. Comply with the requirements of Division 33 for utility work within five feet outside the building and otherwise as indicated in the Contract Documents.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, “experienced” unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Furnish: Supply and deliver to project site, ready for subsequent requirements.
- C. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
- D. Provide: Furnish and install, complete and ready for intended use.
- E. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.
- F. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.
- G. Concealed Work: Work hidden from view, including inside chases, furred spaces, or above ceilings.
- H. Exposed Work: Work open to view, including inside mechanical and equipment rooms .

1.4 QUALITY ASSURANCE

- A. General:
 - 1. It is the intent of the plans and specifications to obtain a complete, operable and satisfactory installation.
 - 2. All materials shall be new, be properly labeled and/or identified and be in full compliance with the contract documents.
 - 3. All work shall comply with applicable Codes and Standards.
 - 4. Manufacturer's model names and numbers used in these specifications are subject to change per manufacturer's action. Contractor shall therefore verify them with manufacturer's representative before ordering any product or equipment
- B. Furnish new and unused materials and equipment manufactured in the U.S.A. Where two or more units of the same type or class of equipment are required provide units of a single manufacturer.

1.5 CODES AND STANDARDS

- A. Perform work in accordance with the following codes and any applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.
 - 1. Occupational Safety and Health Regulations (OSHA).
 - 2. National Fire Codes
 - a. NFPA 1 Fire Code – 2021 (Florida Edition)
 - b. NFPA 70 National Electrical Code – 2020
 - c. NFPA 72 National Fire Alarm and Signaling Code - 2019

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- d. NFPA 75 Standard for the Fire Protection of Information Technology Equipment – 2020
 - e. NFPA 101 Life Safety Code – 2021 (Florida Edition)
 - 3. Florida Building Code, 2021 Edition
 - a. Building Code
 - b. Energy Conservation Code
 - c. Mechanical Code
 - d. Plumbing Code
 - e. Fuel Gas Code
 - f. Accessibility Code
 - 4. Florida Statutes
 - a. Chapter 471 Engineering
 - b. Chapter 533.80 Building Construction Standards; Florida Building Code - Enforcement
 - 5. Florida Administrative Code
 - a. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - b. Chapter 61G15-32 Responsibility Rules of Professional Engineers Concerning the Design of Fire Protection Systems
 - c. Chapter 61G15-33 Responsibility Rules of Professional Engineers Concerning the Design of Electrical Systems
 - d. Chapter 69A-3 Fire Prevention – General Provisions
 - e. Chapter 69A-60 The Florida Fire Prevention Code
 - 6. ADA Accessibility Guidelines for Buildings (ADAAG)
 - B. Resolve, in writing, any code violation discovered in contract documents with the Engineer prior to bidding. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.
 - C. The Contractor shall include in the Work, without extra cost to the Owner, any labor, materials, services, apparatus, and drawings required to comply with all applicable laws, ordinances, rules, and regulations.
 - D. Where there is conflict between the Contract Documents and the applicable Codes, the Codes shall govern, except where the requirements of the Contract Documents are more stringent.
- 1.6 **REFERENCE SPECIFICATIONS AND STANDARDS**
- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or NEC Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments, or supplements in effect on date bids are received. Specifications and standards are minimum requirements for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.
 - B. Whenever a reference is made to a standard, installation and materials shall comply with the latest published edition of the standard at the time project is bid unless otherwise specified herein

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

1.7 DELEGATED-DESIGN SERVICES

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

1.8 PERMITS FEES AND INSPECTIONS

- A. Obtain and pay for all permits, fees, tap fees, connection charges, demand charges, systems charges, impact fees, and inspections.
- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.9 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
 - 1. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer in writing prior to bid date; however, the most stringent requirement shall govern.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.10 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
 - 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Prepare RFIs as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
- C. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.

