

SPECIFICATIONS MANUAL
100% Construction Documents
ALW Project No. 22470

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Kellogg Building Remodel

Florida State University

FSU Project #2221200

VOLUME 4 of 4



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**SECTION 260100
GENERAL PROVISIONS FOR ELECTRICAL**

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes basic requirements for electrical systems.
- B. Related Work:
 - 1. Division 02 – Existing Conditions
 - a. Refer to Division 02 for demolition and for abatement of hazardous materials.
 - b. Comply with the requirements of Division 02 for selective demolition.
 - 2. 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.
 - 3. 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.
 - 4. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 5. 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.
 - 6. 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.

7. 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.
8. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
9. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
10. 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.
11. 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.
12. 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.
13. Division 27 – Communications
 - a. Refer to Division 27 for all communications work.
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 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.
16. 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.

17. 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.

1.03 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.

1.04 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.

1.05 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. ASME
 - a. ASME A17.3 Safety Code for Existing Elevators and Escalators - 2020
 3. Occupational Safety and Health Regulations (OSHA).
 4. 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)
 5. Florida Building Code, 2023 Edition
 - a. Building Code
 - b. Existing Building Code
 - c. Energy Conservation Code
 - d. Mechanical Code
 - e. Plumbing Code
 - f. Fuel Gas Code
 - g. Accessibility Code
 6. Florida Statutes
 - a. Chapter 471 Engineering
 - b. Chapter 533.80 Building Construction Standards; Florida Building Code - Enforcement
 7. Florida Administrative Code
 - a. Chapter 6A-2 Educational Facilities
 - b. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - c. Chapter 61C-5 Florida Elevator Safety Code
 - d. Chapter 61G15-33 Responsibility Rules of Professional Engineers Concerning the Design of Electrical Systems
 - e. Chapter 69A-3 Fire Prevention – General Provisions
 - f. Chapter 69A-47 Uniform Fire Safety Standards for Elevators
 - g. Chapter 69A-58 Fire Safety in Educational Facilities
 - h. Chapter 69A-60 The Florida Fire Prevention Code
 8. 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.

1.06 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

1.07 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.

1.08 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.

1.09 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.

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.
- 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.

1.12 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Certification Program: Comply with requirements for the Project to obtain certification based on FGBC's "Commercial Building Standard" (hereafter, "Certification Program"). Compliance with requirements needed to obtain Certification Program prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
- B. Related Requirements:
 - 1. General and Supplementary Conditions
 - 2. Division 01 for general sustainable design certification and reporting requirements.
 - 3. Comply with requirements in various Division 21 Sections specifying sustainable products and methods.
- C. Sustainable design submittals are in addition to other submittals.
 - 1. Comply with "Submittals" article in this Section.
 - 2. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record of compliance with indicated Certification Program requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."
- D. Sustainable Design Documentation Submittals
 - 1. Environmental management system documents.
 - 2. Environmental product declarations.
 - 3. Third-party certifications based on multiple attribute standards.
 - 4. Product Data and laboratory test reports for adhesives and sealants indicating VOC content and compliance with requirements for low-emitting materials.
 - 5. Product Data and laboratory test reports for paints indicating VOC content and compliance with requirements for low-emitting materials.

1.13 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.

1.14 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.
 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.
 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.
- 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.

3.06 OWNER-INSTALLED PRODUCTS

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

3.07 UTILITY SERVICES AND ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 2. Arrange to shut off utilities with utility companies.
 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

4. Disconnect, demolish, and remove electrical connections for fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Conduit to Be Removed: Remove portion of conduit indicated to be removed and cap or plug remaining piping with same or compatible conduit material.
 - b. Conduit to Be Abandoned in Place: Remove wiring and cap or plug conduit with same or compatible conduit material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.08 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.
- 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.

3.09 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.
- 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.
- 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

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**SECTION 260513
MEDIUM-VOLTAGE CABLES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Cables.
 - 2. Connectors.
 - 3. Solid terminations.
 - 4. Separable insulated connectors.
 - 5. Splice kits.
 - 6. Medium-voltage tapes.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 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 IEEE C2 and NFPA 70.
- C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.02 CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kerite Power Cable; Marmon Holdings, Inc.; Berkshire Hathaway Inc.
 - 2. Okonite Company (The).
 - 3. Southwire Company, LLC.
- B. Cable Type: Type MV 90.
- C. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 15 kV.
 2. Insulation Thickness: 133 percent insulation level.
- D. Conductor: Copper.
- E. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.
- F. Conductor Stranding: Compact round, concentric lay, Class B.
- G. Shielding: Copper tape, helically applied over semiconducting insulation shield.
- H. Cable Jacket: Sunlight-resistant PVC.

2.03 CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
 2. Eaton.
 3. G&W Electric Company.
- B. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.04 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
1. Class 1 Terminations:
 - a. Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

2.05 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
 2. Eaton.
 3. G&W Electric Company.
- C. Dead-Break Cable Terminators: Elbow-type unit with [200 A] [600 A] continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

- D. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless steel mounting brackets, and attaching hardware.
 - 1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 - 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
 - 3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 - 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

2.06 SPLICE KITS

- A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. ABB, Electrification Business.
 - 3. Eaton.
- C. Standard: Comply with IEEE 404.
- D. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

2.07 MEDIUM-VOLTAGE TAPES

- A. Description: Electrical grade, insulating tape rated for medium voltage application.
- B. Ethylene/propylene rubber-based, 30 mil (0.76 mm) splicing tape, rated for 130 deg C operation. Minimum 3/4 inch (20 mm) wide.
- C. Insulating-putty, 125 mil (3.175 mm) elastic filler tape. Minimum 1-1/2 inch (38 mm) wide.

2.08 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 and ICEA S-94-649 before shipping.
- B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inch (1200 to 1800 mm) on the pull rope.
 - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
 - 2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
 - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 - 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 - 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- H. Install cable splices at pull points and elsewhere as indicated; use standard kits.
- I. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.
- J. Install separable insulated-connector components as follows:
 - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - 2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
 - 3. Standoff Insulator: At each terminal junction, with one on each terminal.

- K. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- L. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
- B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

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SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Copper building wire.
 - 2. 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.

1.02 ACTION SUBMITTALS

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

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 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.

2.02 MINERAL-INSULATED CABLE, TYPE MI

- A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, 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. UL 2196 for fire resistance.
 - 3. 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.
- D. Insulation: Compressed magnesium oxide.
- E. Sheath: Copper.

2.03 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

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 - 1. Copper; 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.

3.02 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.
 - 1. Emergency Feeders as defined by NEC 700: Emergency feeders within assembly or educational occupancies shall be UL listed (FHJR) 2-hour rated, type MI within rigid steel conduit (ERMC-S) raceways.

- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.03 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."

3.04 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.

3.05 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.

3.06 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."

3.07 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.

3.08 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

**SECTION 260523
CONTROL-VOLTAGE ELECTRICAL POWER CABLES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Category 6 balanced twisted pair cable.
 - 2. Balanced twisted pair cable hardware.
 - 3. Control cable.
 - 4. Control-circuit conductors.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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.

2.02 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).

- E. Cable Rating: Plenum.
- F. Jacket: Yellow thermoplastic.

2.03 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.

2.04 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.

2.05 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in race-way.
- B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in race-way.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

PART 3 - EXECUTION

3.01 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.
 - 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.

3.02 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.
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.

3.03 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.

3.04 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.

3.05 FIRESTOPPING

- A. Comply with requirements in Division 07.

3.06 GROUNDING

- A. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.07 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

END OF SECTION

**SECTION 260525
COMMUNICATIONS EQUIPMENT ROOM FITTINGS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Backboards.

1.03 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.

1.04 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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

3.01 INSTALLATION

- A. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- B. Backboards:
 - 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.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 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.

1.02 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. TGB: Telecommunications grounding busbar.
- C. TMGB: Telecommunications main grounding busbar.

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 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.

2.02 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.

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 TMGB 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.

E. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, 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 at least a 2-inch (50-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.

2.03 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.
- 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. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- M. 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.

2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 ft. (19 mm by 3 m).

PART 3 - EXECUTION

3.01 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 TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.
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.
6. Access Floors: Bond all metal parts of access floors to the TGB.

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.

3.02 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.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode must be connected to the equipment grounding conductor and to the frame of the generator.

3.04 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.

3.05 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- 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.

3.06 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.
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. 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.

I. 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.

3.07 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.
- 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

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**SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Support, anchorage, and attachment components.
 - 2. Fabricated metal equipment support assemblies.
- B. Related Requirements:

1.02 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

2.01 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 ris-

er conduits. Plugs 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.

2.02 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

3.01 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.
- 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.

3.02 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, panelboards, 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.

3.03 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.

3.04 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.
- 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.

3.05 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

**SECTION 260533
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Type ERMC-S 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.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Floor boxes.
4. Raceways.
5. Cabinets, cutout boxes, and miscellaneous enclosures.

PART 2 - PRODUCTS

2.01 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.

- c. Options:
 - 1) Minimum Trade Size: 3/4 inch (21 mm).

2.02 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).

2.03 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.

2.04 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:
 - 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).

2.05 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.

2.06 FITTINGS FOR CONDUIT, TUBING, AND CABLE

- A. Fittings for Type ERM 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:
 - 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.

2.07 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.

2.08 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:

2.09 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).

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.

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).

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.
 - 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, CUTOUT 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.
- 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.
- 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.
 - 2) Wallplate Material: 0.032 inch (0.8 mm) thick Type 302/304 non-magnetic stainless steel with brushed finish.

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

3.01 SELECTION OF RACEWAYS

- 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.
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 for raceways.
- E. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. ERM and IMC: Provide threaded type fittings unless otherwise indicated.

3.02 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:
1. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.03 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 ter-

minated with locknuts. 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.
 - 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 ERM:

- 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:

- 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 ERM C before rising above floor.

E. Stub-ups to Above Recessed Ceilings:

1. Provide EMT, IMC, or ERM C 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.

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 C 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 firestopping.

3.04 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".

3.05 INSTALLATION OF SURFACE RACEWAYS

- A. Install surface raceways only where indicated on Drawings.
- B. Install surface raceway with a minimum 2 inch (50 mm) radius control at bend points.
- C. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's written instructions. Tape and glue are unacceptable support methods.

3.06 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.

- 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.

3.07 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07.

3.08 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.09 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

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SECTION 260543
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
 - 2. Rigid nonmetallic duct.
 - 3. Duct accessories.
 - 4. Polymer concrete handholes and boxes with polymer concrete cover.
 - 5. Flowable fill.

1.03 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.

1.04 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.
- B. Shop Drawings:
 - 1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- C. Product Certificates: For concrete and steel used in precast concrete manholes and, comply with ASTM C 858.

1.05 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

2.01 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.02 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.

2.03 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."

2.04 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.
- 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.

2.05 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.

2.06 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

3.01 PREPARATION

- 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.

3.02 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, concrete-encased unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.
- D. Underground Ducts Crossing Driveways, Roadways, and Railroads: Type EPC-40 PVC RNC, encased in reinforced concrete.
- E. Stub-ups: Concrete-encased GRC.

3.03 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, Non-deliberate 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.

3.04 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.
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures.

3.05 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. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- J. 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.
- K. Pulling Cord: Install 200-lbf- (1000-N-) test nylon cord in empty ducts.
- L. 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.
 - 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.

M. 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.
- 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 concrete encasement of duct.
- N. 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.

3.06 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. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- E. 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.
- F. 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.

3.07 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- 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 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.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.08 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.09 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. Sweep floor, removing dirt and debris.
- C. Remove foreign material.

END OF SECTION

SECTION 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve seal systems.
4. Grout.

PART 2 - PRODUCTS

2.01 ROUND SLEEVES

A. Wall Sleeves, Steel:

1. Description: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

2.02 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).

2.03 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.

2.04 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

3.01 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.

3.02 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.

3.03 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

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**SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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.

2.02 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.

- 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. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 4. Color for Neutral: White or gray.
 - 5. 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. 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.

2.03 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. Ceiling Markers:

- a. Letter Color: Black.
 - b. Background Color: Clear.
 - c. 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).
 - d. Minimum Letter Size: 1/2 inch (13 mm).
 - e. 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: "ELEC".
 - 2) Components: "J-BOX, DISCONNECT, CONTACTOR, LTG CTRL".

2.04 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.
- 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).

2.05 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.

2.06 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

3.01 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.

3.02 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."
- 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. Ceiling Marker Labels:
 - 1. Apply labels for each concealed major item of electrical equipment or component requiring service or maintenance.
 - 2. Align labels neatly, parallel to ceiling edges or panel orientation.
 - 3. Apply after ceiling installation and verification of concealed item locations.
 - 4. Do not install labels on surfaces subject to frequent replacement or repainting without coordination.
 - 5. Locate ceiling marker labels where accessible and visible.
 - 6. Application Locations:
 - a. Suspended Acoustical Tile Ceilings (ACT):
 - 1) Apply label to the face of the ceiling grid tee directly adjacent to or centered over the concealed item.

- 2) If grid location is not feasible, affix to accessible tile surface, avoiding any tile likely to be replaced or removed.
 - b. Gypsum Board or Hard-Lid Ceilings with Access Panels:
 - 1) Apply label directly to the surface of the access panel.
 - 2) Label shall be centered, upright, and clearly legible from floor level.
 - c. Exposed Ceilings or Open Structures:
 - 1) Apply label to the nearest permanent building surface or equipment mounting plate visible from below.
 - 2) If no surface is available, affix to suspended tag or placard mounted below the item.
 - d. Multiple Components at Single Access Location:
 - 1) Use a single label listing all concealed components above the ceiling at that location, aligned vertically or in column format.
 - 2) Use consistent labeling format and spacing.
- P. 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.
- Q. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- R. 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.
- S. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using plenum-rated cable ties.
- T. 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.

3.03 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, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive labels.
 - 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 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.
 - 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.
- E. 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."
- F. 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.
- G. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- H. 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.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- J. 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.
- K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

- L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- M. 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.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Self-adhesive labels.
- P. 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.
- Q. Equipment Identification Labels:
 - 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. Power-transfer equipment.
 - l. Contactors.
 - m. Power-generating units.
 - n. Monitoring and control equipment.

END OF SECTION

**SECTION 262413
SWITCHBOARDS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Disconnecting and overcurrent protective devices.
 - 3. Instrumentation.
 - 4. Control power.
 - 5. Accessory components and features.
 - 6. Identification.

1.03 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
 - 1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
 - 9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01, include the following:
 - a. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.05 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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
 - 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.08 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Owner's written permission.
 4. Comply with NFPA 70E.

1.09 COORDINATION

- A. Coordinate layout and installation of switchboards 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. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. Schneider Electric.
 3. Siemens Industry, Inc., Energy Management Division.
 4. ABB Inc
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel and fixed individually mounted.
 - 3. Sections front and rear aligned.
- I. Indoor Enclosures: Steel, NEMA 250, Type 1.
- J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- K. Barriers: Between adjacent switchboard sections.
- L. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- N. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 - 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, .
 - 3. Copper feeder circuit-breaker line connections.
 - 4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 5. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) tin plated, hard-drawn copper of 98 percent conductivity.
 - 6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- O. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- P. Communications Connectivity: Provide connections for data transmission via ModBus.

2.02 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. 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 with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 5. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - d.
- B. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
- C. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
 - 1. Fixed circuit-breaker mounting.
 - 2. Two-step, stored-energy closing.
 - 3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Time adjustments for long- and short-time pickup.
 - c. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - 5. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 6. Remote trip indication and control.
 - 7. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system.
 - 8. Control Voltage: 120-V ac.

2.03 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
 - 1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; bushing type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 - 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.04 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.05 ACCESSORY COMPONENTS AND FEATURES

- A. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.06 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03.
 - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 - 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Install spare-fuse cabinet.
- H. Comply with NECA 1.

3.03 CONNECTIONS

- A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- B. Support and secure conductors within the switchboard according to NFPA 70.
- C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.04 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.05 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 and Inspections:
 - 1. Test ground-fault protection of equipment for service equipment per NFPA 70.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. 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 switchboard. Remove front panels so joints and connections are accessible to portable scanner.
- 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.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Switchboard will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 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 as specified in Section 260573.16 "Coordination Studies."

3.07 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.08 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

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**SECTION 262416
PANELBOARDS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Lighting and appliance branch-circuit panelboards.

1.03 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.

1.04 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.

1.05 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.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.06 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.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.08 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.

1.09 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

2.01 PANELBOARDS CENTERS COMMON REQUIREMENTS

- 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: Galvanized steel.
- 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.
 - 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

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.

2.02 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.
 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.

2.03 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. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
7. Subfeed Circuit Breakers: Vertically mounted.
8. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - 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.

2.04 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

3.01 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.

3.02 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.
- 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.

3.03 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.

3.04 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.
 - 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.

3.05 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

**SECTION 262726
WIRING DEVICES**

PART 1 - GENERAL

1.01 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.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Toggle switches.
 - 2. Duplex straight-blade receptacles.
 - 3. Receptacles with GFCI device.
 - 4. USB Receptacles

PART 2 - PRODUCTS

2.01 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.
- C. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Brown unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Essential Power System: Red.
 - 3. Wiring Devices Connected to Optional Standby Power System: Gray.

2.02 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:
 - a. Reference Standards: UL CCN WMUZ and UL 20.
3. Options:
 - a. Configuration:
 - 1) General-duty, 120-277 V, 20 A.

2.03 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.

2.04 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

- A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
 - 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.

2.05 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: 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel.
 - 3. Color: Brown.
 - 4. 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 clear, in-use, lockable cover.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Receptacles:
 - 1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.02 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:

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. Pigtail 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, multi-gang wall plates.

3.03 SELECTION OF GFCI RECEPTACLES

- A. Provide non-feed-through GFCI receptacles.

3.04 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.

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.

3.05 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.

3.06 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.

3.07 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.
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

**SECTION 262813
FUSES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Panelboards.
 - c. Switchboards.
 - 2. Spare-fuse cabinets.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.04 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.05 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Bussmann, Inc.
 2. Edison Fuse, Inc.
 3. Littelfuse, Inc.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
 3. Type J: 600-V, zero- to 600-A rating, 200 kAIC, fast acting , time delay.
 4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- 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.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.03 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

- A. Cartridge Fuses:
 1. Service Entrance: Class L, time delay or Class J, time delay.
 2. Feeders: Class L, time delay or Class J, time delay.
 3. Large Motor Branch (601-4000 A): Class L, time delay.
 4. Other Branch Circuits: Class RK1, time delay, Class J, fast acting or Class CC, fast acting.
 5. Control Transformer Circuits: Class CC, time delay, control transformer duty.
 6. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.04 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

**SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosures.

1.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.04 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.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. 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 electronic format.