1.11 SUBMITTALS

- A. Submittals (including Product Data, Shop Drawings, and any other Action Submittal or Information Submittal) will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions, Division 01, and the following:
 1. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are approved by the Engineer.
 3. Submittals shall only contain relevant product data. Remove or strikeout irrelevant product data.
 4. Prepare submittals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. **All electronic files shall ONLY be transmitted to inbox@h2engineering.com and shall not be transmitted to any individual email addresses for H2Engineering personnel.** Submittals shall be in searchable PDF format and not a scanned copy.
 5. Options: Identify options requiring selection by Engineer.
 6. Deviations: Clearly identify deviations from requirements in the Contract Documents, including minor variations and limitations.
 7. Revisions: Include relevant additional information and revisions, other than those specifically requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached submittal sheet.
 8. Contractor's Review:
 - a. Submittals shall have been reviewed and approved by the General Contractor / Construction Manager. Include approval stamp, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - b. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.
 9. Electrical Modifications:
 - a. The electrical design indicated on the plans supports the Basis of Design specifications for the Fire Safety and Emergency Communications systems at the time of design.
 - b. If Fire Safety and Emergency Communications systems equipment is submitted with different electrical requirements, it is the responsibility of the Contractor to resolve all required electrical design changes, including, but not limited to: wire and conduit size, type or size of disconnect or overload protection, breaker coordination, point(s) of connection, etc. Any corrections required shall be provided at no additional cost.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- c. Submittal shall clearly show the electrical design revisions with a written statement that this change will be provided at no additional cost. Submittals made with no written reference to the electrical design revisions will be presumed to work with the electrical design.
 - B. Processing Time: Time of review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of the failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Allow not less than 15 days for submittal review. Allow not less than 21 days for review of large or complex submittals. Submittals received by Engineer after 1:00 p.m. Eastern Time will be considered as received the following working day.
 - 2. If Contractor transmits more than five submittals over two consecutive business days, review time shall increase by no less than 7 days for submittal review.
 - 3. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 - 4. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received. Time of review shall commence on receipt of all other related submittals.
 - C. The Contractor shall not be relieved of responsibility for deviations from requirements of the contract documents by the Engineer's approval of shop drawings, product data, samples, or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal, and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved of responsibility for errors or omissions in shop drawings, product data, samples, or similar submittals by the Engineer's approval thereof.
 - D. Submittal Review Fees:
 - 1. Additional Reviews: Submittals on any particular phase of Work will receive only one review and one re-review (if required). If additional reviews are required beyond these two, the Contractor will be charged \$200.00 per hour for review time, in addition to any expedited review charges. This fee shall be paid to the Engineer prior to Submittal release.
 - 2. Expedited Reviews: If General Contractor / Construction Manager requests for an expedited review, whether by official request or unofficially by assigning a review time less than required above, the General Contractor / Construction Manager will be charged \$1,000.00 per Submittal, in addition to any charges for additional reviews. This fee shall be paid to the Engineer prior to Submittal release.
- 1.12 COORDINATION DRAWINGS (NOT REQUIRED)
- A. Should the Contractor elect to provide Coordination Drawings when not expressly required by the Engineer, such Drawings shall be considered for informational purposes only. The Engineer will not conduct a review of these Drawings, and their submission or any implied approval shall not relieve the Contractor of the obligation to fully comply with the requirements set forth in the Construction Documents. The Contractor remains solely responsible for ensuring that all work meets the contract specifications and standards, regardless of the content or status of the Coordination Drawings.
- 1.13 SUBSTITUTIONS

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- A. By submitting a bid, the Bidder represents that its bid is based on materials and equipment described in the Procurement and Contracting Documents, including Addenda. Bidders are encouraged to request approval of qualifying substitute materials and equipment when the Specifications Sections list materials and equipment by product or manufacturer name.
- B. Substitution Requests shall include, at a minimum:
 - 1. Statement indicating why specified material, equipment, or installation method cannot be provided, if applicable.
 - 2. Coordination of information, including a list of changes and revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - 3. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include an annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - 5. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - 6. Cost information, including a proposal of change, if any, in the Contract Sum.
 - 7. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - 8. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- C. Procurement Substitution Requests submitted prior to receipt of bids will be received and considered by Owner when the following conditions are satisfied, as determined by Engineer; otherwise, requests will be returned without action:
 - 1. Requests for substitution of materials and equipment are received no later than 10 days prior to date of bid opening.
 - 2. Extensive revisions to the Contract Documents are not required.
 - 3. Proposed changes are in keeping with the general intent of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
 - 4. The request is fully documented and properly submitted.
- D. Substitutions for Cause, as required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms will be received and considered by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
 - 1. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - 2. Substitution request is fully documented and properly submitted.
 - 3. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - 4. Requested substitution is compatible with other portions of the Work.
 - 5. Requested substitution has been coordinated with other portions of the Work.
 - 6. Requested substitution provides specified warranty.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

7. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- E. Substitutions for Convenience, not required in order to meet other Project requirements but may offer advantage to Contractor or Owner, will be received and considered by Owner, as determined by Engineer, only when the following conditions are satisfied; otherwise, requests will be returned without action, except to record noncompliance with these requirements:
1. Requested substitution is received within 60 days after the Notice of Award.
 2. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 3. Requested substitution does not require extensive revisions to the Contract Documents.
 4. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 5. Substitution request is fully documented and properly submitted.
 6. Requested substitution has received necessary approvals of authorities having jurisdiction.
 7. Requested substitution is compatible with other portions of the Work.
 8. Requested substitution has been coordinated with other portions of the Work.
 9. Requested substitution provides specified warranty.
 10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- F. If a requested substitution is approved but contains differences or omissions not specifically identified to the attention of the Engineer in the substitution request, the Owner reserves the right to require equal or similar features to be added to the substituted products or to have the substituted products replaced at the Contractor's expense.