1.07 FIELD CONDITIONS

- 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).

1.08 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

2.01 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.

2.02 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, Double 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.
 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.

2.03 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.

2.04 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.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 FIELD QUALITY CONTROL

- 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.
- 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

**SECTION 263213.17
GASEOUS ENGINE GENERATORS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes packaged engine generators for non-emergency use with the following features:
 - 1. Natural gas engine.
 - 2. Gaseous fuel system.
 - 3. Control and monitoring.
 - 4. Generator overcurrent and fault protection.
 - 5. Generator, exciter, and voltage regulator.
 - 6. Outdoor generator-set enclosure.
 - 7. Vibration isolation devices.
 - 8. Finishes.

1.03 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include thermal damage curve for generator.
 - 3. Include time-current characteristic curves for generator protective device.
 - 4. Include fuel consumption in cubic feet per hour (cubic meters per hour) at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
 - 5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
 - 6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95 deg F (35 deg C), 80 deg F (27 deg C), 70 deg F (21 deg C), and 50 deg F (10 deg C). Provide drawings showing requirements and limitations for location of air intake and exhausts.
 - 7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.
- B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified.
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. Identify fluid drain ports and clearance requirements for proper fluid drain.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:
 - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - b. Operating instructions laminated and mounted adjacent to generator location.
 - c. Training plan.

1.07 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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 4. Tools: Each tool listed by part number in operations and maintenance manual.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.09 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Caterpillar, Inc.; Electric Power Division.
 2. Cummins Power Generation.
 3. Generac Power Systems, Inc.
 4. Kohler Power Systems
- B. Source Limitations: Obtain packaged engine generators and auxiliary components through one source from a single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. B11 Compliance: Comply with B11.19.
- B. NFPA Compliance:
 1. Comply with NFPA 37.
 2. Comply with NFPA 70.
- C. UL Compliance: Comply with UL 2200.
- D. Engine Exhaust Emissions: Comply with EPA Tier 4 requirements and applicable state and local government requirements.
- E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).
 2. Relative Humidity: Zero to 95 percent.
 3. Altitude: Sea level to 1000 feet (300 m).

2.03 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.

- C. Power Rating: Standby.
- D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.
- E. Power Factor: 0.8, lagging.
- F. Frequency: 60 Hz
- G. Phase: Three-phase, four wire, wye.
- H. Governor: Adjustable isochronous, with speed sensing.
- I. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- J. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
 - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- K. Engine Generator Performance:
 - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 - 7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 - 8. Start Time: 10 seconds.
 - 9. .

2.04 GASEOUS ENGINE

- A. Fuel: Natural gas .
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid-mounted.
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499.
- E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- F. Muffler/Silencer: Commercial type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 - 1. Minimum sound attenuation of 12 dB at 500 Hz.
 - 2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 90 dBA or less.
- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 24-V electric, with negative ground.
 - 1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: 60 seconds.
4. Battery: Nickel cadmium, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for nickel cadmium batteries. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.05 GASEOUS FUEL SYSTEM

- A. Natural Gas Piping: Comply with requirements in Division 22.
- B. Gas Train: Comply with NFPA 37.
- C. Engine Fuel System:
- D. Natural Gas , Vapor-Withdrawal System:
 1. Carburetor.
 2. Secondary Gas Regulator.
 3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valve.
 4. Fuel Filter.

5. Manual Fuel Shutoff Valve.
6. Flexible Fuel Connector.

2.06 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- C. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.
- D. Comply with UL 508A.
- E. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:
 1. Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
- F. Control and Monitoring Panel:
 1. Digital controller with integrated LCD, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
 2. Instruments: Located on the control and monitoring panel and viewable during operation.
 - a. Engine lubricating-oil pressure gage.
 - b. Engine-coolant temperature gage.
 - c. DC voltmeter (alternator battery charging).
 - d. Running-time meter.
 - e. AC voltmeter, for each phase.
 - f. AC ammeter, for each phase.
 - g. AC frequency meter.
 - h. Generator-voltage adjusting rheostat.
 3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication, including the following:
 - a. Cranking control equipment.
 - b. Run-Off-Auto switch.
 - c. Control switch not in automatic position alarm.
 - d. Overcrank alarm.

- e. Overcrank shutdown device.
- f. Low water temperature alarm.
- g. High engine temperature prealarm.
- h. High engine temperature.
- i. High engine temperature shutdown device.
- j. Overspeed alarm.
- k. Overspeed shutdown device.
- l. Low fuel main tank.
- m. Coolant low-level alarm.
- n. Coolant low-level shutdown device.
- o. Coolant high-temperature prealarm.
- p. Coolant high-temperature alarm.
- q. Coolant low-temperature alarm.
- r. Coolant high-temperature shutdown device.
- s. EPS supplying load indicator.
- t. Battery high-voltage alarm.
- u. Low cranking voltage alarm.
- v. Battery-charger malfunction alarm.
- w. Battery low-voltage alarm.
- x. Lamp test.
- y. Contacts for local and remote common alarm.
- z. Low-starting air pressure alarm.
- aa. Low-starting hydraulic pressure alarm.
- bb. Remote manual stop shutdown device.
- cc. Air shutdown damper alarm when used.
- dd. Air shutdown damper shutdown device when used.
- ee. Hours of operation.
- ff. Engine generator metering, including voltage, current, Hz, kW, kVA, and power factor.
- gg. Generator overcurrent protective device not closed alarm.

G. Connection to Datalink:

- 1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
- 2. Provide connections for datalink transmission of indications to remote data terminals via ModBus.

H. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

- 1. Overcrank alarm.
- 2. Coolant low-temperature alarm.
- 3. High engine temperature prealarm.
- 4. High engine temperature alarm.
- 5. Low lube oil pressure alarm.
- 6. Overspeed alarm.
- 7. Low fuel main tank alarm.
- 8. Low coolant level alarm.
- 9. Low cranking voltage alarm.
- 10. Contacts for local and remote common alarm.
- 11. Audible-alarm silencing switch.

12. Air shutdown damper when used.
 13. Run-Off-Auto switch.
 14. Control switch not in automatic position alarm.
 15. Fuel tank derangement alarm.
 16. Fuel tank high-level shutdown of fuel supply alarm.
 17. Lamp test.
 18. Low cranking voltage alarm.
 19. Generator overcurrent protective device not closed.
- I. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- J. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

2.07 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.

2.08 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six lead alternator.
- E. Range: Provide broad range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter.
1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
 2. Maintain voltage within 15 percent on one step, full load.

- 3. Provide anti-hunt provision to stabilize voltage.
- 4. Maintain frequency within 5 percent and stabilize at rated frequency within 2 seconds.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

2.09 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 130 mph (209 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Description: Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure, erected on concrete foundation.
- C. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 130 mph (209 km/h).
- D. Hinged Doors: With padlocking provisions.
- E. Space Heater: Thermostatically controlled and sized to prevent condensation.
- F. Lighting: Provide weather-resistant LED lighting with 30 fc (330 lux) average maintained.
- G. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- H. Muffler Location: External to enclosure.
- I. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
 - 3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.
- J. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
 - 1. AC lighting system and connection point for operation when remote source is available.
 - 2. DC lighting system for operation when remote source and generator are both unavailable.
- K. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.10 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Material: Standard neoprene separated by steel shims.
 - 2. Minimum Deflection: 1 inch (25 mm).
- B. Comply with requirements in Division 23 for vibration isolation and flexible connector materials for steel piping.
- C. Comply with requirements in Division 23 for vibration isolation and flexible connector materials for exhaust shroud and ductwork.
- D. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Test generator, exciter, and voltage regulator as a unit.
 - 3. Full load run.
 - 4. Maximum power.
 - 5. Voltage regulation.
 - 6. Transient and steady-state governing.
 - 7. Single-step load pickup.
 - 8. Safety shutdown.
 - 9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 - 10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than five working days in advance of proposed interruption of electrical service.

3.03 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation.
- C. Equipment Mounting:
 - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
 - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
 - 3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases.
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.
- F. Gaseous Fuel Piping:
 - 1. Natural gas piping, valves, and specialties for gas distribution are specified in Division 22.
- G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.04 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuelpiping adjacent to packaged engine generator to allow service and maintenance.
- C. Gaseous Fuel Connections:
 - 1. Connect fuel piping to engines with a gate valve and union and flexible connector.
 - 2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
 - 3. Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- F. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.05 IDENTIFICATION

- A. Identify system components according to Division 23 and Section 260553 "Identification for Electrical Systems."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.06 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. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below as specified in the NETA ATS. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify the unit is clean.

b. Electrical and Mechanical Tests

- 1) Perform insulation-resistance tests in accordance with IEEE 43.
 - a) Machines larger than 200 hp (150 kW). Test duration shall be 10 minutes. Calculate polarization index.
 - b) Machines 200 hp (150 kW) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
 - 2) Test protective relay devices.
 - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
 - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
 - 5) Perform vibration test for each main bearing cap.
 - 6) Verify correct functioning of the governor and regulator.
2. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
- a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
5. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
6. Exhaust Emissions Test: Comply with applicable government test criteria.
7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at **[four]** locations 25 feet (8 m) from edge of the generator enclosure, and compare measured levels with required values.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- L. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

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**SECTION 263600
TRANSFER SWITCHES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes automatic transfer switches rated 600 V and less.

1.03 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 transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 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. Comply with NEMA ICS 1.
- C. Comply with NFPA 110.
- D. Comply with UL 1008 unless requirements of these Specifications are stricter.
- E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
 - 2. Short-time withstand capability for three cycles.
- G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- J. Neutral Terminal: Solid and fully rated unless otherwise indicated.
- K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
 - 4. Accessible via front access.
- M. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.02 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Caterpillar, Inc.; Electric Power Division.
 2. Cummins Power Generation.
 3. Eaton.
 4. Kohler Power Systems.
 5. Vertiv, Co. (ASCO).
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
 4. Conductor Connectors: Suitable for use with conductor material and sizes.
 5. Material: Hard-drawn copper, 98 percent conductivity.
 6. Main and Neutral Lugs: Compression type.
 7. Ground Lugs and Bus-Configured Terminators: Compression type.
 8. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- G. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- H. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.
 2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 "Cast-in-Place Concrete."
 2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 3. Provide workspace and clearances required by NFPA 70.
- B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

- E. Comply with NECA 1.

3.02 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
 - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."
- G. Route and brace conductors according to manufacturer's written instructions. and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.
- H. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.03 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.
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.
 - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

- 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
 3. Electrical Tests:
 - a. Verify settings and operation of control devices.
 - b. Calibrate and set all relays and timers.
 - c. Verify phase rotation, phasing, and synchronized operation.
 - d. Perform automatic transfer tests.
 - e. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.
 - 2) Engine start sequence.
 - 3) Time delay on transfer.
 - 4) Alternative source voltage-sensing and frequency-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer on normal power restoration.
 - 8) Engine cool-down and shutdown feature.
 4. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and re-transfer from emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

- D. Transfer switches will be considered defective if they do not pass tests and inspections.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Prepare test and inspection reports.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Coordinate this training with that for generator equipment.

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**SECTION 264113
LIGHTNING PROTECTION FOR STRUCTURES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes lightning protection system for ordinary structures.

1.03 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.

1.04 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.

1.05 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.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: UL-listed installer, category OWAY.

PART 2 - PRODUCTS

2.01 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.

2.02 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

END OF SECTION

**SECTION 265119
LED INTERIOR LIGHTING**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes the following types of LED luminaires:
 - 1. Materials.
 - 2. Finishes.
 - 3. Luminaire support.

1.03 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.

1.04 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.

- 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.

1.05 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.

1.06 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.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.08 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

2.01 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.

2.02 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.

2.03 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.

2.04 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

3.01 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 to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 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.

3.03 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.

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.

3.04 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.

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**SECTION 270100
GENERAL PROVISIONS FOR COMMUNICATIONS**

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes basic requirements for communication systems.
- B. Related Work:
 - 1. Division 02 – Existing Conditions
 - a. Refer to Division 02 for demolition and for abatement of hazardous materials.
 - b. Comply with the requirements of Division 02 for selective demolition.
 - 2. 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.
 - 3. 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.
 - 4. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 5. 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.
 - 6. 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.

7. 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.
8. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
9. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
10. Division 22 – Plumbing
 - a. Refer to Division 22 for all plumbing work.
11. Division 23 – Heating, Ventilation, and Air-Conditioning
 - a. Refer to Division 23 for all heating, ventilation, and air-conditioning work.
12. 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.
13. Division 26 – Electrical
 - a. Refer to Division 26 for all electrical work.
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 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.
16. 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.
17. 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.

1.03 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.

1.04 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.

1.05 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. ASME

- a. ASME A17.3 Safety Code for Existing Elevators and Escalators - 2020
 2. Occupational Safety and Health Regulations (OSHA).
 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 75 Standard for the Fire Protection of Information Technology Equipment – 2020
 - e. NFPA 76 Standard for the Fire Protection of Telecommunications Facilities – 2020
 - f. NFPA 101 Life Safety Code – 2021 (Florida Edition)
 4. Florida Building Code, 2023 Edition
 - a. Building Code
 - b. Existing Building Code
 - c. Energy Conservation Code
 - d. Mechanical Code
 - e. Plumbing Code
 - f. Fuel Gas Code
 - g. 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 6A–2 Educational Facilities
 - b. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - c. Chapter 61C-5 Florida Elevator Safety Code
 - d. Chapter 61G15-33 Responsibility Rules of Professional Engineers Concerning the Design of Electrical Systems
 - e. Chapter 69A-3 Fire Prevention – General Provisions
 - f. Chapter 69A-47 Uniform Fire Safety Standards for Elevators
 - g. Chapter 69A–58 Fire Safety in Educational Facilities
 - h. 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.

1.06 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

1.07 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.

1.08 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.

1.09 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.

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.
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.

1.12 SUSTAINABLE DESIGN REQUIREMENTS

A. Sustainable Certification Program: Comply with requirements for Project to obtain certification based on FGBC's "Commercial Building Standard" (hereafter, "Certification Program"). Compliance with requirements needed to obtain Certification Program prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.

B. Related Requirements:

1. General and Supplementary Conditions
 2. Division 01 for general sustainable design certification and reporting requirements.
 3. Comply with requirements in various Division 21 Sections specifying sustainable products and methods.
- C. Sustainable design submittals are in addition to other submittals.
1. Comply with "Submittals" article in this Section.
 2. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record of compliance with indicated Certification Program requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."
- D. Sustainable Design Documentation Submittals
1. Environmental management system documents.
 2. Environmental product declarations.
 3. Third-party certifications based on multiple attribute standards.
 4. Product Data and laboratory test reports for adhesives and sealants indicating VOC content and compliance with requirements for low-emitting materials.
 5. Product Data and laboratory test reports for paints indicating VOC content and compliance with requirements for low-emitting materials.

1.13 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.

1.14 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.
 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.
 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.
- 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.

3.06 OWNER-INSTALLED PRODUCTS

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

3.07 UTILITY SERVICES AND COMMUNICATION SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove communication systems, equipment, and components indicated on Drawings to be removed.
 - a. Conduit to Be Removed: Remove portion of conduit indicated to be removed and cap or plug remaining piping with same or compatible conduit material.
 - b. Conduit to Be Abandoned in Place: Remove wiring and cap or plug conduit with same or compatible conduit material and leave in place.

- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.08 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.
- 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.

3.09 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. 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.

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

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SECTION 270526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Selection and installation of communications busbars.
 - 2. Selection and installation of communications bonding conductors.

1.02 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

3.01 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.

3.02 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).

3.03 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. UBC: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
 - 6. 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.

3.04 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:
 - a. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 12 inch (300 mm) above finished floor unless otherwise indicated.
 - b. 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.
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.

3.05 IDENTIFICATION

- A. Comply with Section 270553 "Identification for Communications Systems."
- 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 TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.06 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.

3.07 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

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**SECTION 270528
PATHWAYS FOR COMMUNICATIONS SYSTEMS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Boxes, enclosures, and cabinets.

1.03 DEFINITIONS

- A. GRC: Galvanized rigid conduit.

1.04 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Wireways and fittings.
 - 2. Raceways.
 - 3. Boxes, enclosures, and cabinets.

PART 2 - PRODUCTS

2.01 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.
- 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.

2.02 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.
 - 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.

PART 3 - EXECUTION

3.01 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).

3.02 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
 - 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.
- 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 locknut 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. 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.
- X. 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.
- Y. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- Z. 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.
- AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- BB. Set metal floor boxes level and flush with finished floor surface.

3.03 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."

3.04 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07.

3.05 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

**SECTION 270529
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.01 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.

- 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.

2.02 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

3.01 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.

1. Secure raceways and cables to these supports with single-bolt conduit clamps, using spring friction action for retention in support channel.

3.02 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.

3.03 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.

3.04 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.

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**SECTION 270536
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Ladder cable tray.
 - 2. Wire-mesh cable tray.
 - 3. Cable tray accessories.

1.03 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

2.01 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.

2.02 LADDER CABLE TRAY

- A. Description:

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.

2.03 WIRE-MESH CABLE TRAY

A. Description:

1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
2. Width: 12 inches (300 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. Structural Performance: 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.
6. Class Designation: Comply with NEMA VE 1, Class 8A.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. 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 Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
 - 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: Electrogalvanized after fabrication, complying with ASTM B 633.
- 1) Hardware: Galvanized, ASTM B 633.

2.04 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

3.01 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.
- 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 wire-basket cable trays with trapeze hangers.

- L. Support trapeze hangers for wire-basket trays with 1/4-inch- (6-mm-) diameter rods.
- M. 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.
- N. 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.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07.
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.

3.02 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.

3.03 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).

3.04 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.

3.05 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

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SECTION 290100
GENERAL PROVISIONS FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS

PART 1 - GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes basic requirements for electronic safety and security systems.
- B. Related Work:
 - 1. Division 02 – Existing Conditions
 - a. Refer to Division 02 for demolition and for abatement of hazardous materials.
 - b. Comply with the requirements of Division 02 for selective demolition.
 - 2. 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.
 - 3. 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.
 - 4. Division 06 – Wood, Plastics, and Composites
 - a. Refer to Division 06 for framed openings for equipment.
 - 5. 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.
 - 6. 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.

7. 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.
8. Division 10 – Specialties
 - a. Refer to Division 10 for fire protection cabinets and fire extinguishers.
9. Division 21 – Fire Suppression
 - a. Refer to Division 21 for all suppression work.
10. Division 22 – Plumbing
 - a. Refer to Division 22 for all plumbing work.
11. Division 23 – Heating, Ventilation, and Air-Conditioning
 - a. Refer to Division 23 for all heating, ventilation, and air-conditioning work.
12. 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.
13. Division 26 – Electrical
 - a. Refer to Division 26 for all electrical work.
14. Division 27 – Communications
 - a. Refer to Division 27 for all communications work.
 - b. Coordinate with Division 27 for integration with communication systems.
15. 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.
16. 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.
17. 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.

1.03 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.

1.04 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.

1.05 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. ASME

- a. ASME A17.3 Safety Code for Existing Elevators and Escalators - 2020
 2. Occupational Safety and Health Regulations (OSHA).
 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 101 Life Safety Code – 2021 (Florida Edition)
 4. Florida Building Code, 2021 Edition
 - a. Building Code
 - b. Existing Building Code
 - c. Energy Conservation Code
 - d. Mechanical Code
 - e. Plumbing Code
 - f. Fuel Gas Code
 - g. 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 6A–2 Educational Facilities
 - b. Chapter 9B-7 Florida Building Commission Handicapped Accessibility Standards
 - c. Chapter 61C-5 Florida Elevator Safety Code
 - d. Chapter 61G15-32 Responsibility Rules of Professional Engineers Concerning the Design of Fire Protection Systems
 - e. Chapter 61G15-33 Responsibility Rules of Professional Engineers Concerning the Design of Electrical Systems
 - f. Chapter 69A-3 Fire Prevention – General Provisions
 - g. Chapter 69A-47 Uniform Fire Safety Standards for Elevators
 - h. Chapter 69A–58 Fire Safety in Educational Facilities
 - i. 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.

1.06 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

1.07 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.

1.08 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.

1.09 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.

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.
- 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.

1.12 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Certification Program: Comply with requirements for Project to obtain certification based on FGBC's "Commercial Building Standard" (hereafter, "Certification Program"). Compliance with requirements needed to obtain Certification Program prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.

B. Related Requirements:

1. General and Supplementary Conditions
2. Division 01 for general sustainable design certification and reporting requirements.
3. Comply with requirements in various Division 21 Sections specifying sustainable products and methods.

C. Sustainable design submittals are in addition to other submittals.

1. Comply with "Submittals" article in this Section.
2. If submitted item is identical to that submitted to comply with other requirements, include an additional copy with other submittal as a record of compliance with indicated Certification Program requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."

D. Sustainable Design Documentation Submittals

1. Environmental management system documents.
2. Environmental product declarations.
3. Third-party certifications based on multiple attribute standards.
4. Product Data and laboratory test reports for adhesives and sealants indicating VOC content and compliance with requirements for low-emitting materials.
5. Product Data and laboratory test reports for paints indicating VOC content and compliance with requirements for low-emitting materials.

1.13 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.

1.14 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.
 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.
 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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".

1.19 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.
- 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.

3.06 OWNER-INSTALLED PRODUCTS

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

3.07 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.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 4. Disconnect, demolish, and remove communication systems, equipment, and components indicated on Drawings to be removed.
 - a. Conduit to Be Removed: Remove portion of conduit indicated to be removed and cap or plug remaining piping with same or compatible conduit material.
 - b. Conduit to Be Abandoned in Place: Remove wiring and cap or plug conduit with same or compatible conduit material and leave in place.

- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.08 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.
- 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.

3.09 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.

3.10 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. 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.

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

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SECTION 290523
CONTROL-VOLTAGE CABLES FOR FIRE SAFETY AND EMERGENCY COMMUNICATIONS

PART 1 - GENERAL

1.01 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.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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.

2.02 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.

- D. Shielding/Screening: Unshielded twisted pairs (UTP). Cable Rating: Plenum.
- E. Jacket: Red thermoplastic.

2.03 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.

2.04 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.

2.05 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.

2.06 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.

2.07 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 .

2.08 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, NTRL listed for fire-alarm and cable tray installation, plenum rated.

PART 3 - EXECUTION

3.01 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.
- 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.

3.02 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:
 - 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.

3.03 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.

3.04 FIRESTOPPING

- A. Comply with requirements in Division 07.

3.05 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.

3.06 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

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**SECTION 291323
OPTICAL FIBER BACKBONE CABLING FOR FIRE SAFETY AND EMERGENCY
COMMUNICATIONS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Type OFNP optical fiber cable.
 - 2. Optical fiber cable connecting hardware, patch panels, and cross-connects.

1.02 DEFINITIONS

- A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.
- B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.
- C. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.

1.03 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
- B. Field Quality-Control Submittals:
 - 1. Optical fiber cable testing plan.
 - 2. Field quality-control reports.

1.05 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.

PART 2 - PRODUCTS

2.01 TYPE OFNP OPTICAL FIBER CABLE

- A. Description: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air 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. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
 - d. 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 OFNP, Designation OS1, Inside-Outside 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, 125 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.
 - 3. Options:
 - a. Configuration:
 - 1) 12-fiber, single loose tube, 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.
- D. Type OFNP, Designation OS1, 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, 125 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.

3. Options:
 - a. Configuration: 12 fibers, tight buffered, optical fiber cable.
 - b. Maximum Attenuation: 1.0 dB/km at 1310 nm wavelength; 1.0 dB/km at 1550 nm wavelength.
 - c. Jacket Color: Yellow.

2.02 OPTICAL FIBER CABLE HARDWARE

- 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

3.01 PREPARATION

- A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.02 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Optical fiber backbone cabling system must provide interconnections fire alarm control panels.

- 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. Conceal raceway and cables except in unfinished spaces.
 - a. Install pathways in accordance with Division 26.
 - 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.
 - 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. 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.
 - 6. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 7. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- H. Group connecting hardware for cables into separate logical fields.

3.03 FIRESTOPPING

- A. Comply with requirements in Division 07.
- B. Comply with TIA-569, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.04 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. Bond metallic equipment to grounding bus bar, using not smaller than 6 AWG equipment grounding conductor.

3.05 IDENTIFICATION

- A. 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.
- B. 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.

3.06 FIELD QUALITY CONTROL

- A. 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.
- B. Nonconforming Work:
 - 1. Cables will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective cables and retest.
- C. 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.

END OF SECTION

SECTION 294621.11
ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 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. Carbon monoxide detectors.
 - 7. Heat detectors.
 - 8. Fire-alarm notification appliances.
 - 9. Fire-alarm remote annunciators.
 - 10. Fire-alarm addressable interface devices.
 - 11. Digital alarm communicator transmitters (DACTs).

1.03 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:
 - 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.

1.04 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.
 - 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.

1.05 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:

- 1. Software operating and upgrade manuals.
- 2. Program Software Backup: On USB media.
- 3. Device address list.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:

- 1. Installation must be by personnel certified by NICET as fire-alarm Level II or greater technician.

1.07 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

2.01 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.

b. Speech Intelligibility Requirements: As indicated on the Drawings.

2.02 ADDRESSABLE FIRE-ALARM SYSTEM

A. Manufacturers: Subject to compliance with requirements, BOD: Johnson Controls - Simplex or 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.
 - 5) Carbon monoxide detectors.
 - 6) Automatic sprinkler system water flow.
 - 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) Recall elevators to primary or alternate recall floors.
 - 10) Activate elevator power shunt trip.
 - 11) Activate emergency lighting control.
 - 12) Activate emergency shutoffs for gas and fuel supplies, except for shutoffs serving legally required life-safety systems such as emergency generators and fire pumps.
 - 13) Record events in system memory.
 - 14) Record events by system printer.
 - 15) Indicate device in alarm on graphic annunciator.
- 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. 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.
- i. Document Storage Box:
 - 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.

2.03 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.
 - 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. Elevator Recall: Initiate by one of the following alarm-initiating devices:
 - 1) Elevator lobby detectors except lobby detector on designated floor.
 - 2) Smoke detectors in elevator machine room.
 - 3) Smoke detectors in elevator hoistway.
- m. Elevator controller must be programmed to move cars to alternate recall floor if lobby detectors located on designated recall floors are activated.

- n. Water-flow alarm connected to sprinkler in elevator shaft and elevator machine room must shut down elevators associated with location without time delay.
 - 1) Water-flow switch associated with sprinkler in elevator pit shall have delay to allow elevators to move to designated floor.
- o. 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.
- p. 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.
- q. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
- r. 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.
- s. 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."
 - 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.
- t. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communication zones.
- u. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
- v. 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.
- w. 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.
- x. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
- y. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
- z. 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.

2.04 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.

2.05 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:

1. Performance Criteria:
 - 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.

2.06 DUCT SMOKE DETECTORS

A. Description: Photoelectric-type, duct-mounted smoke detector.

B. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. UL 268A.

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.

2.07 CARBON MONOXIDE DETECTORS

- A. Description: Carbon monoxide detector listed for connection to fire-alarm system.
- B. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. NFPA 72
 - b. NFPA 720.
 - c. UL 2075.
 - 2. General Characteristics:
 - a. Mounting: Adapter plate for outlet box mounting.
 - b. Testable by introducing test carbon monoxide into sensing cell.
 - c. Detector must provide alarm contacts and trouble contacts.
 - d. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - e. Locate, mount, and wire in accordance with manufacturer's written instructions.
 - f. Provide means for addressable connection to fire-alarm system.
 - g. Test button simulates alarm condition.
 - h. Integral alarm that provides four-pulse signal pattern that is distinctive from fire evacuation signal
 - 1) Minimum rating of 85 dBA when mounted at 10 feet.

2.08 HEAT DETECTORS

- A. Combination-Type Heat Detectors:
 - 1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:
 - 1) Temperature sensors must test for and communicate sensitivity range of device.
 - c. Actuated by fixed temperature of 135 deg F (57 deg C) or rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - d. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.

- f. Detector must have functional humidity range of 10 to 90 percent relative humidity.
- g. Color: White.

2.09 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Audible Notification Appliances:

- 1. Description: Horns, bells, or other notification devices that cannot output voice messages.
- 2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - b. General Characteristics:
 - 1) Individually addressed, connected to signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
 - 2) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 3) Chimes, Low-Level Output: Vibrating type, 75 dB(A-weighted) minimum rated output.
 - 4) Chimes, High-Level Output: Vibrating type, 81 dB(A-weighted) minimum rated output.
 - 5) Sounders, High Volume 24 V(dc): Less than 6 mA of alarm current.
 - 6) Sounders, Low Volume 24 V(dc): Less than 4 mA of alarm current.
 - 7) Audible notification appliances must have functional humidity range of 10 to 95 percent relative humidity.
 - 8) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 90 dB(A-weighted), measured 10 ft. (3 m) from horn, using coded signal prescribed in UL 464 test protocol.
 - 9) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
 - 10) 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".

B. 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.

C. 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".

2.10 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.

2.11 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Performance Criteria:

1. Regulatory Requirements:

- 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.

2.12 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.
 - 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

3.01 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.

3.02 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.

3.03 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.
 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. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- H. 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.
- I. 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.
- J. 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.
- K. Device Location-Indicating Lights: Locate in public space near device they monitor.

3.04 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.

3.05 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.

3.06 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.

3.07 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. Supervisory connections at elevator shunt-trip breaker.
9. Data communication circuits for connection to building management system.
10. Supervisory connections at fire-extinguisher locations.
11. Supervisory connections at ERCES.
12. Alarm-initiating connection to smoke-control system at firefighters' smoke-control system panel.

3.08 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.

3.09 GROUNDING

- 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. Administrant 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.

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.

END OF SECTION

**SECTION 294700
MASS NOTIFICATION SYSTEMS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. MNS wiring, raceways, terminal cabinets, outlets, and mounting boxes.
 - 2. Control equipment.
 - 3. Notification appliances.
 - 4. Accessories.
- B. Related Requirements:
 - 1. Section 294621.11 "Addressable Fire-Alarm Systems" for fire alarm system that interfaces with the equipment of this Section.

1.03 DEFINITIONS

- A. ATP: Acceptance Test Procedure.
- B. Broadcast Media: The speakers, radio, cell phone, and other media that will carry the selected message to the selected audience.
- C. LOC: Local operating console.
- D. MNS: Mass notification system.
- E. NICET: National Institute for Certification in Engineering Technologies.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Power calculations.
 - 4. Battery capacity calculations with the following supporting information:
 - a. Supervisory power requirements for all equipment.
 - b. Alarm power requirements for all equipment.

- c. Power supply rating.
- d. Voltage drop calculations for wiring runs demonstrating worst-case condition.
- e. Notification appliance circuit design.

B. Shop Drawings:

1. Prepare Shop Drawings by persons with the following qualifications:
 - a. Trained and certified by manufacturer in MNS design.
 - b. NICET-certified technician; Level III minimum.
 - c. Licensed or certified according to the requirements of the authorities having jurisdiction.
2. Include plans, elevations, sections, and mounting details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail fabrication and assembly of the following:
 - a. Speaker clusters on poles.
 - b. Racks with amplifiers and terminations.
 - c. Control panels.
5. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For items listed below, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Speaker placement.
2. Speaker dB output.
3. Amplifier output.
4. Remote power booster rating and locations.
5. Battery sizing calculations.
6. Voltage drop calculations.
7. Seismic mounting and supports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For amplifiers and speakers to include in emergency, operation, and maintenance manuals.
- B. Computer-generated instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. The card shall indicate those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions: normal, alarm, supervisory, and trouble.
- C. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On USB media and approved online or cloud solution.
 3. Device address list.
 4. Printout of software application and graphic screens.

- D. Proprietary equipment and software required to implement future changes to the MNS.
- E. System documentation to the owner, including but not limited to the following:
 - 1. System record Drawings and wiring details, including one set of full-size printed Drawings, and a CD ROM with copies of the record Drawings in PDF format and DXF format.
 - 2. Documentation of all component and wiring identification, including a copy of each equipment nameplate.
 - 3. System matrix showing interaction of all input signals with output commands.
 - 4. Documentation of system voltage, current, and resistance readings taken during the installation, testing, and ATP phases of the system installation.
 - 5. System program showing control devices and operations, and system functions of equipment and devices.

1.06 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. Speakers: Quantity equal to five percent of quantity installed for each type indicated, but no fewer than one unit.
 - 2. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
 - 3. Special Tools: Software, connecting cables, and proprietary equipment necessary for the maintenance, testing, and reprogramming of the equipment. Tools listed by part number in the operation and maintenance manuals are considered special tools.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 certified for products delivered.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation of units required for this Project.
 - 1. Personnel certified by NICET as Audio Systems Level III Technician.
- C. Testing Agency Qualifications: An NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

1.08 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of the MNS that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. BOD: KELTRON COPORATION.
- B. Source Limitations: Obtain MNS from single source or producer.

2.02 PERFORMANCE REQUIREMENTS

- A. Comply with UL 2572.
- B. Mass Notification Messaging System:
 - 1. Software-operated, network-based communications system with wired and wireless access points for control interface. Designated operators shall be able to log in via a web browser and have complete access to their own portion of the MNS.
 - 2. An autonomous voice notification control unit shall monitor and control the notification appliance network and provide consoles for local operation. Authorized personnel shall be able to use a console to initiate delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe and optional textual message notification appliances. The autonomous voice notification control unit shall temporarily override audible fire alarm notification while delivering mass notification messages to ensure they are intelligible.
 - 3. The MNS messaging system shall be capable of the following:
 - a. Communicating through the use of wired or wireless networks for one- or two-way communications and control between a building or area and emergency personnel.
 - b. Automatically distribute at least 100 simultaneous and unique messages to the appropriate notification appliances.
 - c. Allow multiple operators to send messages simultaneously.
 - d. Grant access for control to another control station if the location in control becomes inoperable and/or the authorized operator at that control station can no longer operate the control station.
 - e. Send voice messages and text messages with an indication of the source of the message that can only be sent from the message source.
 - f. Send alert messages to end users (recipients) via multiple delivery methods, including but not limited to the following:
 - 1) Audio-visual network alerts to computers via desktop pop-up.
 - 2) Text alerts to mobile phones and pagers.
 - 3) Text alerts to email clients.
 - 4) Text alerts to textual visible appliances.
 - 5) Alerts to visible appliances.
 - 6) Audio alerts to phones.
 - 7) Audio alerts to speakers.
 - 8) Audio alerts to existing wide-area or building voice and/or other MNS.
 - 9) Network alerts to any other IP-connected devices via standard XML and CAP protocols.
 - g. Suppress contact information for other end users with messages or in message headers.
 - 4. Live announcements or prerecorded messages. Live messages shall take precedence over prerecorded messages.

5. Notification appliance network shall consist of speakers and visual notification devices located to provide intelligible instructions at areas as indicated.
 6. Interface with the fire alarm system to utilize the voice modules, visual alarms, and speakers of the fire alarm system.
 7. Give priority to MNS announcements over other audible announcements of the system including fire alarm system in a normal or alarm state. When an announcement is activated during a fire alarm, fire alarm system functions shall continue in an alarm state, except for the output signals of the fire alarm audible and visual notification appliances.
 8. Comply with speech intelligibility requirements of NFPA 72 as measured according to ANSI/ASA S3.2.
 9. Capable of overriding local control of speaker volume levels for emergency communications. Local controls shall be permitted to adjust volume levels of non-emergency signals only, such as, but not limited to, background music and convenience paging.
 10. Capable of providing separate messages to one individual building or to multiple buildings at any given time if the MNS serves more than one building.
 11. Capable of monitoring emergency notifications from multiple data sources (National Weather Service, Emergency Managers Weather Information Network, Naval Meteorology and Oceanography, and others as determined locally) and automatically send out notifications to designated facilities and personnel based on pre-defined rules.
 12. Capable of centrally tracking, in real-time, all alerting activities for each individual recipient, including sending, receiving, and responding to alerts, and of generating reports based on tracked information.
 13. Capable of operating remote printer via a USB output. Provide matching printer listed and labeled as part of the MNS.
- 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.