1.14 PROJECT RECORD DOCUMENTS

- A. Recording: Maintain one copy of the Contract Documents and Shop Drawings during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation:
1. Contract Drawings and Shop Drawings:
 - a. Mark revisions to show where the actual installation varies from that shown originally.
 - b. Mark record sets completely and accurately, including important information that was either shown schematically or omitted from original Drawings.
 - c. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - d. Record underground and under-slab piping installed, dimensioning exact location and elevation of piping.
 2. Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

3. Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

C. Deliver: Prior to Final Completion, provide record documents to Owner as indicated below:

1. Record Drawings: Submit PDF electronic files of scanned record prints and one set of prints.
2. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
3. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
4. Miscellaneous Record Submittals: Submit annotated PDF electronic files directories of each submittal.

1.15 OPERATION AND MAINTENANCE MANUALS

A. Prepare and submit a comprehensive manual of emergency, operation, and maintenance data and materials in full accordance with the General and Supplementary Conditions, Division 01, and the following:

1. Operations and Maintenance Manuals: Assemble a complete set of data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system, including:
 - a. Information required for daily operation and management, operating standards, and routine and special operating procedures.
 - b. Manufacturers' maintenance documentation, preventative maintenance procedures and frequency, repair procedures, wiring and systems diagrams, list of spare parts, and warranty information.
2. Submit manuals as PDF electronic files and electronically transmit to Engineer through email or web-based project software site, in accordance with Division 01 Specification Sections. Submittals shall be in searchable PDF format and not a scanned copy.

1.16 DEMONSTRATION AND TRAINING

A. Prepare and provide services of qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system in accordance with the General and Supplementary Conditions, Division 01, individual Specification Sections, and the following:

1. Demonstration and training shall occur upon completion of the Work and at a time designated by the Owner's representative.

1.17 DELIVERY, STORAGE, AND HANDLING

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

B. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected in Division 01 "Product Requirements".

1.18 WARRANTY

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- A. Warranty work and equipment within specified warranty period. During the warranty period, provide labor and materials to make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship without expense to the Owner.
 - 1. Warranty Period: One year from date of Substantial Completion.
- B. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.
- C. Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving the Contractor of responsibilities during the warranty period.

PART 2 - PRODUCTS (NONE)

PART 3 - EXECUTION

3.1 CONTRACT DOCUMENTS

- A. Examine all drawings and specifications carefully before submitting a bid. Architectural drawings take precedence over mechanical or electrical drawings with reference to building construction.
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site.
- C. The drawings indicate required size and points of termination of pipes, conduits, and ducts and suggest proper routes to conform to structure avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the responsibility of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing without additional compensation.
- E. Any and all questions about a subcontractor's scope of work responsibility shall be addressed to and answered by the General Contractor / Construction Manager.
- F. Questions About Construction Documents: Any and all questions shall be submitted through the proper channels IN WRITING and, in turn, shall be answered by the Engineer in writing. All telephone conversations shall be considered unofficial and, as such, shall not be considered official or binding responses to Contractor's questions.
- G. Drawings, specifications, or other documents issued by the Engineer in electronic format and/or electronic media are provided for convenience only and are not intended for use as Contract Documents.
 - 1. The electronic files are provided merely as a convenience to the Recipient.
 - 2. The electronic files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.
 - 3. The Engineer makes no representation, warranty, or guarantee that electronic files:

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- a. Are suitable for any other usage or purpose.
 - b. Have any particular durability.
 - c. Will not damage or impair the Recipient's computer or software.
 - d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.
4. Due to the unsecured nature of the electronic files and the inability of Engineer or the Recipient to establish controls over their use, the Engineer assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained therein. The Recipient shall at all times refer to the signed and sealed drawings, specification or other documents for the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of the electronic files.

3.2 SUPERVISION OF WORK

- A. Perform all work under the direct supervision of an experienced, qualified superintendent. The Engineer has the right to remove a superintendent who, in the Engineer's opinion, is not satisfactory.

3.3 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.4 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Engineer.