2.03 MASTER CONTROL PANEL

- A. Description:
1. Fully enclosed in a lockable steel cabinet with access for testing, and maintenance from the front of the enclosure.
 2. Solid-state, modular components, internally mounted and arranged for easy access for power, supervision, control, and logic for the system.
 3. 120 V ac, 60 Hz power supply.
 4. An indicator for each message source shall indicate which sources are available and which are selected.
 5. Indicators for broadcast media used to convey the selected message to selected audience shall indicate which sources are available and which are selected.
 6. Capable of confirming the receipt of a message. If the message was not confirmed received, the system shall be capable of using other means of contact until receipt of confirmation or until a preset time period.
 7. Capable of automatically sending another message after the receipt of a message or messages.
 8. Operator Access Functions:
 - a. Select prerecorded message for transmission.
 - b. Select microphone for live broadcast.
 - c. Initiate message broadcast.
 - d. Terminate message broadcast.
 9. Supervisory Access Functions:

- a. Reset time and date.
 - b. Enable or disable event-initiated programs, printouts, and initiators.
 - c. Enable or disable individual message sources and broadcast media.
 - d. Supervisory level functions shall not require computer programming skills. MNS shall record changes to program functions, to be maintained in the control panel for a minimum of **[one year]** <Insert time>. The control panel shall maintain the ID of the supervisor making the change.
10. System operator level access functions:
 - a. Clear supervisory trouble alarms.
 - b. Revise programming.
 - c. Revise prerecorded messages.
 - d. Assign access rights to all levels.
 - e. MNS shall record changes at system operator level in the control panel, to be maintained for a minimum of one year. The control panel shall maintain the ID of the system operator making the change.
11. Each panel shall have supervisory functions for power failure, internal component failure, and operation.
12. MNS shall have a complete set of self-diagnostics for controller and appliance network, and local diagnostic information display, local diagnostic information, and system event log.
13. Printed records of changes, supervisory functions, message transmission, and operator actions shall be maintained for a minimum of one year.

2.04 NOTIFICATION COMPONENTS

A. Voice/Alarm Signaling Service:

1. One-way, multichannel voice notification system incorporating at least eight distinct sounds selectable by user for tone signaling and incorporating a voice module for delivery of prerecorded messages.
2. Redundant microphones, preamplifiers, amplifiers, and tone generators provided in separate main and remote cabinets.
3. Voice notification system shall support facility public address paging.
4. Audible appliances shall produce a code 3 temporal tone for three cycles followed by a voice message that is repeated until the control panel is reset or silenced.
5. Automatic messages shall be broadcast through speakers throughout the building or facility, but not in stairs or elevators.
6. When using microphones, live messages shall be broadcast throughout a selected floor or floors or all call, including stairs and elevators.
7. Live voice message shall override automatic or recorded audible output through use of a microphone input at the main control panel or the remote cabinet.
8. Number of alarm channels shall be indicated for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone.
 - a. Allow sending an evacuation signal to selected zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."

B. Audible Notification System: Comply with the requirements of NFPA 72 and ISO 7240-16 for Emergency Voice/Alarm Communications System, except where more stringent requirements are specified. Voice intelligibility shall be evaluated according to IEC 60268-16.

1. Amplifiers:

- a. Comply with UL 1711.
- b. Audio output shall be selectable for line level. Minimum amplifier output shall be 100 W rms.
- c. Capable of operating all speakers at the same time.
- d. Loss of operating power, supervisory power, or any other malfunction that could render the voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

2. Audible Notification Devices:

- a. Handheld push-to-talk microphone shall be supervised and a key shall be required to enable remote microphone use.
- b. Microprocessor shall actively integrate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of stored voice data into appropriate amplifier input.

C. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Indoor Speakers for Voice Notification:
 - a. Construction: High-efficiency, sealed back; for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz.
 - b. Standard: UL 1480.
 - c. Speaker Locations: Comply with NFPA 72, "Notification Appliances" and "Emergency Communications Systems" chapters.
 - d. High-Range Units: Rated 2 to 15 W.
 - e. Low-Range Units: Rated 1 to 2 W.
 - f. Matching Transformers: Tap range matched to acoustical environment of speaker location.

D. Text Displays:

1. Programmable, digital text displays having a minimum of 4-inch (100-mm) high letters for hearing-impaired occupants displaying the content of the voice message being played.
2. Capable of sending static, flashing, or scrolling messages to textual visible appliances.
3. Mass notification control panel shall interface with and control the programmable display controller to activate the proper message.
4. Textual visible notification shall be primary notification when it is the only method used to convey emergency MNS information to the general public or to specific individuals.

E. Visual Notification Appliances:

1. Strobes used in combination systems where the same strobe is used for both MNS and fire notification shall be clear or nominal white complying with UL 1971.
2. Strobes used for MNS shall be synchronized.

F. Web Interfaces:

1. Capable of utilizing dedicated or existing IP networks to send alert messages. System shall be able to communicate with multiple modalities to include but not limited to pop-up alerts on personal computers, text messages to cellular phones, email messaging to IP-

- capable computers or devices, and recorded voice messages to voice-over-IP (VoIP) telephones and PCs.
 - 2. Capable of activating, through a single interface, non-IP alerting systems such as wide-area alerting systems, fire alarm systems, PA systems, handheld radio systems, radio broadcast systems, personal pager systems, nurse call systems, and traditional dial-up telephone alerting systems.
 - 3. Capable of accessing user screens via multiple web browsers such as MS Explorer, Mozilla Firefox, or Apple Safari.
 - 4. Capable of sending live video stream from an IP-based camera or security camera system to any PC or video display.
- G. Primary Power:
- 1. 24-V dc obtained from 120-V ac service and a power-supply module.
 - a. Power supplies shall be sized to furnish a minimum of 125% of the total connected load in a worst-case condition.
 - 2. Devices Powered by 24-V dc:
 - a. Control panels.
 - b. Notification appliances.
 - c. Text displays.
 - d. Trouble signals.
 - e. Supervisory signals.
 - f. Supervisory and digital alarm communicator transmitters.
 - g. Digital alarm radio transmitters.
- H. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
- 1. Batteries: Sealed lead calcium.
 - 2. Batteries: Sealed, valve-regulated, recombinant lead acid.
 - 3. Batteries: Sealed lead calcium, valve-regulated, recombinant lead acid.
 - 4. Battery size shall be a minimum of 125% of the calculated requirement.
- I. Overvoltage and Surge Protection:
- 1. Signaling Line Circuit Surge Protection: Protected against surges induced on any signaling line circuit located outdoors, and complying with IEEE C62.41.1 and IEEE C62.41.2.
 - 2. Protect cables and conductors that serve as communications links with surge protection devices installed at each end that meet the following waveforms:
 - a. 10 by 1000 mic.sec. waveform with a peak of 1500 V and a peak current of 60 A.
 - b. 8 by 20 mic.sec. waveform with a peak of 1000 V and a peak current of 500 A. Protection shall be provided at the equipment. Additional surge protectors, rated for the application, shall be installed on each circuit within 36 inches (900 mm) of the cable entrance to the building.
 - c. Fuses shall not be used for surge protection.
 - 3. Sensor Wiring Surge Protection: Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring. The inputs and outputs shall be tested with the following waveforms:
 - a. 10 by 1000 mic.sec. waveform with a peak of 1500 V and a peak current of 60 A.

- b. 8 by 20 mic.sec. waveform with a peak of 1000 V and a peak current of 500 A.
- c. Fuses shall not be used for surge protection.

2.05 ACCESSORIES

- A. Operator's Console:
 - 1. Capable of initiating recorded messages and displays, and for delivering live voice messages.
 - 2. Capacity for at least eight pre-recorded messages and the ability to automatically repeat pre-recorded messages.
 - 3. Having a microphone for delivering live messages.
- B. LOC:
 - 1. LOC shall provide redundant control of the notification system control panel.
 - 2. When an installation has more than one LOC, they shall be programmed to allow only one LOC to be available for messaging at a time. Once one LOC becomes active, all other LOC will have an indication that the system is busy (Amber Busy Light) and cannot be used at that time.
 - 3. LOC shall be capable of being locked out or overridden from the Master Control Panel according to NFPA 72.
- C. Fire Alarm Interface: Adequate discrete outputs to temporarily deactivate the fire alarm audible notification appliances while delivering voice messages.

2.06 SOFTWARE

- A. Control Units and Control Panels: PC-based equipment that is field programmable for control, notification, and supervisory functions; menu-driven program configuration; is password protected.
- B. Operational Capability:
 - 1. Loading and editing instructions and operating sequences as necessary.
 - 2. Storing and downloading while the system is in operation.
 - 3. A second set of operating software shall reside in control panels as backup in case primary operating software is corrupted.
- C. Memory: Software operations shall be stored in a nonvolatile programmable memory within the MNS control unit. Loss of primary and secondary power shall not erase nonvolatile programmable memory.

2.07 SOURCE QUALITY CONTROL

- A. MNS will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas 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.

3.02 INSTALLATION

- A. Comply with installation requirements in NFPA 70, NFPA 72, and NECA 1.
- B. Install remote amplification and control units in terminal cabinets. Power each remote amplification and control unit from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote unit.
- C. Comply with requirements in Division 27 for cables and conductors for mass notification systems.
- D. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings and in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring is used.
 - 2. Comply with requirements for cable trays specified in Section 270536 "Cable Trays for Communications Systems."
 - 3. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- E. Do not install cable through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Secure and support cables at intervals not exceeding 30 inches (750 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- G. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Maintain separation of conductor types as recommended by manufacturer. Install lacing bars and distribution spools.
- H. 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.
- I. Cold-Weather Installation: Bring cable to room temperature before dereeling. The use of heat lamps is prohibited.
- J. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.
- K. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install MNS wiring in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker-microphone wiring and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

- L. 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. Route conductors to allow accessibility to equipment for adjustment and maintenance.
- M. Connections:
 - 1. Make all terminations on numbered terminal strips in terminal cabinets or equipment enclosures. No splices or butt joints will be accepted.
 - 2. Terminate all conductors; no cable shall contain unterminated elements.
 - 3. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
- N. Mount all devices and appliances to or in an approved electrical box.
- O. Install operating instruction placard on the interior of the mass notification control panel.
- P. Cybersecurity:
 - 1. Software:
 - a. Coordinate security requirements with IT department.
 - b. Ensure that latest stable software release is installed and properly operating.
 - c. Disable or change default passwords to password using a combination of upper-case and lower letters, numbers, and symbols at least 8 characters in length. Record passwords and turn over to party responsible for system operation and administration.
 - 2. Hardware:
 - a. Coordinate location and access requirements with IT department.
 - b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
 - c. Disable dual network connections.

3.03 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Connect to instrument ground system and isolate from power system and equipment grounding.

3.04 IDENTIFICATION

- A. Comply with requirements in Division 27.
- B. Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
- C. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.

- D. Install framed instructions in a location visible from mass notification control unit.

3.05 FIELD QUALITY CONTROL

- A. Prepare a written ATP for testing the MNS components and installation according to NFPA 72 and this Section. Demonstrate specified function of the system and verify the correct operation of all system components, circuits, and programming.
 - 1. Prepare a complete listing of device labels for alphanumeric annunciator displays prior to the ATP.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. Take resistance, current, and voltage readings as work progresses.
 - 2. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Section 270526 "Grounding and Bonding for Communications Systems."
 - 3. Verify that wiring for each device is terminated at the properly identified terminals.
 - 4. Test wiring runs for continuity, short circuits, and grounds before system is energized.
 - 5. All test equipment, instruments, tools, and labor required to conduct the system tests shall be made available by the installing Contractor. The following equipment shall be a minimum for conducting the tests:
 - a. Ladders and scaffolds as required to access all installed equipment.
 - b. Multi-meter for reading voltage, current, and resistance.
 - c. Two-way radios and flashlights.
 - d. Decibel meter.
 - e. In addition to the testing specified to be performed by the installing Contractor, the installation shall be subject to test by the Owner.
 - 6. Schedule tests with at least seven days' advance notice of test performance.
 - 7. After installing MNS and after electrical circuitry has been energized, test for compliance with requirements.
 - 8. Perform the following tests in 50 percent of all zones and rooms.
 - 9. Perform indoor sound tests in a single test location in rooms less than 20 ft. (6 m) by 20 ft. (6 m). Tests shall be made on a 20 ft. (6 m) by 20 ft. (6 m) grid for larger rooms.
 - 10. Sound test measurements shall be taken at a worst case location within each room or grid, not near any speaker.
 - 11. Operational Test: Perform tests that include originating messages at microphone outlets, prerecorded messages, cellular and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
 - 12. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
 - a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio.
 - b. Repeat test for each separately controlled zone of loudspeakers.
 - c. Minimum acceptance ratio is 50 dB.
 - 13. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier

- channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
14. Intelligibility Test: Test for intelligibility in accordance with ANSI/ASA S3.2.
 15. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies shall not exceed plus or minus 1 dB. Outdoor sound levels where personnel may be present shall not exceed 120 dB when measured on the A-scale of a standard sound level meter at slow response. Sound levels shall not exceed 85 dB at any local microphone of the MNS under the same conditions.
 16. System notification appliances shall be demonstrated as follows:
 - a. All alarm notification appliances actuate as programmed.
 - b. Audibility and visibility at required levels.
 17. System indications shall be demonstrated as follows:
 - a. Correct message display at MNS control panel for each alarm input.
 - b. Correct message display at remote panels and annunciators for each alarm input.
 - c. Correct history logging for all system activity.
 18. System off-site reporting functions shall be demonstrated as follows:
 - a. Correct zone transmitted for each alarm input.
 - b. Trouble signals received.
- D. MNS will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.06 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

3.07 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.
1. Conduct training on the installed equipment after acceptance testing.
 2. Train on system operation, including manual control of output functions from the system control panel.
 3. Train on testing of the system, including logging of system tests, field test of devices, and response to common troubles.

END OF SECTION

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SECTION 310220 EARTHWORK

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work includes all clearing, excavation, borrow, filling, backfilling and grading indicated on the Drawings and necessary for the proper completion of the project, including for pipes, structures, and pavement. Contractor shall review Geotechnical Report prepared by Soils Testing Company for site specific soils classifications, testing, compaction, and backfill requirements.

1.2 APPLICABLE CODES, STANDARDS, AND SPECIFICATIONS

- A. All work shall be performed in accordance with Florida Department of Transportation standards, specifications and indexes and in accordance with other state and local requirements.
- B. Current editions or revisions of the following specifications and standards will apply unless specifically noted otherwise herein or on the Drawings.

1. American Society for Testing and Materials (ASTM) Standard

ASTM C 33-85 Concrete Aggregate

ASTM D 698-78 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb. (2.49 Kg) Rammer and 12 in. (304.8 mm) Drop. Standard Proctor.

ASTM D 1556-82 Test Methods for Density of Soil in Place by the Sand-Cone Method.

ASTM D 1557-78 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. (45 Kg) Rammer 2 and 18 in. (457 mm) Drop. Modified Proctor.

ASTM D 2487-83 Classification of Soil for Engineering Purposes

ASTM D 2922-76 Density of Soil and Soil-Aggregate in place by Nuclear Methods (Shallow Depth)

ASTM D 3017-78 Moisture Content of Soil and Soil-Aggregate in place by Nuclear Methods (Shallow Depth)

2. American Association of State Highway and Transportation Officials (AASHTO) Standards

AASHTO T-99 Standard Proctor

AASHTO T-180 Modified Proctor

1.3 SUBMITTALS

- A. Contractor shall have reports submitted to the Engineer as required in the testing portion of this Section.

1.5 SITE CONDITIONS

A. Character of Excavation Material: Prior to submitting his bid, the Contractor shall satisfy himself as to the character and amount of different soil materials, groundwater and the subsurface conditions to be encountered in the work to be performed. Information and data, when furnished, are for the Contractor's general information. However, it is expressly understood that any interpretation or conclusion drawn there from is totally the responsibility of the Contractor.

- B. Subsurface Investigation: If subsurface information is included as an appendix of these specifications it is the results of soil borings and soil classification and testing made at the exact locations only. While the soil borings and information are representative of

subsurface conditions at their respective exact locations, local variations in soils and groundwater will be encountered.

- C. Existing Underground Facilities: Underground structures and utilities shown on the drawings are located according to the best available records. However, it shall be the Contractor's responsibility to acquaint himself with all information, and to accurately locate and uncover all underground structures and utilities along the line of work in order to avoid conflicts with existing facilities. Underground utilities shall be located by the Contractor far enough in advance of the trench or site excavation and pipe laying operations to assure ample opportunity to make the necessary adjustments to avoid conflicts. The Owner shall not be held accountable for inaccuracies or omissions in the locations or grade of facilities of this type.
- D. Conflicts: Where actual conflicts are unavoidable, work shall be performed so as to cause as little interference as possible with the service rendered by the facility disturbed. The Owner may require the Contractor to work in off hours (i.e. 1:00am or Holidays) in order to minimize disturbance. Facilities or structures damaged in the prosecution of the work shall be repaired immediately in conformance with the best standard practices or according to the direction of the owner of such facility, to the extent required, including replacement, at no cost to the Owner.

PART 2 - MATERIALS AND EQUIPMENT

2.1 BACKFILL

- A. The following shall define the terms used in the plans and specifications.
 - 1. Topsoil - shall be the upper most layer of soil usually dark in color and approximately 6 inches thick, rich in organic matter.
 - 2. Gravel Bedding - Gravel bedding shall consist of well-graded crushed stone or crushed gravel meeting the requirements of ASTM Designation C-33, Graduation 67 (3/4-inches to No. 4). Air cooled blast furnace slag, alone or in combination with crushed stone and/or crushed gravel, conforming to ASTM C-33 requirements may also be used.
 - 3. Select Backfill - shall be a select granular material free from organic matter and of such size and gradation that desired compaction can be readily attained. Select backfill is defined as those complying with AASHTO soil classification Groups A-1 and A-3 having a maximum size not to exceed 3 inches with at least 95% passing the 1 1/2 inch sieve and not more than 15% passing the No. 200 sieve with a coefficient of uniformity of six or greater. The liquid limit shall be less than 15. In most situations the existing backfill will not meet these requirements, therefore, select backfill is material which must be transported to the site from an approved borrow pit.
 - 4. Suitable or Common Backfill - shall be a satisfactory soil material free from organic matter, muck, marl and rock exceeding 3 inches in diameter. At least 95% shall pass the 1 1/2 inch sieve. Common backfill shall comply with AASHTO soil classification Groups of A-2-5, A-2-6, A-2-7, A-4, A-5, A-6, and A-7 providing that the liquid limit shall be less than 35. Suitable backfill is usually considered on site material that meets these requirements.
 - 5. Existing or Unsatisfactory Backfill - shall be material obtained from the Contractor's excavations to be used in areas not requiring specific compaction densities. This material shall not be used for pipe bedding nor under streets, street shoulders, or structures. Such backfill shall be free of debris, deleterious materials and shall contain no material larger than 6 inches. Under no conditions are destroyed pavement materials, curbs, broken concrete, etc., to be included in the backfill.
 - 6. Concrete Encasement - shall be of portland cement type with a compressive strength at 28 days of 2500 psi.

7. Clean Sand - shall be a quartz material with less than 5 percent of the soil particles finer than the No. 200 mesh sieve, a uniformity coefficient greater than 1.5 and an effective grain size of 0.20 to 0.55 millimeters in diameter. Clean sand is required for filter material requiring good permeability.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Safety

1. In the Contractor's use of streets and highway for the work to be done under these Specifications he shall conform to all City, State, and local laws and regulations. The Contractor shall provide, erect, and maintain effective barricades, danger signals, and signs on all intercepted streets or highways for protection of the work and safety of the public rights-of-ways shall be provided with lights which shall be kept burning at all times between sunset and sunrise. The Contractor shall be responsible for all damages resulting from any neglect or failure to meet these requirements. Where conditions require the presence of a watchman to fulfill the requirements stated herein, same shall be furnished without extra cost to the Owner.
 - a. Access to Fire hydrants shall be maintained at all times. Do not block or barricade with spoil, materials or equipment for any period of time.

B. Maintenance of Service

1. The Contractor shall arrange his work to cause minimum disturbance of normal pedestrian and vehicular traffic and will be held responsible for providing suitable means of access to all public and private properties during all stages of the construction. Should the construction work require repairs, changes or modifications of other utilities, it shall be the responsibility of the Contractor to provide for the maintenance of continuous water, electric, telephone, and gas as well as sewage and other utility services to all present customers of such utilities, unless approval in writing is secured from the utility company for interruption of such service. A minimum of one lane of traffic shall be maintained at all times. Contractor shall keep all disturbed roads graded smooth and passable. If the road becomes impassable, the Contractor shall stabilize with dry, select backfill. The Owner may require the Contractor to work in off hours (i.e. 1:00am or Holidays) in order to minimize disturbance.

C. Limits of Construction

1. In locations where the work is to be installed in streets or road rights-of-way the activities of the Contractor shall be confined to these public properties. Where the use of private property is deemed necessary by the Contractor to facilitate construction work arrangement for such use with the property owner shall be the responsibility of the Contractor. The Contractor shall save the Owner harmless from all claims by adjacent property owners for trespassing or damage due to the activities of the Contractor in the prosecution of the work.

D. Existing Utilities

1. The Contract Documents contain data relative to existing public utility installations and structures above and below the ground surface. These data are not guaranteed as to their completeness or accuracy and it is the responsibility of the Contractor to make his own investigations to inform himself fully of the character, condition and extent of all such installations and structures as may be encountered and as may affect the construction operations.
2. All existing improvements such as pavements, conduit, poles, pipes, overhead wires and other structures, shall be carefully supported and fully protected from injury. The Contractor shall be responsible for damages to these existing utilities

and shall, in case they are damaged, restore them to their original condition at no cost to the Owner.

3. Contractor shall give written notice to the Owner and other governmental utility departments and other owners of public utilities of the location of his proposed construction operations, at least forty-eight hours in advance of breaking ground in any area or on any unit of work. This can be accomplished by making the appropriate contact with the utility companies listed on Sheet 2 of the Construction Drawings.

E. Property Protection

1. Trees, fences, poles, and all other property shall be protected unless their removal is authorized; and any property damaged shall be satisfactorily restored by the Contractor at the Contractor's expense to a condition equal to or better than that existing prior to beginning the work.

3.2 **CLEARING AND GRUBBING**

- A. On all areas within limits of clearing and grubbing indicated on the Drawings or specified where earthwork is to be done, all timber, brush, stumps, roots, rubbish, and unsuitable material shall be removed to a depth of not less than one foot below the ground surface. Sound trees and shrubs which do not interfere with the construction and are elsewhere indicated or directed not to be removed, shall be protected properly from damage. The surface shall be plowed to a depth of not less than six (6) inches and all stumps, roots and other perishable matter thus exposed shall be removed to a depth of not less than one foot. Any deposits of muck, peat, bark or trash occurring within the limits of clearing and grubbing or where directed by the Engineer shall be removed to their full depth and backfilled with suitable backfill as specified herein. Material removed during clearing and grubbing shall be hauled to the County landfill in accordance with local laws and regulations. Landfill fees shall be paid by the Contractor. All shrubbery, ornamental trees and other such plantings including those within construction area shall be fully protected. If it becomes necessary to remove any grass, shrubbery or planting to accomplish the work, it shall be satisfactorily replaced before the work will be accepted. All areas disturbed during construction shall be restored to a condition equal to or better than that existing prior to beginning the work.
- B. Trees and shrubs selected for preservation shall have their root systems protected from construction traffic, surface storage of materials, and any type of land disturbance within the drip line of the tree or shrub. The drip line of a tree or shrub is the outer outline of the tree crown where it intercepts the ground. Barricade all trees or tree groups which are selected for preservation if the possibility of root damage, surface soil disturbance within the drip line, soil compaction, or impact with construction equipment is prevalent. Barricading shall consist of continuous wood fencing constructed to the outline of the tree crown and shall be sturdy, highly visible and shall be maintained during the construction.

3.3 **EROSION AND FLOODING CONTROL**

- A. During construction operations, the Contractor shall install and maintain temporary erosion and flooding control features to the extent necessary to prevent pollution of streams and lakes, detrimental effects on public or private property adjacent to the construction or damage to work on the Project. Additional erosion control devices may be requested by the Engineer to protect the property described above. This shall be done immediately when directed by Engineer at no additional cost to the Owner.
- B. The Contractor shall attempt to limit the surface areas of erodible earth exposed by clearing and grubbing, excavation or filling operations.
- C. Temporary features may include, but not be limited to silt fences, temporary grassing, sodding, mulching, sandbagging, slope drains, sediment basins, sediment checks,

artificial coverings or berms. All City, County, State and Federal ordinances will be complied with.

- D. The contractor shall comply with The Florida Development Manual -- A Guide to Sound Land and Water Management, Department of Environmental Regulation -- Stormwater Management Practices.

3.4 DUST CONTROL

- A. If, in the opinion of the Owner or the Engineer, it is necessary to control dust during construction period, the Contractor shall furnish and spread water or calcium chloride at points where dust is a nuisance, or as directed by the Engineer, at no additional cost to the Owner.

3.5 PAVEMENT AND SIDEWALK REMOVAL AND REPLACEMENT

- A. Pavement and sidewalk shall be removed and replaced as follows unless shown otherwise on the Drawings.
- B. Pavement, which is to be removed for open-cut trenching, shall be cut vertically with a power-driven friction saw prior to removal. The surface shall be scored to sufficient depth to provide uniform, straight break lines. All removal of pavement shall conform to local, County, State or Federal requirements where applicable. Under no condition shall pavement be cut with a trenching machine, power shovel or backhoe. Width of cut of pavement or sidewalk shall be two feet wider than top of trench, one foot on each side of trench. In the event that trench excavation becomes wider than initial cut, pavement or sidewalk shall be recut to at least one foot back from all edges of actual excavation by the Contractor at his own expense.
 - 1. All cut lines shall be parallel to or at right angles to the longitudinal axis of the pipeline.
- C. Pavement, driveway or sidewalk material shall be separated from other excavated materials and shall not be placed in backfill but shall be satisfactorily disposed of by the Contractor. Base materials may be salvaged and stockpiled for reuse, but such reuse of base materials shall be subject to the review of the Engineer.
- D. All pavement and sidewalk removed shall be replaced with base and surface materials which conform as closely as possible in thickness and quality to materials removed. Minimum pavement and pavement base replacement shall consist of 1 1/2 inch of Type S-1 asphaltic concrete surface with a 6-inch limerock base (LBR 100 compacted to 98% Modified Proctor). All painted street markings and other traffic control devices shall be restored to former conditions. Use Safety Coatings Co. Roadrunner Traffic marking paint, or approved equal, and Ferro Co. glass spheres or approved equal. Pavement with traffic control devices and sidewalks shall be replaced as soon as practicable after compaction of backfill. Replacement pavement shall be tapered at curb.
- E. Workmanship and materials shall be in accordance with best standard practice for work of this type, and shall conform to the requirements of Section 330-12, Surface Requirements of Florida Department of Transportation Road and Bridge Manual.
- F. All necessary barricades, detours, lights and other protective measures shall be provided for protection of both pedestrians and vehicular traffic and shall conform to Florida DOT specifications where no local agency has specifications.

3.6 STATE HIGHWAY AND RAILROAD RIGHTS-OF-WAY

- A. Pipe crossings and installations along all railroads and State highways shall be in accordance with the applicable portions of American Railroad Engineers Association (AREA) Specifications for "Pipeline Crossing under Railroad Tracks for Non-Flammable Substances" or Florida DOT "Utility Accommodation Guide" and with details shown on

the drawings. Verify the existence of a formal permit to work on the right-of-way at each specific location prior to any work at that site and notify the owner of the right-of-way as required by that permit. Furnish the Engineer and the Owner with a copy of any separate certificate of insurance that is required by the owner of the right-of-way.

3.7 CURB AND GUTTER REMOVAL REPLACEMENT

- A. Curb or curb and gutter removal, where required in construction of this work, shall be held to a minimum. Curb and gutter material to be removed shall be carefully separated from trench excavation material and shall be satisfactorily disposed of by the Contractor.
- B. The Contractor shall replace all curb or curb and gutter which has been removed. Curb or curb and gutter shall be replaced as soon as possible after backfill is placed and compacted and shall be a duplicate in all respects to original construction. Workmanship shall be in accordance with the controlling agency (City, County, State).

3.8 RESTORATION OF ROADWAY CROSSINGS AND DRIVEWAY CROSSINGS

- A. Clay, marl, shell or similar roadways and driveways that are crossed or traversed by trenches shall be restored to existing conditions prior to excavation. The Contractor may reclaim existing material, or he may furnish and compact new material. There will be no additional compensation for this type of restoration unless specifically called for in the Special Provisions or on the Bid Proposal.
- B. Final and complete restoration of crossings in existing public roadways shall be completed not more than 24 hours subsequent to the final lift of the backfill.

3.9 EXCAVATION

A. General

- 1. Excavation shall be performed in accordance with all State, County and local regulations. Blasting will not be permitted except by written approval of the Engineer for each specific location where it is to be performed. Excavation shall conform to the dimensions indicated or specified for the pipeline or structure and topography and subgrade conditions encountered.
- 2. The Contractor shall notify the Engineer in due time to permit him to inspect completed excavations, and no pipes or concrete shall be placed in excavations or upon subgrades until they have been approved by the Engineer.
- 3. In areas where excavation may endanger existing structures, roads or utilities, Contractor will provide suitable support to these existing facilities so as to insure that damage will not occur. Contractor shall submit proposed method of support of these facilities to the Engineer for approval. The Contractor shall obtain written approval from the facility concerned before proceeding with any construction which might undermine or endanger existing facilities.

B. Control of Water

- 1. Furnish, install and operate all necessary machinery, appliances and equipment to keep excavations free from water during construction. Dewater and dispose of water so as not to cause injury to public or private property or to cause a nuisance or a menace to the public. The Contractor shall at all times have on-hand sufficient pumping equipment and machinery in good working condition for all ordinary emergencies and shall have available at all times competent workmen for operation of pumping equipment. Dewatering systems shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written approval from the Engineer.
- 2. Control of ground water shall be such that softening of the bottom of excavations or formation of "quick" conditions or "boils" shall be prevented. Dewatering

systems shall be designed and operated so as to prevent removal of natural soils.

3. Static water level shall be drawn and maintained one-foot below bottom of excavation so as to maintain undisturbed state of natural soils and allow placement of backfill to required density. Dewatering system shall be installed and operated so that ground water level outside excavation is not reduced to extent that would damage or endanger adjacent structures or property.
4. Release of ground water to its natural static level shall be performed in a manner so as to maintain undisturbed state of natural foundation soils, prevent disturbance of compacted fill or backfill and prevent flotation or movement of all structures and pipelines.
5. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

C. Shoring, Sheet piling and Bracing

1. Excavations shall be shored and sheeted in accordance with requirements of the Department of Labor Occupational Safety and Health Administration (OSHA) with members of sizes and arrangement sufficient to prevent injury to persons, damage to structures, injurious caving, or erosion. They shall be designed, furnished, placed, maintained and removed by the Contractor. Sheet piling and shoring design shall be submitted to the Engineers as a shop drawing prior to installation and shall bear the seal of a structured engineer registered in the State of the job site.
2. Design, planning, installation and removal of all sheet piling, shoring, sheet piling and bracing shall be accomplished in a manner so as to maintain required trench or excavated section with an undisturbed state of soils at and below excavation bottom.
3. Sheet piling and timbers used in trench excavations shall be withdrawn in such a manner so as to prevent subsequent settlement or misalignment of pipe or additional backfill loadings which might overload pipe. Where, in the opinion of the Engineer, removal of sheet piling and shoring will or may cause damage to the work or to adjacent buildings, utilities or property, the Engineer may direct Contractor to leave all or a portion of sheet piling and shoring in place. Sheet piling and shoring shall also be provided as necessary to keep excavations within the available right-of-way.
4. The right of the Engineer to order sheet piling and bracing left in place shall not be construed as creating any obligation on his part to issue orders, and his failure to exercise his right to do so shall not relieve the Contractor from liability for damages to persons or property occurring from or upon the work occasioned by negligence or otherwise growing out of a failure on the part of the Contractor to leave in place sufficient sheet piling and bracing to prevent any caving or moving of the ground.

D. Excavation for Pipe System

1. Common Excavation

- a. Machine excavation shall be carried to a depth above final pipeline grade that will allow final grading using hand tools, as indicated on the Plans. Care shall be taken to not excavate below required depth. If excavations is carried below required depth, overcut depth shall be backfilled with select backfill material or gravel bedding material furnished at Contractor's expense and compacted to provide pipe support at least equal to that of original material.

- b. Contractor may, at his option, elect to overcut trench and backfill with select backfill or bedding material. If Contractor so elects, depth of overcut shall be such that a minimum of two inches of compacted backfill material will result under lowest projection of pipe bell. No additional payment will be made for this overcut or for furnishing and placing of the required backfill material.
- c. The Contractor shall exercise sound construction practices in excavating trench and maintaining it so no damage will occur to any foundation structure, pole line, pipeline or other facility because of slough of slopes or from any other cause. If, as a result of excavation, there is a disturbance of ground that endangers other property, the Contractor shall immediately take remedial action at his own expense. No act of the Owner or his representatives shall in any way affect liability of the Contractor for damages, expenses or costs that may result from trench excavation.
- d. Trees, stumps and roots within limits of trench excavation shall be removed to a depth of at least 12 inches below bottom of trench.

2. Trench Requirements

- a. Width of trench banks from bottom to 12 inches above top of pipe shall not exceed 18 inches nor be less than 12 inches on each side of the pipe with the exception of pre-assembled pressure pipe in non-paved areas for which the minimum trench width shall be pipe diameter plus 1 inch on each side of the pipe.
- b. Trenches for gravity sewers shall be of such depth that the invert of pipe will be at elevations shown on the plans, or as may be determined by the Engineer. Trenches shall provide a minimum cover of 36 inches for water mains and 48 inches for sewage force mains over barrel of pipe, except as otherwise shown. Greater depth may be required to accommodate appurtenances or avoid obstruction.
- c. Excavation for appurtenances shall be made to a size that will allow at least 12 inches between their outer surfaces and embankment or shoring.
- d. The trench shall be dry when the bottom is prepared. A continuous trough shall be excavated by hand to receive the bottom 120 degrees of the pipe barrel. In addition, bell holes shall be excavated so that only the barrel of the pipe receives bearing pressure from, and is uniformly supported by, the bottom of trench. Preparation of trench bottom and placement of pipe shall be such that final position of pipe is true to line and grade and uniformly supported throughout barrel of each pipe length. When pipe is placed in select backfill over rock or other over depth, additional backfill of same material shall be tamped on each side of barrel to height of spring line, thus forming a trough of firm, compacted bedding.

3. Pipe Interferes and Encasements

- a. In no case shall there be less than 4 inches between any two pipelines or between pipelines and structures. Pipe deflections shall be performed in accordance with the plans and as contained herein. Wherever there is more than 4 inches but less than 18 inches clearance between sewers, sewer house laterals, force mains and water mains or water services, then a concrete encasement shall be provided for a distance of 10 feet on each side of the obstruction pipe. Wherever there is more than 4

inches but less than 1.0 foot clearance between any two pipe lines, other than water or sewer, or between pipe lines and structures, then a concrete encasement shall be provided for a distance of 3 feet on each side of the obstruction pipe.

- b. The Engineer shall have full authority to direct the placement of the various pipes and structures in order to facilitate construction, expedite completion and to avoid conflicts.

E. Excavation for Structures

1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection, or as shown on the Drawings.
2. In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive concrete.
3. In areas underlain by expansive clay, undercutting or excavation of clay pockets will be required beneath footings and slab areas as may be shown on the drawings and directed by the Engineer. Post-hole diggers may be used to determine the depth to the clay materials in all of the footing bottoms. Heavy clay that is encountered within a zone that is four (4) feet below the bottom of any footing or floor slab should be undercut and replaced with suitable or common backfill material. The width of undercutting in the footing should extend at least four (4) feet beyond the edge of the footing or slab to provide a non-expansive water barrier above the clay. Other clay pockets discovered during construction may also require complete removal upon the recommendation of the geotechnical engineer.

F. Unsuitable Material

1. Unsuitable materials are soils exposed at the bottom of excavations that are compressible, expansive, contain extraneous rubble, or offer uneven foundation support. Unsuitable materials/soils will include, but not be limited to, mulch, peat, expansive clays, boulders, rubble, any portion of trees or similar vegetation, wood, or unyielding material such as rock.
2. The Contractor shall notify the Engineer immediately when unsuitable material is encountered. The Engineer will investigate questionable material to determine its suitability. Should the Engineer require soils testing be performed to aid in his determination, then tests revealing suitable materials shall be paid for by the Contractor.
3. Where the Engineer determines that unsuitable material is present below the excavation which will not provide adequate support the Contractor shall remove the unsuitable material as directed by the Engineer and replace the unsuitable material with Select backfill. Prior to the excavation of any unsuitable material, written approval must be obtained from the Engineer. The approval shall state the linear feet of excavation. No payment shall be made for the removal of any unsuitable bedding material if prior approval is not obtained.