3.5 INSTALLATION

- A. Install materials and equipment in a professional manner. The Engineer may direct replacement of items which, in the Engineer's opinion, do not present a professional appearance or do not allow adequate space for maintenance. Replace or reinstall items at the expense of the Contractor.
- B. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 - 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- C. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- D. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- G. Obstructions
 - 1. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
 - 2. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
 - 3. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
 - 4. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.
- H. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof, or ceiling to the satisfaction of the authority having jurisdiction.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- I. Structural Elements: Do not cut structural elements without written approval from Engineer. Notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. If approved by Engineer:
 - 1. Shore, brace, and support structural elements during cutting and patching.
 - 2. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- J. Space Requirements: Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
- K. Tools and Equipment: Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.
- L. Phasing: Provide all temporary valves, piping, ductwork, equipment, and devices as required. Maintain temporary services to areas as required. Remove all temporary material and equipment on completion of work unless Engineer concurs that such material and equipment would be beneficial to the Owner on a permanent basis.

3.6 OWNER-INSTALLED PRODUCTS

- A. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

3.7 PROTECTION OF EXISTING FINISHES, CARPET, AND FURNISHING

- A. Protect existing finishes, carpet, casework, furnishing, and other building components against damage and soiling throughout construction activities. Take care during construction not to damage existing items. Contractor shall be responsible for replacing damaged material or restoring damaged materials to the Owner's satisfaction.
- B. When permitted by Engineer, items may be removed to a suitable, protected storage location during construction and cleaned and reinstalled in their original locations after construction operations are complete.
- C. Furniture may be relocated during construction and reinstalled in their original locations after construction operations are complete.
- D. Means and methods for protection are the responsibility of the Contractor. Utilize plywood, polyethylene sheeting, dust cloths, and other means as required.

3.8 UTILITY SERVICES AND ELECTRONIC SAFETY AND SECURITY SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

3.9 CUTTING AND PATCHING

- A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Structural Elements: When cutting and patching structural elements, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- F. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
- G. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- H. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- I. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- J. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable or with in-place materials.
 - 1. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 2. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials.
- K. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.10 PAINTING

- A. Comply with requirements with General and Supplementary Conditions, Division 01, Division 09, and individual Specification Sections.
- B. Touch-up factory finishes on equipment provided under Division 28. Obtain matched color coatings from the manufacturer and apply as directed. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required.
- C. Paint the following work where exposed to view:
 - 1. Metal conduit
 - 2. Plastic conduit
- D. Paint the following work where exposed in occupied spaces:
 - 1. Other items as directed by Engineer.

3.11 REPAIR OF WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

3.12 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests
 - 1. Include all tests specified and/or required under laws, rules and regulations of all departments having jurisdiction. Tests shall also be performed as indicated herein and other sections of the specifications.
 - 2. After all systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems.
 - 3. All parts of the work and associated equipment shall be tested and adjusted to work properly and be left in perfect operating condition.
 - 4. Correct defects disclosed by these tests without any additional cost to the Owner. Repeat tests on repaired or replaced work.
 - 5. Maintain a log of all tests being conducted and have it available for review by the Engineer. Log to indicate date, type of tests, duration, and defects noted and when corrected.
 - 6. Special tests on individual systems are specified under individual Specification Sections.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

3.13 CLEANING

- A. Progress Cleaning: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Final Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove labels that are not permanent.
 - c. Wipe surfaces of equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

END OF SECTION 290100

**SECTION 290100 - GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY
COMMUNICATIONS (continued):**

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SECTION 290523 - CONTROL-VOLTAGE CABLES FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category 6 balanced twisted pair cable.
 - 2. Balanced twisted pair cable hardware.
 - 3. RS-485 cable.
 - 4. Control cable.
 - 5. Control-circuit conductors.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inch (1520 mm) or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 CATEGORY 6 BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100 ohm, No. 23 AWG solid copper.

SECTION 290523 - CONTROL-VOLTAGE CABLES FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- D. Shielding/Screening: Unshielded twisted pairs (UTP). Cable Rating: Plenum.
- E. Jacket: Red thermoplastic.

2.3 BALANCED TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
- B. General Requirements for Balanced Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables must be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.
- D. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
 - 2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.

2.4 RS-232 CABLE

- A. Plenum-Type, TIA 232-F:
 - 1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PE insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with NFPA 262.

2.5 RS-485 CABLE

- A. Plenum-Rated Cable: NFPA 70, Type CMP.
 - 1. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - 2. Fluorinated ethylene propylene insulation.
 - 3. Unshielded.
 - 4. Fluorinated ethylene propylene jacket.
 - 5. Flame Resistance: NFPA 262.

2.6 CONTROL CABLE

- A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

SECTION 290523 - CONTROL-VOLTAGE CABLES FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.7 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway .

2.8 FIRE-ALARM WIRE AND CABLE

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG in pathway.
 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor[**with outer jacket**] with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Division 26 for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 1. Outlet boxes for cables must be no smaller than **4 inch (102 mm)** square by **2-1/8 inch (53 mm)** deep with extension ring sized to bring edge of ring to within **1/8 inch (3.1 mm)** of the finished wall surface.
 2. Flexible metal conduit must not be used.
 3. Concealed and exposed junction boxes must be painted red enamel.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

SECTION 290523 - CONTROL-VOLTAGE CABLES FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
 - 2. Secure conduits to backboard if entering the room from overhead.
 - 3. Extend conduits 3 inch (75 mm) above finished floor.
 - 4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Install all cabling in raceway.
 - 2. Comply with TIA-568-C Series of standards.
 - 3. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
 - 4. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 5. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
 - 6. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
 - 7. Secure and support cables at intervals not exceeding 30 inch (760 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
 - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
 - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
 - 11. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
 - 12. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.
- C. Balanced Twisted Pair Cable Installation:
 - 1. Comply with TIA-568-C.2.
 - 2. Install termination hardware as specified in Division 27 unless otherwise indicated.
 - 3. Do not untwist balanced twisted pair cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.
- D. Installation of Control-Circuit Conductors:

SECTION 290523 - CONTROL-VOLTAGE CABLES FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS (continued):

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

E. Installation of Fire Alarm Wiring and Cables:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

F. Installation of Cables other than Fire Alarm Wiring:

1. Install wiring in raceways.

3.3 **CONTROL-CIRCUIT CONDUCTORS**

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.4 **FIRESTOPPING**

- A. Comply with requirements in Division 07.

3.5 **GROUNDING**

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For control-voltage wiring and cabling, comply with requirements in Division 26.

3.6 **IDENTIFICATION**

- A. Comply with requirements for identification specified in Division 26.
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

END OF SECTION 290523

**SECTION 290523 - CONTROL-VOLTAGE CABLES FOR FIRE SAFETY AND EMERGENCY
COMMUNICATIONS (continued):**

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SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Addressable fire-alarm system.
 - 2. Fire-alarm control unit (FACU).
 - 3. Manual fire-alarm boxes.
 - 4. System smoke detectors.
 - 5. Duct smoke detectors.
 - 6. Fire-alarm notification appliances.
 - 7. Fire-alarm remote annunciators.
 - 8. Fire-alarm addressable interface devices.
 - 9. Digital alarm communicator transmitters (DACTs).

1.3 DEFINITIONS

- A. CIS: Common Intelligibility Scale.
- B. DACT: Digital alarm communicator transmitter.
- C. EMT: Electrical metallic tubing.
- D. ERCES: Emergency responder communications enhancement system.
- E. FACU: Fire-alarm control unit.
- F. FSCS: Firefighters' smoke control station.
- G. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- H. NICET: National Institute for Certification in Engineering Technologies.
- I. PC: Personal computer.
- J. STI: Speech Transmission Index.
- K. STIPA: Speech Transmission Index – Public Address.
- L. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.4 ACTION SUBMITTALS

- A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Engineer.
- B. Product Data: For each type of product, including furnished options and accessories.
 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C. Shop Drawings: For fire-alarm system.
 1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 2. Include plans, elevations, sections, and details, including details of attachments to other Work.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 4. Graphic Annunciator panel details as required by authorities having jurisdiction.
 5. Detail assembly and support requirements.
 6. Include voltage drop calculations for notification-appliance circuits.
 7. Include battery-size calculations.
 8. Include input/output matrix.
 9. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
 10. Include performance parameters and installation details for each detector.
 11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 12. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
 13. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
 - c. Locate detectors in accordance with manufacturer's written instructions.
 14. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 15. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data in conformance with Fire Protection System Layout Documents.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
 2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.
- E. Fire Protection System Layout Documents: Layout drawings, supporting calculations (battery calculations, voltage drop, spacing and sensitivity of detection, etc.), catalog information on standard products, and other construction data prepared by either a licensed contractor or a licensed Engineer that provides detail on the location of risers, distribution, devices, equipment, sizing of circuits, hanger locations, and supporting calculations and also serves as a guide for fabrication and installation of a fire protection system. Fire Protection System Layout Documents are based upon engineering direction (performance requirements and design criteria) provided in the Fire Protection System Engineering Documents and require no additional engineering input.
1. If prepared by a licensed contractor, these documents do not require the seal of a licensed engineer.
 2. If prepared by a licensed engineer, these documents are Engineering Documents and therefore require sealing by a licensed engineer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Division 01 "Operation and Maintenance Data" and Section 290100 "General Provisions for Fire Safety and Emergency Communications include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.
 - i. Abbreviated operating instructions for mounting at FACU and each annunciator unit.
- B. Software and Firmware Operational Documentation:

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media.
3. Device address list.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installation must be by personnel certified by NICET as fire-alarm Level II or greater technician.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire alarm system equipment, specialties, accessories, installation, and testing shall comply with NFPA 72.

B. Fire Protection System Layout Documents: Engage either a licensed contractor or a qualified professional engineer to provide Fire Protection System Layout Documents for the fire alarm system based upon the engineering direction (performance requirements and design criteria) provided in the Fire Protection Engineering Documents.

1. Fire alarm system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Secondary Power Supply Duration: 20 percent, above the calculated amp-hour capacity required at design system demand.
 - 1) Battery backup must provide 24 hours standby, followed by 5 minutes at maximum connected load, unless otherwise required by system types below.
 - 2) In-Building Fire Emergency Voice / Alarm Communications Systems: Battery backup must provide 24 hours standby, followed by 15 minutes at maximum connected load.
 - 3) Supervising Station Facilities and Equipment: Battery backup must support operations for a minimum of 24 hours.
 - 4) Wide Area Mass Notification Systems: Battery backup for high power speaker arrays must provide 3 days standby, followed by 60 minutes at maximum connected load.
 - 5) Textual Visual Notification Appliances: Battery backup must provide 2 hours of continuous display during an emergency event.
 - 6) In-Building Mass Notification Systems: Battery backup must provide 24 hours standby, followed by 30 minutes at maximum connected load.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- b. Speech Intelligibility Requirements: As indicated on the Drawings.

2.2 ADDRESSABLE FIRE-ALARM SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Honeywell International (Notifier).
- 2. Honeywell International (Silent Knight).
- 3. Siemens Industry, Inc., Building Technologies Division.
- 4. Tyco International (Johnson Controls - SimplexGrinnell).
- 5. Edwards Fire Safety (EST).

- B. Description:

- 1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice-and-strobe notification for evacuation.

- C. Performance Criteria:

- 1. Regulatory Requirements:

- a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.

- 2. General Characteristics:

- a. Automatic sensitivity control of certain smoke detectors.
- b. Fire-alarm signal initiation must be by one or more of the following devices and systems:
 - 1) Manual stations.
 - 2) Heat detectors.
 - 3) Smoke detectors.
 - 4) Duct smoke detectors.
- c. Fire-alarm signal must initiate the following actions:
 - 1) Continuously operate alarm notification appliances, including voice evacuation notices.
 - 2) Identify alarm and specific initiating device at FACU and any connected network control panels, off-premises network control panels, and remote annunciators.
 - 3) Transmit alarm signal to remote alarm receiving station.
 - 4) Unlock electric door locks in designated egress paths.
 - 5) Release fire and smoke doors held open by magnetic door holders.
 - 6) Activate voice/alarm communication system.
 - 7) Switch HVAC equipment controls to fire-alarm mode.
 - 8) Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 9) Activate emergency lighting control.
 - 10) Activate emergency shutoffs for gas and fuel supplies, except for shutoffs serving legally required life-safety systems such as emergency generators and fire pumps.
 - 11) Record events in system memory.
 - 12) Record events by system printer.
 - 13) Indicate device in alarm on graphic annunciator.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- d. Supervisory signal initiation must be by one or more of the following devices and actions:
 - 1) Valve supervisory switch.
 - 2) Elevator shunt-trip supervision.
 - 3) Independent fire-detection and -suppression systems.
 - 4) Zones or individual devices have been disabled.
 - 5) FACU has lost communication with network.
 - 6) ERCES status or alarm.
- e. System trouble signal initiation must be by one or more of the following devices and actions:
 - 1) Open circuits, shorts, and grounds in designated circuits.
 - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4) Loss of primary power at FACU.
 - 5) Ground or single break in internal circuits of FACU.
 - 6) Abnormal ac voltage at FACU.
 - 7) Break in standby battery circuitry.
 - 8) Failure of battery charging.
 - 9) Abnormal position of switch at FACU or annunciator.
 - 10) Voice signal amplifier failure.
- f. System Supervisory Signal Actions:
 - 1) Initiate notification appliances.
 - 2) Identify specific device initiating event at FACU and any, connected network control panels, off-premises network control panels, and remote annunciators.
 - 3) Record event on system printer.
 - 4) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
- g. Network Communications:
 - 1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
 - 2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
- h. System Printer:
 - 1) Printer must be listed and labeled as integral part of fire-alarm system.
- i. Device Guards:
 - 1) Description: Welded wire mesh of size and shape for manual station, smoke detector, gong, or other device requiring protection.
 - a) Factory fabricated and furnished by device manufacturer.
 - b) Finish: Paint of color to match protected device.
- j. Document Storage Box:

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- 1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch (216-by-279 mm) manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
- 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
- 3) Color: Red powder-coat epoxy finish.
- 4) Labeling: Permanently screened with 1 inch (25 mm) high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
- 5) Security: Locked with 3/4 inch (19 mm) barrel lock. Provide solid 12 inch (304 mm) stainless steel piano hinge.