3.10 BACKFILL AND COMPACTION FOR PIPES

A. General

1. Contractor shall not perform any backfilling operation other than that necessary to hold pipe in place until the locations of connections and appurtenances have been recorded on the "as-built" drawings and the line has been inspected and released for backfilling. Backfill and compaction shall be performed as specified herein and as shown on the drawings. Backfilling of trenches shall progress as rapidly as the construction, testing and acceptance of work permits. In areas subject to traffic temporary backfill or base material is required to provide a smooth stable driving surface until final base and/or pavement can be constructed.
- B. Haunching and Initial Backfill
 1. After pipe has been properly laid and inspected backfill shall be carefully placed and compacted around the pipe in loose horizontal layers not exceeding 6 inches loose depth, equally on both sides of pipe and shall be spaded (walked in) and compacted with hand tampers to obtain the required density. This shall continue to a level of one foot above the top of the pipe.
- C. Subsequent Backfill
 1. Above the level of initial backfill, the trench shall be filled in horizontal layers and mechanically compacted to the density required up to 3 feet below the base of pavement or structures, up to 6 inches in areas to receive topsoil, seeding, or soiling and up to final grade in non-paved streets.
- D. Backfill and Compaction Requirements for Pipe (unless shown differently on the plans)
 1. Paved Areas
 - a. Initial - Select backfill in 6" lifts at 98%.
 - b. Subsequent - Select backfill in 8" lifts at 98%.
 - c. Top 3 feet below road base - Select backfill in 6" lifts at 98%.
 2. Unpaved Street and Street Shoulder Areas
 - a. Initial - Suitable backfill in 6" lifts at 95%.
 - b. Subsequent - Suitable backfill in 8" lifts at 95%.
 3. Off Street Areas
 - a. Initial - Suitable backfill in 6" lifts at 95%.
 - b. Subsequent - Unsuitable or existing backfill in 18" lifts compact till firm.

NOTE: Density listed are maximum dry density in accordance with AASHTO T-180 Modified Proctor Density.

3.11 BACKFILL AND COMPACTION FOR STRUCTURES

- A. For the area under the structure and within a 2 foot of the perimeter, compact the top 12 inches of subgrade and each 6 inch layer of select backfill or fill material to 98% Modified Proctor density.

3.12 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil to not less than the following percentages of maximum dry unit density in accordance with AASHTO T-180 Modified Proctor density:
Initial - Suitable backfill in 6" lifts at 95%.
Subsequent - Suitable backfill in 8" lifts at 95%.

3.13 GRADING

- A. Grading shall be performed at such places as are indicated on the drawings, to the lines, grades, and elevations shown or as directed by the Engineer and shall be made in such a manner that the requirements for formation of embankments can be followed. All unacceptable material encountered, of whatever nature within the limits indicated, shall be removed and disposed of as directed. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.
- B. Grade all areas as indicated. Fill shall be brought to finish grades shown and shall be graded to drain water away from structures.
- C. Overall area grading for which no grades are indicated within the limits of construction and outer limits of clearing and grubbing, all holes and other depressions shall be filled, all mounds and ridges cut down and the area brought to sufficiently uniform contour that the Owner's subsequent mowing operations will not be hindered by irregular terrain. This work shall be done regardless of whether the irregularities were the result of the Contractor's operations or originally existed. Permanent ponds or other permanent water areas, as so designated by the Engineer, will not be required to be filled.

3.14 TESTING

A. General

- 1. Contractor shall comply and pay for the services of an independent testing laboratory in accordance with Section 01 40 00 "Testing and Laboratory Services" to perform testing specifically indicated herein.
- 2. Exact location of the test shall be selected by the Engineer or his representative. If the Engineer, after being notified by the Contractor, is unable to be present during the test, the laboratory personnel shall randomly select testing locations that are representative of the work being tested. All cost of this testing and providing of certificates shall be a subsidiary obligation of the Contractor with the cost included in the item for which the testing is associated.
- 3. The minimum testing rate shall not prevent the Contractor nor the testing laboratory from performing additional testing to insure the construction is in accordance with the plans and specifications.
- 4. A minimum of two (2) copies of reports of test results of all maximum dry density and optimum moisture content determinations and all in-place density tests shall be submitted to the Engineer. Reports must be signed by a registered Professional Engineer.
- 5. The Contractor shall repair all test holes and borings resulting from the testing and retesting of his work at no cost to the Owner. Any areas failing to pass the tests as called for, and interpreted by the Engineer, shall immediately be brought into conformance with these Specifications at the Contractor's expense.

B. Minimum Schedule of Test Required

- 1. Determination of the soil classification for each type of soil material used to determine its suitability for use as defined herein and in accordance with the AA-SHTO or Unified Soil Classification System.
- 2. Determination of maximum dry density and optimum moisture content for each type of soil to be compacted to a specified density. At least one determination will be made for each soil used. Tests shall be performed in accordance with the appropriate ASTM or AASHTO Standards.

3. In-place (insitu) density test shall be made in accordance with ASTM and AASHTO Standards and shall be made at a frequency to assure contract requirements are met but in no case less than the following:
 - a. Pipeline backfill at the rate of one test for each 50 linear feet of trenchline for each backfill lift. A backfill lift shall never be considered to be greater than one foot in thickness. In unpaved areas, testing rate by be reduced to one test for each 150 lineal feet of trenchline for each backfill lift.
 - b. Structure backfill at the rate of one test for each 2000 square feet for each backfill lift (maximum lift of 12 inches).
 - c. Pavement, sidewalk and curb backfill at the rate of one test for each 50 lineal feet of street for each backfill lift (maximum lift of 12 inches).

3.15 MAINTENANCE

- A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

END OF SECTION 310220

SECTION 311000 SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Materials Ownership: Except for materials indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.
- B. Traffic: Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earthwork."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site. Materials to be obtained from approved site with required permits. Material test will be supplied to Owner prior to placement of materials.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Locate and clearly flag trees and vegetation to remain or to be relocated.
- B. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.
- C. Protect adjacent property from damage during construction.

3.2 TREE PROTECTION

- A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
 - 1. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
- B. Do not excavate within drip line of trees, unless otherwise indicated.
- C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Owner's Representative.

3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted. Arrange to provide temporary utility services.
 - 1. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
- B. Fill depressions with satisfactory soil material. Place fill material in horizontal layers not exceeding 8-inch loose depth and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. If available, refer to owner's geotechnical report for estimated depths and extent of topsoil on-site.
- D. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.7 DISPOSAL

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property. Owner to be notified of disposal site.

PART 4 - SCHEDULE

4.1 SUBMITTAL

- A. Existing Conditions/Demolition Plan
 - 1. Indicate construction limits, trees to be protected, underground and aboveground utilities.
 - 2. Demolition scheme
 - 3. Spoils area should be indicated.
 - 4. On-site benchmark should be shown.

END OF SECTION 311000

SECTION 312300 EXCAVATION AND FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes temporary excavation support and protection systems.
- B. Related Sections include the following:
 - 1. Section "Dewatering" for dewatering excavations.
 - 2. Section "Earthwork" for excavating and backfilling and for existing utilities.

1.3 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
 - 1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.

1.4 SUBMITTALS

- A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.
 - 1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: For Installer and professional engineer.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 - 2. The geotechnical report is referenced elsewhere in the Project Manual.

- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 4 inches (100 mm).
- E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER BEAMS AND LAGGING

- A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier beams as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

- C. Install wales horizontally at centers indicated and secure to soldier beams.

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to **60 inches (1500 mm)**. Accurately align exposed faces of sheet piling to vary not more than **2 inches (50 mm)** from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Tiebacks: Drill for, install, grout, and tension tiebacks into position. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
 - 2. Maintain tiebacks in place until permanent construction can withstand lateral earth and hydrostatic pressures.

3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by Architect.
 - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - 1. Remove excavation support and protection systems to a minimum depth of **48 inches (1200 mm)** below overlying construction and abandon remainder.
 - 2. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place.

END OF SECTION

SECTION 320251
CONCRETE CURBS, CURBS AND GUTTERS, AND SIDEWALKS

PART 1 – GENERAL

1.1 SCOPE OF WORK

This Section includes all labor, materials, transportation and equipment necessary to properly perform all work specified here, indicated on the Drawings, or reasonably implied to complete the construction. Included as a part of the work of this Section, but not necessarily limited by it, are curbs, curbs and gutters and sidewalks.

1.2 REFERENCED SPECIFICATIONS

A. All materials and methods of construction shall conform to the requirements of the "Florida Department of Transportation, Standard Specifications for Road and Bridge Construction" therein.

B. Section 310220 - Earthwork

PART 2 - MATERIALS

2.1 CONCRETE

Curbs, curbs and gutters shall be Class I concrete as required in Section 346 of the FDOT Standard Specifications. Concrete for retaining walls shall be Class II as specified therein.

2.2 REINFORCEMENT

Any steel reinforcement shall conform to the requirements of Section 415 of the FDOT Standard Specifications.

2.3 JOINT MATERIALS

Joint materials shall be in accordance with Section 932-1, FDOT Standard Specifications.

PART 3 - EXECUTION

3.1 CURBS AND CURBS AND GUTTERS

Curbs and curbs and gutters shall be formed, excavated for, placed, constructed jointed, finished, cured and backfilled, and the concrete tested in accordance with Section 520 of the FDOT Standard Specifications.

3.2 SIDEWALKS

Sidewalks shall be formed, excavated for, placed, jointed, finished and cured in accordance with Section 522 of the FDOT Standard Specifications.

3.3 MACHINE PLACEMENT

Curbs, curbs and gutters, and sidewalks may be placed by machines at the Contractor's option. The finished product shall be true to line, grade and cross-section as shown on the Drawings.

Notwithstanding Sections 520 and 522 of the FDOT Standard Specifications, the following shall apply to items placed by machines.

Contraction joints shall be sawed. Joints shall be sawed as soon as the concrete has hardened sufficient that raveling will not occur and within 24 hours of placement. Sawing shall be with mechanically driven carborundum or diamond saws. The depth of cut shall not be less than 2 inches.

Construction joints shall be sawed. The time element for sawing shall be as set forth above. Construction joints occur at the beginnings and ends of runs by machine placement. Saw cuts shall be made the full height of vertical faces before the wasted material is removed.

END OF SECTION

SECTION 321273 PAVEMENT JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Expansion and contraction joints within portland cement concrete pavement.
 - 2. Joints between portland cement concrete and asphalt pavement.
- B. Related Sections include the following:
 - 1. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
 - 2. Division 32 Section "Portland Cement Concrete Paving" for constructing joints in concrete paving.
 - 3. Division 32 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in **1/2-inch** wide joints formed between two **6-inch** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Compatibility and Adhesion Test Reports: From joint sealant manufacturer indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backer materials have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Product Test Reports: From a qualified testing agency indicating joint sealants comply with requirements, based on comprehensive testing of current product formulations.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency, based on testing current sealant formulations within a 36-month period.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
 - 2. Test joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
- D. Preconstruction Compatibility and Adhesion Testing: Submit to joint sealant manufacturer, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - a. Perform tests under environmental conditions replicating those that will exist during installation.
 - 2. Submit not fewer than nine pieces of each type of material, including joint substrates, joint-sealant backer materials, secondary seals, and miscellaneous material.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
 - 5. Testing will not be required if joint sealant manufacturer submits joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.

2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.
 3. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than that allowed by joint sealant manufacturer for application indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: Match Architect's samples.
- C. Colors of Exposed Joint Sealants: As indicated by referencing manufacturer's designations.
- D. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range for this characteristic.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent Jet-Fuel-Resistant Sealant for Concrete: Pourable, chemically curing elastomeric formulation complying with the following requirements for formulation and with ASTM C 920 for type, grade, class, and uses indicated:
1. Urethane Formulation: Type M; Grade P; Class 12-1/2; Uses T, M, and, as applicable to joint substrates indicated, O.
 2. Coal-Tar-Modified Polymer Formulation: Type M; Grade P; Class 25; Uses T and, as applicable to joint substrates indicated, O.
 3. Bitumen-Modified Urethane Formulation: Type M; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
- B. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete: Single-component, pourable, coal-tar-modified, urethane formulation complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
- C. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
- D. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.

- E. Multicomponent Low-Modulus Sealant for Concrete and Asphalt: Proprietary formulation consisting of reactive petropolymer and activator components producing a pourable, self-leveling sealant.
- F. Available Products: Subject to compliance with requirements, cold-applied joint sealants that may be incorporated into the Work include, but are not limited to, the following:
- G. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Multicomponent Jet-Fuel-Resistant Sealant for Concrete:
 - a. Vulkem 202; Mameco International.
 - b. SEALTIGHT GARDOX; W.R. Meadows, Inc.
 - c. Urexpam NR-300; Pecora Corporation.
 - d. Sonomeric 2; Sonneborn Building Products Div., ChemRex, Inc.
 - 2. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete:
 - a. Vulkem 200; Mameco International.
 - b. Sonomeric 1; Sonneborn Building Products Div., ChemRex, Inc.
 - 3. Type NS Silicone Sealant for Concrete:
 - a. Roadsaver Silicone-SL; Crafcro Inc.
 - b. 888; Dow Corning.
 - 4. Type SL Silicone Sealant for Concrete and Asphalt:
 - a. 890-SL; Dow Corning.
 - 5. Multicomponent Low-Modulus Sealant for Concrete and Asphalt:
 - a. SOF-SEAL; W.R. Meadows, Inc.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Jet-Fuel-Resistant Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3569.
- B. Jet-Fuel-Resistant Sealant for Concrete and Tar Concrete: Single-component formulation complying with ASTM D 3581.
- C. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
- D. Sealant for Concrete and Asphalt: Single-component formulation complying with ASTM D 3405.
- E. Available Products: Subject to compliance with requirements, hot-applied joint sealants that may be incorporated into the Work include, but are not limited to, the following:
- F. Products: Subject to compliance with requirements, provide one of the following:

1. Jet-Fuel-Resistant Elastomeric Sealant for Concrete:
 - a. Superseal 444/777; Crafcro, Inc.
 - b. POLY-JET 3569; W.R. Meadows, Inc.
2. Jet-Fuel-Resistant Sealant for Concrete and Tar Concrete:
 - a. SUPERSEAL 1614A; Crafcro Inc.
 - b. POLY-JET 1614; W.R. Meadows, Inc.
 - c. POLY-JET 3406; W.R. Meadows, Inc.
 - d. POLY-JET 3569, W.R. Meadows, Inc.
3. Elastomeric Sealant for Concrete:
 - a. Superseal 444/777; Crafcro, Inc.
 - b. POLY-JET 3406; W.R. Meadows, Inc.
4. Sealant for Concrete and Asphalt:
 - a. ROADSAVER 221; Crafcro Inc.
 - b. Product #9005; Koch Materials Company.
 - c. Product #9030; Koch Materials Company.
 - d. SEALTIGHT HI-SPEC; W.R. Meadows, Inc.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rod for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint- sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's written installation instructions applicable to products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.
 - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealants from surfaces adjacent to joint.
 - 2. Use tooling agents that are approved in writing by joint sealant manufacturer and that do not discolor sealants or adjacent surfaces.

- F. Provide joint configuration to comply with joint sealant manufacturer's written instructions, unless otherwise indicated.
- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 321273

**SECTION 328000
IRRIGATION SYSTEMS**

PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. Work of this section includes a complete and operating irrigation system, and shall include the following:
 - 1. Connection to water supply
 - 2. Irrigation piping, valves, and auxiliary equipment
 - 3. Sprinkler heads
 - 4. Controller and power connections

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Landscaping – 32 90 00
- B. See Division 33 Section "Water Distribution" for water supply piping, water meters, and backflow preventers

1.3 APPLICABLE CODES AND ORDINANCES

- B. The installation shall comply with all laws, ordinances and regulations in effect at the time place of work.

1.4 SUBMITTALS

- A. Submit manufacturer's product information and a complete list of materials for approval by the Landscape Architect.
- C. Shop Drawings: Show lawn sprinkler piping, including plan layout and locations, types, sizes, capacities, and flow characteristics of lawn sprinkler piping components. Include water meters, backflow preventers, valves, piping, sprinklers and devices, accessories, controls, and wiring. Show areas of sprinkler spray and over spray.
- D. Operation and Maintenance Data: For the following:
 - 1. Water regulators
 - 2. Automatic control valves
 - 3. Sprinklers
 - 4. Specialties
 - 5. Controllers

1.5 FEES AND PERMITS

- A. The contractor shall obtain and pay for fees and permits required by law.

1.6 QUALITY CONTROL

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with requirements of utility supplying water and authorities having jurisdiction for preventing backflow and back siphonage.
- G. Comply with ASTM F 645, "Guide for Selection, Design, and Installation of Thermoplastic Water Pressure Piping Systems."
- H. Comply with NFPA 70, "National Electrical Code," for electrical connections between wiring and electrically operated devices.

- I. The work shall be done by an organization that is established and installs lawn irrigation systems as a full time occupation.
- J. The Contractor shall provide references from (3) projects, similar in scope, installed within the past three years.
- K. Owner reserves the right to verify and inspect referenced projects.

1.7 APPROVED MANUFACTURERS:

- A. Refer to Part 3 "Piping Applications" and "Valve Applications" articles for application of pipe and tube materials, joining methods, and valve applications.
- L. Approved Sprinklers:
 - 1. Rainbird
 - 2. Hunter Industries
 - 3. Approved Alternate
- M. Soft Copper Tube: ASTM B 88, Type L, annealed-temper, water tube.
- N. Hard Copper Tubing: ASTM B 88, Types L and M, drawn-temper, water tube.
- O. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedule 40.
- P. PVC Pressure-Rated Pipe: ASTM D 2241; PVC 1120 compound; SDRs 21, 26, and 32.5.
- Q. PE Controlled ID Pipe: ASTM F 771 and ASTM D 2239; PE 3408 compound; SDRs 7, 9, 11.5, and 15.
- R. **PIPE AND TUBE FITTINGS:**
 - 1. Copper Unions: ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder joint, and threaded or solder-joint ends. Include threads complying with ASME B1.20.1.
 - a. Wrought-Copper Fittings: ASME B16.22, solder-joint, pressure fittings.
 - b. Cast-Bronze Flanges: ASME B16.24, Class 150, raised ground face, bolt holes spot faced.
 - c. PVC Socket Fittings, Schedule 40: ASTM D 2466.
 - d. PVC Threaded Fittings: ASTM D 2464.
 - e. Insert Fittings for PE Pipe: ASTM D 2609, NP or PP. Include bands or other fasteners.
 - f. Transition Fittings: Manufactured assembly or fitting, with pressure rating at least equal to that of system and with ends compatible to piping where fitting is to be installed.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. The contractor shall provide three (3) bound manuals to include instructions for operation and maintenance of the system, and a complete list of parts and equipment installed in the system.