2.3 FIRE-ALARM CONTROL UNIT (FACU)

- A. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.
- B. Performance Criteria:
 1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
 2. General Characteristics:
 - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
 - b. Include real-time clock for time annotation of events on event recorder and printer.
 - c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.
 - d. FACU must be listed for connection to central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.
 - f. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
 - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.
 - g. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
 - 1) Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into system for control of smoke-detector sensitivity and other parameters.
 - h. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1) Pathway Class Designations: NFPA 72, Class A.
 - 2) Pathway Survivability: Level 1.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- 3) Install no more than 256 addressable devices on each signaling-line circuit.
 - 4) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
- i. Serial Interfaces:
- 1) One dedicated RS 485 port for central-station operation using point ID DACT.
 - 2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - 3) One USB or RS 232 port for PC configuration.
 - 4) One RS 232 port for voice evacuation interface.
- j. Smoke-Alarm Verification:
- 1) Initiate audible and visible indication of "alarm-verification" signal at FACU.
 - 2) Activate approved "alarm-verification" sequence at FACU and detector.
 - 3) Record events by system printer.
 - 4) Sound general alarm if alarm is verified.
 - 5) Cancel FACU indication and system reset if alarm is not verified.
- k. Notification-Appliance Circuit:
- 1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
 - 2) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.
- l. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls must be connected to fire-alarm system.
- 1) Access Control System Interface: Provide addressable relay to release required egress doors upon activation of fire alarm.
- m. Remote Smoke-Detector Sensitivity Adjustment: Controls must select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out final adjusted values on system printer.
- n. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
- o. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as special module that is part of FACU.
- p. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.
- 1) Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
 - 2) Programmable tone and message sequence selection.
 - 3) Standard digitally recorded messages for "Evacuation" and "All Clear."

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- 4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACU.

- q. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of fire-fighters' two-way telephone communication zones.
- r. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
- s. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate printing of list of existing alarm, supervisory, and trouble conditions in system and historical log of events.
- t. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals must be powered by 24 V(dc) source.
- u. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
- v. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
- w. Batteries: Sealed, valve-regulated, recombinant lead acid.

C. Accessories:

1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate alarm, breaking-glass or plastic-rod or pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
2. Station Reset: Key- or wrench-operated switch.
3. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm.
4. Able to perform at up to 90 percent relative humidity at 90 deg F (32 deg C).
5. Able to be used in outdoor areas.

2.5 SYSTEM SMOKE DETECTORS

- A. Photoelectric Smoke Detectors:

1. Performance Criteria:

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

a. Regulatory Requirements:

- 1) NFPA 72.
- 2) UL 268.

b. General Characteristics:

- 1) Detectors must be two-wire type.
- 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
- 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- 5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
- 7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - a) Primary status.
 - b) Device type.
 - c) Present average value.
 - d) Present sensitivity selected.
 - e) Sensor range (normal, dirty, etc.).
- 8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
- 9) Color: White.
- 10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
- 11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for **15 or 20 deg F (8 or 11 deg C)** per minute.
- 12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at **135 or 155 deg F (57 or 68 deg C)**.
- 13) Multiple levels of detection sensitivity for each sensor.
- 14) Sensitivity levels based on time of day.

2.6 DUCT SMOKE DETECTORS

A. Description: Photoelectric-type, duct-mounted smoke detector.

B. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. UL 268A.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

2. General Characteristics:
 - a. Detectors must be two-wire type.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
 - f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
 - h. Each sensor must have multiple levels of detection sensitivity.
 - i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Voice/Tone Notification Appliances:

1. Description: Notification appliances capable of outputting voice evacuation messages.
2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1480.
 - b. General Characteristics:
 - 1) Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - 2) High-Range Units: Rated 2 to 15 W.
 - 3) Low-Range Units: Rated 1 to 2 W.
 - 4) Mounting: Surface mounted and bidirectional.
 - 5) Matching Transformers: Tap range matched to acoustical environment of speaker location.
 - 6) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

B. Fire-Alarm Visible Notification Appliances:

1. Performance Criteria:

a. Regulatory Requirements:

- 1) NFPA 72.
- 2) UL 1971.

b. General Characteristics:

- 1) Rated Light Output:
 - a) 15/30/75/110 cd, selectable in field.
- 2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
- 3) Mounting: Wall mounted unless otherwise indicated.
- 4) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
- 5) Flashing must be in temporal pattern, synchronized with other units.
- 6) Strobe Leads: Factory connected to screw terminals.
- 7) Mounting Faceplate: Factory finished, white.
- 8) For devices used as notification devices for fire alarm and Mass Notification Systems, housing shall read "ALERT". For all other devices, housing shall read "FIRE".

2.8 FIRE-ALARM REMOTE ANNUNCIATORS

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. Annunciator functions must match those of FACU for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACU, including acknowledging, silencing, resetting, and testing.
 - 1) Mounting: Flush cabinet, NEMA 250, Type 1.
- b. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACU. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Performance Criteria:

1. Regulatory Requirements:

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- a. NFPA 72.
- 2. General Characteristics:
 - a. Include address-setting means on module.
 - b. Store internal identifying code for control panel use to identify module type.
 - c. Listed for controlling HVAC fan motor controllers.
 - d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
 - e. Integral Relay: Capable of providing direct signal to elevator controller to initiate elevator recall or to circuit-breaker shunt trip for power shutdown.
 - 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
 - f. Control Module:
 - 1) Operate notification devices.
 - 2) Operate solenoids for use in sprinkler service.

2.10 **DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTs)**

A. Performance Criteria:

- 1. Regulatory Requirements:
 - a. NFPA 72.
- 2. General Characteristics:
 - a. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
 - b. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically capture one telephone line(s) and dial preset number for remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of telephone line to remote alarm receiving station over remaining line. Transmitter must automatically report telephone service restoration to central station. If service is lost on both telephone lines, transmitter must initiate local trouble signal.
 - c. Local functions and display at DACT must include the following:
 - 1) Verification that both telephone lines are available.
 - 2) Programming device.
 - 3) LED display.
 - 4) Manual test report function and manual transmission clear indication.
 - 5) Communications failure with central station or FACU.
 - d. Digital data transmission must include the following:
 - 1) Address of alarm-initiating device.
 - 2) Address of supervisory signal.
 - 3) Address of trouble-initiating device.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- 4) Loss of ac supply.
- 5) Loss of power.
- 6) Low battery.
- 7) Abnormal test signal.
- 8) Communication bus failure.
- e. Secondary Power: Integral rechargeable battery and automatic charger.
- f. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
- B. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before other trades have completed cleanup must be replaced.
 - 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than **78 inch (1980 mm)** above finished floor.
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in normal path of egress within **60 inch (1520 mm)** of exit doorway.
 - 2. Mount manual fire-alarm box on background of contrasting color.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

3. Operable part of manual fire-alarm box must be **48 inch (1220 mm)** above floor level. Devices must be mounted at same height unless otherwise indicated.
 - D. Smoke- and Heat-Detector Spacing:
 1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing must not exceed **30 ft. (9 m)**.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A or Annex B in NFPA 72.
 5. HVAC: Locate detectors not closer than **36 inch (910 mm)** from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than **12 inch (300 mm)** from lighting fixture and not directly above pendant mounted or indirect lighting.
 - E. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
 - F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than **36 inch (9100 mm)** long must be supported at both ends.
 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
 - G. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
 - H. Audible Alarm-Indicating Devices: Install not less than **6 inch (150 mm)** below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
 - I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least **6 inch (150 mm)** below ceiling. Install devices at same height unless otherwise indicated.
 - J. Device Location-Indicating Lights: Locate in public space near device they monitor.
- 3.4 **ELECTRICAL CONNECTIONS**
- A. Connect wiring in accordance with Division 26.
 - B. Ground equipment in accordance with Division 26.
 - C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
 - D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Division 26.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 290523 "Control-Voltage Cables for Fire Safety and Emergency Communications"
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

- A. Install pathways in accordance with Division 26.
- B. Pathways must be installed in EMT.
 - 1. Pathways must be installed in EMT or RSC.
 - 2. Exposed raceways must be painted red enamel.
 - 3. Concealed and exposed junction boxes must be painted red enamel.

3.7 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08. Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than **36 inch (910 mm)** from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to elevator recall system and components.
 - 5. Alarm-initiating connection to activate emergency lighting control.
 - 6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 7. Supervisory connections at valve supervisory switches.
 - 8. Data communication circuits for connection to building management system.
 - 9. Supervisory connections at fire-extinguisher locations.

3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 27.
- B. Install framed instructions in location visible from FACU.

3.9 GROUNDING

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

- A. Ground FACU and associated circuits in accordance with Division 26.
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Adminstrant for Tests and Inspections:
 - 1. Owner will engage qualified testing agency to administer and perform tests and inspections.
 - 2. Engage qualified testing agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
 - 2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
 - 4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
 - 5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
 - 6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

SECTION 294621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS (continued):

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner.

3.12 MAINTENANCE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.13 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 294621.11