1.9 GUARANTEE

- A. The contractor shall guarantee the system to be free of defects in labor and material for a period of one year.
- B. Repairs and maintenance required because of such defects shall be at no cost to the Owner.

PART 2 - PRODUCTS

2.1 SCHEDULES

- A. Materials are scheduled on the drawings.

2.2 VALVES

- S. Automatic, 24 volts, electric as shown on the plan.
- T. Valves shall be installed in valve wells of appropriate size and of a type as described under "Valve Boxes".
- U. Valves shall comply with drawings.

2.3 PIPE

- A. Normal impact Type 1, Schedule 40 Polyvinyl Chloride Pipe.

2.4 FITTINGS

- V. PVC Schedule 40 or approved equal.
- W. Dissimilar Piping Material Joints: Construct joints using adapters or couplings that are compatible with both piping materials, outside diameters, and system working pressure.

2.5 BACKFLOW PREVENTERS

- A. The following backflow prevention device shall be provided unless the governing code specifies otherwise:
- B. A 1" Reduced Pressure Assembly, City approved, mounted 12" above grade, with galvanized pipe and fittings.
- C. Backflow Preventers should be installed in an inconspicuous area such as shrubbery and enclosed.

2.6 SPRINKLER EQUIPMENT

- A. Sprinkler heads shall be made of high impact plastic (cycolac) and shall have adjustable arcs, and be capable of producing 100% coverage over the entire site except as indicated on the landscape plans.

2.7 VALVE BOXES

- A. Provide for underground valves. Boxes shall be high impact thermoplastic, with covers, sizes as required by installation, color-green, Ametek or approved equal.

2.8 CONTROLLER

- A. For electric valves is 115 volt V.A.C. input and 24 V.A.C. output, electric type. Wiring connections shall be 24 volts.
- B. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3 inches maximum to 3/4 inch minimum.
- C. Controller shall comply with drawings.
- D. Exterior Control Enclosures: NEMA 250, Type 4 weatherproof enclosure with locking cover and two matching keys; and include provision for grounding.
 - 1. Material: Enameled-steel sheet metal
 - 2. Mounting: Surface type for wall mounting
- E. Wiring: UL 493, Type UF, solid-copper-conductor, insulated cable, suitable for direct burial.
 - 1. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.

2. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves and color-coded different than feeder-circuit-cable jacket color and with jackets of different colors for multiple-cable installation in same trench.
3. Splicing Materials: Pressure-sensitive, thermoplastic tape; waterproof sealing packets; or other waterproof connectors.

PART 3 - EXECUTION

3.1 LAYOUT

- A. Drawings are diagrammatic. The contractor shall adjust the layout as required by project conditions to insure 100% coverage of the areas shown on the drawings and provide as-built drawings.

3.2 UNDERGROUND UTILITIES

- A. Locate and protect underground utilities in the work area.

3.3 SEQUENCE OF WORK

- A. Complete the installation of the irrigation system before grassing, seeding, and landscape work begins.

3.4 TRENCHING AND BACKFILLING

- X. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
- Y. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.
- Z. Install piping and wiring in sleeves under sidewalks, roadways, parking lots, and railroads.

3.5 INSTALLATION OF PIPE

- A. Minimum depth: Main pipelines shall be buried to provide 18" minimum cover, all piping downstream of solenoid valves shall have a 12" minimum cover.
- B. Connections: P.V.C. pipe to metal-threaded connection: poly-vinyl chloride pipe-solvent welding, according to the pipe manufacturers' printed directions.
- C. Sleeves: Schedule 40 PVC pipe, Schedule 40 PVC socket fittings, and solvent-cemented joints.
- D. Install piping free of sags and bends.
- E. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- F. Install fittings for changes in direction and branch connections.
- G. Install unions adjacent to valves and final connections to other components with NPS 2 (DN 50) or smaller pipe connection.
- H. Install flanges adjacent to valves and final connections to other components with NPS 2-1/2 (DN 65) or larger pipe connection.
- AA. Install dielectric fittings to connect piping of dissimilar metals.
- BB. Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690.
- CC. Lay piping on solid subbase, uniformly sloped without humps or depressions.
- DD. Install PVC piping in dry weather when temperature is above 40 deg F (4.4 deg C). Allow joints to cure at least 24 hours at temperature above 40 deg F (4.4 deg C) before testing, unless otherwise recommended by manufacturer.

3.6 INSTALLATION OF HEADS

- A. Flush circuit piping with full head of water and install sprinklers after hydrostatic test is completed.
- B. Install lawn sprinklers at manufacturer's recommended heights or ½ inch above finished grade.
- C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries, unless otherwise indicated.
- D. Lawn Heads: Set at finish grade with tolerance for installation of sod. Mount on flexible PVC.
- E. Adjustment: Adjust heads for coverage required to completely irrigate the lawn and landscape areas.

3.7 AUTOMATIC CONTROL SYSTEM INSTALLATION

- A. Install controllers according to manufacturer's written instructions and as indicated.
- B. Install freestanding controllers on pre-cast concrete bases not less than 36 by 24 by 4 inches thick, and not less than 6 inches greater in each direction than overall dimensions of controller.
- C. Install control wiring in same trench with piping. Install wiring with loops at control valves and controllers, at intervals not greater than 100 feet and changes in direction to allow for expansion. Bundle wiring in same trench at 10-foot intervals.

3.8 IDENTIFICATION

- A. Identify the zone valves with an aluminum or brass tag embossed with the zone number shown on the as-built drawings.

3.9 FIELD QUALITY CONTROL

- A. When the installation is complete, the system shall be tested through a full cycle, final adjustments made, and defects corrected to meet the approval of the owner's representative.
- B. Testing: Hydrostatically test piping and valves before backfilling trenches. Piping may be tested in sections.
 - 1. Cap and test piping with a minimum static water pressure of 50 psi above system operating pressure and without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours.
 - 2. Repair leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
- C. Flush dirt and debris from piping before installing sprinklers and other devices.
- D. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
- E. Carefully adjust lawn sprinklers so they will be flush with, or not more than 1/2 inch above, finish grade.
- F. Adjust settings of controllers and automatic control valves.

END OF SECTION 328000

SECTION 329000 LANDSCAPE

PART 1 - GENERAL

1.1 SUMMARY

- A. This section contains requirements relating to lawns, trees, shrubs, flowering plants and ground covers including site preparation, material installation and removal policies.
- B. Contractor to establish boundaries for the site as determined and reviewed with University Project Manager in order to ensure seamless transitions between adjacent sites, coordinate project overlaps and to maximize the potential of open space.

1.2 WORK INCLUDED IN THIS SECTION

- A. The Contractor shall furnish all labor, tools, equipment, products, materials and transportation. The work shall include, but is not necessarily limited to, the following:
 - 1. Backfill Soil Mixture
 - 2. Selection and Transporting Plant Materials
 - 3. Planting Operations
 - 4. Maintenance and Guarantee of Plantings and Landscape Areas
 - 5. Weed Control
 - 6. Warranty
 - 7. Topsoil

1.3 RELATED WORK INCLUDED ELSEWHERE

Automatic Irrigation, Salvage, Tree and Plant Protection, Inert Groundcovers.

1.4 QUALITY ASSURANCE

- A. Prior to Design Development, the Landscape Architect of Record, if applicable, shall coordinate through the FSU Project Manager, and in conjunction with the Grounds Department develop an acceptable level of quality for each project. This shall be a written plan to include:
 - 1. Development of a landscape design
 - 2. Determination of submittal and sample requirements for the specific project.
 - 3. Determination of specific/unusual installation criteria.
 - 4. Criteria for material acceptance.
 - 5. Terms of replacement under warranty.
 - 6. Other terms as deemed necessary by FSU Grounds specific to the project.
- B. Prior to beginning installation, the Contractor shall request a pre-construction meeting with the FSU Project Manager, Grounds Department, and Landscape Architect of Record.
- C. All planting work shall be done in strict accordance with sound nursery practice and shall include maintenance and watering of all plant materials installed until Substantial Completion acceptance by the University.
- D. Sidewalks adjacent to work areas shall be kept broom clean daily during planting operation. Plant containers, empty fertilizer bags and containers are to be picked up and disposed of daily. Contractors trash shall be removed from the site at the completion of work each day. Any damage to the sidewalk shall be repaired or if necessary replaced.

E. Plant Materials

1. Trees, Shrubs

- a. Plant materials shall have been grown in nurseries which have been approved by State of Florida Department of Agriculture and shall be tagged with correct names. All plant materials shall be inspected by the FSU Grounds Department Representative and/or the Landscape Architect of Record post or prior to delivery, and all plant material not meeting Specification requirements shall be rejected. Contractor shall, at his own expense, replace rejected plant material with material of species and variety that meet Specification requirements.
- b. Plants shall be quality material having the habit and growth which is normal for the species; sound, vigorous, healthy, free from insects, plant diseases and injury.
- c. Container stock should not show evidence of being root bound.
- d. All Plants shall be in accordance with Florida #1 Grade as specified in "Grades and Standards for Nursery Plants", Second Edition; published by Florida Department of Agricultural & Consumer Services. Refer:

http://www.doacs.state.fl.us/pi/plantinsp/publications/g&s_updates.pdf

1.5 SUBMITTALS – SAMPLES

- A. Submit duplicate samples and manufacturer's guaranteed analysis of the following items and such other materials as may be required by the Landscape Architect and/or FSU Grounds Department Representative per above Quality Assurance requirements. All materials requiring approval prior to delivery must obtain written approval before beginning fabrication or delivery of material to the project site. Finished work shall match approved samples. Submittals will typically consist of the following, but may be required for other items at the discretion of the Landscape Architect or FSU:

1. Tree ties and stakes
2. Fertilizers: 1/2 pound of each fertilizer with noted analysis
3. Topsoil
4. Seed Mix
5. Plant Materials
6. Site Soil Analysis

B. Plant Guarantee and Replacement:

1. As a requirement of Substantial Completion, the Contractor shall submit to the Landscape Architect of Record or FSU Project Manager (2) copies of a written guarantee for all plant material for a period of one year post Substantial. The guarantee shall stipulate the following:
 - a. All trees, shrubs, ground cover, and grass lawns shall be guaranteed to take root, grow, and thrive through the one year guarantee period. Exception: The guarantee period for deciduous trees and grass lawns shall be in effect for a period of one year OR until all are showing new growth, the spring following the end of the warranty period.
 - b. Any plant materials that die back and lose the form and size originally specified shall be considered unacceptable and shall be replaced, even though they have taken root and are growing after the die-back.
 - c. Any plant required under this specification which is dead or otherwise not acceptable and not in a satisfactory growing condition in the opinion of

the FSU Grounds Department Representative, shall be removed from the site and replaced with a suitable plant as specified within fifteen (15) days. Refer to Quality Assurance above.

- d. Replacements shall be made to the same specifications required for original materials and shall carry the same guarantee from the time they are replaced.

C. Inspection and Analysis Certificates:

- 1. Submit the following to the FSU Project Manager for review by FSU Grounds Department, prior to or upon delivery, of the materials to the site:
 - a. Plant material inspection certificates required by State and Federal laws with respect to inspection for plant disease and insect infestation shall accompany each shipment of plant materials.
 - b. Other analysis certificates as required by the construction documents.

1.6 PRODUCT DELIVER, STORAGE, AND HANDLING

- A. Manufactured materials shall be delivered in original containers with brand and manufacturer's name marked there on. Materials in broken containers or showing evidence of damage will be rejected and must immediately be removed from the site. Odorous materials shall not be brought to the site until they are to be used.
- B. Store fertilizers and all other moisture sensitive materials in a dry place and protect from intrusion of moisture.
- C. Plant material
 - 1. Protect plant material at all times during handling, shipping, storage and planting from extreme weather conditions, wind, drying roots and root balls and injury.
 - 2. Support root systems of container plant material when lifting and moving to minimize injury to root ball.
 - 3. Plant material showing damage from shipping, while in storage or during planting may be rejected by the FSU Grounds Department Representative. Rejected plant material shall be removed and replaced by the Contractor at his own expense.

1.7 SITE CONDITIONS

- A. No planting procedures or other site work shall be performed during wet or muddy conditions
- B. All existing plant material not indicated for removal shall be protected as necessary to ensure survival. In support of University's sustainability initiatives, all trees and landscape materials designated for removal shall be delivered to the FSU Nursery for mulching and later use in University landscape beds.

1.8 INSPECTIONS

- A. A written notice or phone call requesting an inspection shall be given to the FSU Project Manager who will coordinate with the Grounds Department Representative a minimum of 48 hours prior to each anticipated inspection date.
- B. Progress Inspections:
The following inspections will be required.
 - 1. Tillage and soil preparation of all planting areas.
 - 2. Finish grading.
 - 3. Inspection and approval of all plant materials upon delivery to the site. The plant material shall be assembled for this inspection.
 - 4. Inspection and approval of trees and shrubs at site after being spotted by

- Contractor.
5. Inspection of irrigation system before backfilling trenches.
 6. Inspection for both applications of pre-emergent herbicide before and after placement of inert ground cover.
- C. Final Planting Inspection for Acceptance:
1. Final inspection of trees and shrubs shall be made at the conclusion of the project, provided that on such date all other project improvements and corrective work has been completed.
 2. Prior to the time of final inspection, the following work shall have been completed:
 - a. All weeds shall be sprayed with systemic herbicide and removed from all planted areas.
 - b. All errant trash and debris shall be removed from all planted areas.
 - c. All components of irrigation system shall be operable and in proper working order.
 - d. All work put in a neat, orderly condition.

PART 2 PRODUCTS

2.1 GENERAL – QUALITY

- A. Specifications define minimum acceptable quality. Materials installed shall be as listed in this section on the drawings by manufacturer's name and model number or by description of attributes, performance of other standards.
- B. Substitutions:
 1. No material substitutions will be accepted unless request is submitted in writing to the FSU Grounds Department Representative for approval prior to commencing work on this Section. Any substitute material installed without prior approval may be rejected by the FSU Grounds Department Representative, and if rejected shall be removed and replaced to the satisfaction of the FSU Grounds Department Representative at no additional cost.
 2. The Contractor shall submit to the FSU Grounds Department Representative proof that a specified plant is not reasonably available in the local region before a request for plant substitution will be considered.

2.2 MATERIALS – PLANT MATERIAL

- A. Contractor shall furnish and plant all plants shown on the drawing and as specified.
- B. All plants shall be healthy, shapely, and well-rooted.
- C. Genus, species, and variety; quantity, size and condition as indicated on the drawings and plant material listing. No substitutions without prior written approval of FSU Grounds Department Representative.
- D. Plant material shall be healthy nursery stock, full foliage when in leaf; free from disease, injury, insects, all weeds, and weed roots.
- E. Plants shall be in accordance with the Grades and Standards for Nursery Plants by Florida Department of Agriculture, current edition.
- F. Cold storage is not acceptable.
- G. Potted and container stock well rooted, vigorous enough to ensure survival and healthy growth.

- H. Container plants, one gallon size and larger shall have grown therein a minimum of six months and a maximum of two years, with roots filling the container but not showing evidence of being or having been restricted, deformed or root bound.
- I. Trees: Untapped, straight, single leader trees except for multiple stem (clump) trees. Deciduous trees with heavier than normal top and balanced branching.
- J. Plant material shall be free from disfiguring knots, sunscald injuries, bark abrasion, evidence of improper pruning, and other objectionable disfigurements.
- K. Trees shall have well-developed branch systems.
- L. Thin, weak and leggy plants will be rejected by the FSU Grounds Department Representative.
- M. All plant material shall be legibly tagged by species and variety with minimum of one tag per 10 trees.
- N. Plant material not meeting these requirements shall be removed from the site and replaced to the satisfaction of the FSU Grounds Department Representative.
- O. All plants shall conform to the measurements specified in the plant list. Exceptions are as follows: Plants larger than specified in the plant list may be used if approved by the FSU Grounds Department Representative, but use of such plants shall not increase the contract price. If the use of the larger plants is approved, the spread of root or ball of earth shall be increased in proportion to the size of the plant.
- P. Weed Fabric: Do not use weed fabric in landscape beds without the approval of the FSU Grounds Department Representative.
- Q. Lawns and Grasses: Unless specifically approved otherwise, newly grassed areas will be constructed using sod of a species appropriate to the site location. Seeding will be allowed in large areas with low public visibility only if approved in advance by FSU Grounds Department Representative.
 - 1. Grass type shall be approved by FSU Grounds Department.
 - 2. Any area of vegetation damaged during construction shall be restored to its original state within 96 hours of the completion of the associated construction work. Grassed areas will be re-sodded. Under no circumstances is sod to be placed against tree trunks. Special care will be taken before and after the restoration to ensure the area is not subject to erosion. Contractor shall be responsible for watering all replacement vegetation until project area is turned over to FSU Grounds.
- R. Fertilizers: in conformance with the State Agricultural Code.
 - 1. Dry chemical fertilizer: 16-20-0 (N-P-K).
 - 2. Controlled slow release: Osmocote with 18-6-12 analysis (N-P-K), surface application.
- S. Pre-Emergence Control Herbicide:
 - 1. Surflan
 - 2. Dacthal – DCPA W-75
- T. Topsoil:
 - 1. Topsoil shall be a fertile, friable soil, obtained from well-drained arable land, and shall be free from nut grass, refuse, roots, heavy clay, clods, noxious weeds or any other material toxic to plant growth. At least 10 days prior to delivery of topsoil to the site, the Contractor shall furnish the FSU Grounds Department Representative at no additional cost, with a soil sample from each source along with the analysis and test report for each sample. Written acceptance/rejection

of the soil for incorporation into the project will be provided by the University with in 7 working days.

2. To be acceptable the pH factor shall not exceed 7.0 or be lower than 5.5, soluble salts shall not exceed 1500 PPM, the plasticity index shall be in the range of 3 and 15 inclusive, and it shall contain approximately 1 1/2%, by dry weight, or organic matter either natural or added. Gradation shall be in accordance with the table shown below:

Seive Size	Percent Passing
1"	100
1/2"	95-100
#4	90-100
#10	70-100
#200	15-70

PART 3 – EXECUTION

3.1 INSPECTION OF SITE CONDITIONS

- A. Examine site for conditions that will adversely effect execution, permanence, quality of work and survival of plant material. Advise FSU Project Manager and Grounds Department Representative of any concerns.
- B. Work contained in this section shall not begin until after a pre-construction meeting and the site preparation is found to be satisfactory.
 1. Attendees shall include: Construction Manager, Landscape Subcontractor, Landscape Architect, FSU Project Manager, and FSU Grounds Representative.
 2. Required inspections/approvals will be determined in the pre-construction meeting.
 3. Acceptable conditions for planting activities will be defined specific to project conditions. This shall include clarification of acceptable grades, soils, and weather conditions.
 4. Length of plant establishment period shall be reviewed prior to start of construction and documented if determined to exceed 1 year past Substantial Completion.
- C. All existing plant material to remain shall be identified protected and watered manually as necessary to ensure survival until such a time that automatic irrigation can be restored or installed.

3.2 SITE PREPERATION – CLEANING, GRUBBING, AND SOIL LOOSENING

- A. All planting areas shall be cleared of all existing plant material, brush, weeds, debris and rocks over 1 inch in size prior to any soil preparation. Noxious brush weeds and grasses shall be removed by the roots wherever they are found at any stage of the work.

3.3 PLANTING OPERATIONS – BACKFILL MIXTURE

- A. Ingredients by soil type:
 1. Clay Loam:
 - a. 1/3 max. organic matter from "Canadian Sphagnum Moss", "Florida Peat", "Mushroom Compost" or "Nitrolized Mulch".

- b. 2/3 native soil.
 - 2. Sandy Loam:
 - a. 1/3 max. organic matter from "Canadian Sphagnum Moss", "Florida Peat", "Mushroom Compost" or "Nitrolized Mulch".
 - b. 2/3 native soil.
 - B. Mixed thoroughly, leaving no layers of soil amendments or clods of soil. For mass planting, till entire bed with amendment 8"-12" deep.
 - C. FSU Grounds Department Representative's approval shall be required prior to backfilling.
 - D. Finishing Grading:
 - 1. Grades not otherwise indicated shall be uniform levels or slopes between points where elevations are given, or between points established by walks, paving, curbs or catch basins. Finish grades shall be smooth, even and on a uniform plane with no abrupt changes of surface.
 - 2. All grades shall provide for natural runoff of water without low spots or pockets. Flow line grades shall be accurately set and shall not be less than 2 percent gradient where possible.
 - 3. Tops and toes of all slopes shall be rounded to produce a gradual and natural appearing transition between relatively level areas and slopes.
 - 4. Top 6 inches shall be free of rocks or other inert materials over 1/2 inch at greatest dimension.
 - 5. All planting areas shall be free of road base, road materials and gravel. All road materials and gravel shall be removed and replaced with approved topsoil.
 - E. Planting Holes:
 - 1. Locate planting holes per planting plans bringing any conflict with underground utility to the attention of the FSU Project Manager. All plants are to be spotted on the site and locations approved by the FSU Grounds Department Representative before planting.
 - 2. Planting holes shall be excavated with vertical sides and flat bottoms to the size of twice the size of the root ball.
 - F. Planting:
 - 1. Do not install plant material until all construction work that can interfere with planting operations has been completed and irrigation system has been installed and tested. Planting areas shall have been graded and prepared as specified and shall have been approved by the FSU Grounds Department Representative.
 - 2. Do not plant during unfavorable weather. Soil shall be at optimum moisture content for planting. Do not plant in dry soil or muddy soil.
 - 3. Weed control: Licensed pest control operator shall apply pre-emergent herbicide to all planting areas except for the native grass seeding areas before and after placement of inert ground cover, in accordance with the manufacturer's recommended rates. Any plant materials showing loss of vigor or health due to improper application of herbicide shall be replaced by the Contractor. The FSU Grounds Department Representative shall witness both applications of pre-emergent herbicide.
 - G. Container Plant:
 - 1. Do not lift or handle container plants by tops, stems or trunks at any time.
 - 2. Fill bottom of planting hole with backfill mix and compact.

3. Plants shall be set in center of hole plumb and straight and at such an elevation that after settlement the root crown of the plant will be 1-1/2 inch higher than surrounding finish grade.
- H. Backfilling
 1. Backfill the planting hole with the backfill mix herein specified.
 2. Water settles backfill thoroughly, or compact by other method approved prior to planting, so plants do not settle.
- I. Fertilizing Tablets: Osmocote slow release
 1. Surface application prior to watering in. Apply at recommended rates.
- J. Immediately after planting hole is backfilled, a shallow reservoir slightly larger than the planting hole and 4 inches deep shall be formed.
- K. Watering: Immediately after planting water each tree and shrub by filling reservoir twice.
- L. Planting Areas: At project acceptance, planting areas shall be free of gravel or road material. All material found shall be removed by contractor and replaced with approved topsoil as incidental to the cost of plant material installation.
- M. Ground Cover:
 1. All ground cover areas shall be treated with a pre-emergent herbicide.
 2. All ground cover planting shall be immediately watered to avoid drying out until the entire planted area is completed.
 3. All ground cover areas which includes one gallon ground cover areas shall receive the Soil Rototilling and soil backfill mixture.
- N. Inert Ground Cover/Weed Control: See also Section 329220
 1. Prior to placing Inert Ground Cover, the area shall be totally free of weeds, using chemical control as necessary. Apply a pre-emergent herbicide according to manufacturer's recommendations. The Inert Ground Cover shall be evenly distributed in the designated areas. A second application of pre-emergent herbicide shall be applied at this time.
 2. Areas of existing inert ground cover disturbed by new construction are to be replenished with matching color and size, evenly distributed and sprayed with an application of pre-emergent herbicide. Color and size to be approved by FSU Grounds Department Representative.

3.4 CLEAN-UP

- A. Keep project site free from accumulation of debris resulting from work specified herein. Broom clean pavement daily. Remove weed fiber, fertilizers, etc., from walls, pavement and curbs. Project site shall be kept neat at all times.
- B. Upon completion of planting operation, all remaining soil, stones and other debris shall be removed from site and disposed of in a manner satisfactory to the FSU Grounds Department Representative.
- C. Upon completion of work, all trees and shrubs shall have been pruned and injuries repaired. Limit amount of pruning to the minimum necessary to remove dead or injured twigs of branches and to compensate for loss of roots as a result of planting and construction operations.

PART 4 – PROJECT ACCEPTANCE

- 4.1 Contractor shall maintain all landscaped areas on a continuous basis as they are completed during the course of work until accepted as Substantially Complete.

4.2 Maintenance during construction shall include, but is not limited to, the following:

1. All watering, fertilizing, cultivation and spraying necessary to keep the plant material in a healthy growing condition and to keep the landscaped area weed free.
2. All errant trash and debris shall be removed from the site on a continuous basis or as necessary.
3. Mowing of turf shall be done on a schedule as per industry standards based on the time of year and state of turf.

4.2 PLANT ESTABLISHMENT AND WARRANTY PERIOD:

Contractor shall provide full warranty for all plant material for a period of one year from the time of Substantial Completion; OR, if the plant material can not be expected to demonstrate establishment within that time period, the replacement warranty shall extend until a reasonable time shall have passed to ensure that the material is viable. The establishment period shall be determined at the time of the pre-construction meeting.

4.2 WARRANTY INSPECTION:

The FSU Project Manager and the Grounds Representative, in conjunction with the Landscape Architect, shall perform an end of warranty inspection approximately 30 days prior to the end of the warranty period. At that time, all material found to be non-thriving or dead shall be replaced with specification compliant materials at no additional cost. Replacement material shall be installed within 30 calendar days.

END OF SECTION

SECTION 329200 SODDING, SEEDING AND MULCHING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to prepare lawn bed and install sodding, seeding and mulching as shown on contract drawings and as specified. This is not to be construed as landscaping.
- B. Areas to receive sodded grass shall be:
 - 1. Two-foot-wide strip along edge of all asphaltic concrete paving constructed as a part of this contract. This includes roadways and parking areas.
 - 2. Five-foot-wide strip around the perimeter of all concrete structures constructed or reconstructed as a part of this contract. This includes drainage structures, slabs, and pump stations. However, sod is not required around manholes nor fences.
 - 3. All areas in lawns disturbed by Contractor.
 - 4. One-foot wide strip along edge of all sidewalks constructed or reconstructed as a part of this contract.
- C. Areas to receive seed and mulch shall be:
 - 1. All areas disturbed by Contractor that are not required to be sodded.

1.2 SUBMITTALS

Contractor shall submit to the Engineer a signed statement of total weight for each type of seed and fertilizer actually installed on the project with copies of purchase receipts.

PART 2 - MATERIALS

2.1 MULCH

The mulch used shall be normally dry mulch and shall consist of pangola, coastal bermuda or bahia grass hay.

2.2 SEED

Grass seed shall be a mixture of 20 parts of Bermuda seed, 40 parts of Argentine Bahia seed, and 40 parts of brown top millet, except that during the winter months, Rye grass seed or other approved winter cover crop seed shall replace the millet. The three types of seed used shall be thoroughly dry-mixed immediately before sowing. Seed, which has become wet or moldy shall not be used.

The Bermuda seed shall be hulled seed. The Argentine Bahia seed shall be scarified seed, having a minimum active germination of 40 percent and a total germination of 85 percent. All seed shall meet the requirements of the State Department of Agriculture and Consumer Services and all applicable State laws, and shall be approved by the Engineer before being sown.

2.3 FERTILIZER

Commercial fertilizer shall comply with the State fertilizer laws.

The numeral designations for fertilizer indicate the minimum percentage (respectively) of (1) total nitrogen, (2) available phosphoric acid, and (3) water-soluble potash, contained in the fertilizer.

The chemical designation shall be 12-8-8. Either dry or liquid fertilizer may be used.

2.4 SOD

Sod shall be of the same type as the surrounding areas to be restored or as otherwise indicated

on the Drawings or directed by the Engineer. Sod shall meet the applicable requirements of Section 981, Turf Materials of the "Florida Department of Transportation Standard Specification for Road and Bridge Construction", (2018).

2.5 WATER

The Water used in the grassing operations shall be free of excess and harmful chemicals, acids, alkalies, or any substance, which may be harmful to plant growth or obnoxious to traffic. Saltwater shall not be used.

PART 3 - EXECUTION

3.1 LAWN BED PREPARATION

Areas to be seeded shall be cleared of all rough grass, weeds, and debris, and the ground brought to an even grade as approved. The soil shall then be thoroughly tilled to a minimum 8-inch depth. The areas shall then be brought to proper grade, free of sticks, stones, or other foreign matter over 1-inch in diameter or dimension. The surface shall conform to finish grade, free of water-retaining depressions, the soil friable and of uniformly firm texture.

3.2 SEEDING AND MULCHING

Fertilizing, seeding or mulching operations will not be permitted when wind velocities exceed 15 miles per hour. Seed shall be planted or sown only when the soil is moist and in proper condition to induce growth.

Apply the lawn seed with a drop type spreader at the rate of eight (8) pounds per one thousand (1,000) square feet.

Apply half the seed in one direction and the remainder at right angles to the first seeding.

After applying the seed, rake the seed into the seed bed and roll with a lawn roller.

Seeded areas shall be uniformly mulched in a continuous blanket immediately following seeding and compacting operations, using at least 1 1/2 tons of hay or straw per acre. Hay with noxious seeds or plants will not be acceptable. Rotted, brittle, molded hay will not be accepted. It is intended that mulch shall allow some sunlight to penetrate and air to circulate, at the same time shading the ground, reducing erosion and conserving soil moisture. Thickness of covering shall be adequate to hold soil but sufficiently loose and open to favor development of grass. Immediately following spreading of mulch, material shall be anchored to soil by means of a seed drill, dish harrow set to cut only slightly, or other suitable equipment which will secure mulch firmly and prevent loss or bunching by wind or rain or may be anchored with string lines placed at sufficient intervals. On slopes where machinery cannot be used mulch may be retained in place by hand spading, string lines, or non-metallic open weave fabric. Unless rain is imminent, mulched areas shall be watered immediately after placing. Upon completion, surface or mulched areas shall be free from clods of earth, bumps, or waterholding pockets and to required grades.

3.3 SODDING

Sodding shall be incorporated into the project at the earliest practical time in the life of the contract. No sod which has been cut for more than 72 hours shall be used unless specifically authorized by the Engineer after his careful inspection thereof. Any sod, which is not planted within 24 hours after cutting, shall be stacked in an approved manner and maintained properly moistened.

Sodding shall not be performed when weather and soil conditions are, in the Engineer's opinion, unsuitable for proper results.

The sod shall be placed on the prepared surface, with edges in close contact, and shall be firmly and smoothly embedded by light tamping with appropriate tools.

Where sodding is used in drainage ditches, the setting of the pieces shall be staggered such as to avoid a continuous seam along the line of flow. Along the edges of such staggered areas the offsets of individual strips shall not exceed six inches. In order to prevent erosion caused by

vertical edges at the outer limits, the outer pieces of sod shall be tamped so as to produce a featheredge effect.

On areas where the sod may slide, due to height and slope, the Engineer may direct that the sod be pegged, with pegs driven through the sod blocks into firm earth, at suitable intervals.

Any pieces of sod which, after placing, show an appearance of extreme dryness shall be removed from the work.

3.4 MAINTENANCE

Maintenance shall begin immediately following the last operation of grassing and continue until final acceptance. Maintenance shall include watering, mowing, replanting, and all other work necessary to produce a uniform stand of grass.

Sufficient watering shall be done by the Contractor to maintain adequate moisture for optimum development of the lawn areas. Grassed areas shall receive no less than 1.5 inches of water per week.

Grassing will be considered for final acceptance when the permanent grass is healthy and growing on 95 percent of the area with no bare areas wider than twelve (12) inches.

END OF SECTION

**SECTION 330266
WATER DISTRIBUTION SYSTEMS**

1. SCOPE OF WORK

The Contractor shall supply all labor, equipment, materials and incidentals necessary to install, test and disinfect a water distribution system, including all appurtenances as shown on the drawings and as specified herein.

This work shall include, but not be limited to, the following: ductile iron pipe, PVC pipe, copper tubing, valves, fittings and hydrants; all concrete thrust blocks or restrained joints required for all types of piping; also all excavation, backfilling, sheeting, slope protection, drainage, concrete work, rip rap, grading, site restoration, erosion control, environmental protection, traffic control, pedestrian protection, and all other work necessary to complete the construction, installation and testing of the water distribution system.

2. RELATED WORK – Refer to City of Tallahassee Specifications for Water & Sewer Utilities, latest edition. City of Tallahassee specifications shall govern where there is a difference or conflict with these specifications.

Concrete and Concrete Reinforcement

Testing

Excavating, Backfilling and Compacting

Boring and Jacking

Environmental Controls

Electrical

Cross-Connection Control

3. SUBMITTALS

At the Engineer's option, furnish sworn certificates that all tests and inspections required by the Specifications under which the materials were manufactured have been satisfied.

4. INSPECTION & UTILITY LOCATION

All pipe and fittings to be installed under this Contract may be inspected at the site of manufacturer for compliance with these Specifications by an independent laboratory selected by the City. The manufacturer's cooperation shall be required in these inspections. The cost of inspection by and independent laboratory will be borne by the City.

Water mains and services are the responsibility of the Contractor/Developer until such time as the system is deemed accepted by the City. Prior to acceptance, the Contractor/Developer will be responsible for providing all field utility locations in accordance with utility location standards as established by the American Public Works Association. The Contractor/Developer will be responsible for any damages to the water system caused by the installation of any other utilities. The Contractor/Developer will be notified of acceptance in writing after the City receives approved as-builts. Projects will be formally accepted following the guidelines outlined in the General Conditions contained in this document.

5. MANUFACTURER TESTING OF PIPE AND FITTINGS

Each joint of pipe 4 inches and greater in diameter shall be hydrostatically tested at the point of manufacturer as required by the appropriate AWWA Standard, City may request the certificates of compliance be furnished with the material. All fittings shall be domestic manufactured.

All ductile and cast iron fittings to be furnished under this contract shall be inspected and tested at the foundry as required by the AWWA Standard C-110, Section 10-10. All fittings shall be domestic manufactured.

10. CONNECTION TO WORK BY OTHER OR EXISTING LINES

For lines installed under other contracts to which piping of this contract must connect, the following work shall be performed:

- A. Expose buried lines to conform or determine end connection, pipe material and diameter.
- B. Removing the temporary plug provided in the pipe installed under another contract.
- C. Furnishing and installing piping and making proper connections.

For connection to existing lines to which piping of this contract must connect, the following work shall be performed:

- A. Expose buried lined to confirm or determine end connection, pipe material and diameter.
- B. Furnish and install appropriate piping and make proper connections.

The City of Tallahassee Inspector shall be notified 48 hours prior to any connection to the existing water system.

Twenty-four hours before any water outage, there will be a reflective sign with flasher placed on each street coming into the effected area. The sign will be no smaller than 4'x4' and will have an easy to read (4" letters) notice that water will be off tomorrow, that a door hanger has been delivered, the day and night phoned number of the Contractor and City number 891-4968 (day & night).

30. DUCTILE IRON PIPE AND FITTINGS

Ductile iron pipe is an approved material for 4" and larger. All pipe greater than 8" shall be ductile iron.

Ductile iron pipe shall be designed in accordance with the latest version of ANSI/AWWA A21.51/C150 for a minimum 150-psi (or project requirements, whichever is greatest) rated working pressure plus a 100 psi minimum surge and a 2 to 1 factor of safety on the total design pressure. Ductile iron pipe shall be manufactured in the U.S.A. in accordance with the latest revision of ANSI/AWWA A21.51/C150. Each pipe shall be subjected to a hydrostatic pressure test of at least 500 psi at the point of manufacture.

Ductile iron pipe shall be Class 350, unless otherwise called out in the drawings. Type 1 bedding conditions shall be used for 24-inch diameter pipe and smaller. Type 2 bedding conditions shall be used for 30-inch diameter and larger pipe.

Pipe for installation below ground shall be supplied in lengths not in excess of a nominal 20 feet. Pipe may be rubber-ring, push-on joints, standard mechanical joint pipe or restrained joint where required, ball joint pipe and flange joint pipe shall be used where shown on the drawings. The Contractor shall furnish mechanical and restrained joint pipe with sufficient quantities of accessories as required for each joint.

All water main pipefittings shall be ductile iron conforming to the latest version of AWWA C153 or cast-iron conforming to AWWA C110. Rubber gasket joints shall conform to ANSI A21.11 for mechanical push-on type joints. Ball joints shall conform to ANSI A21.51, with separately cast ductile iron bell conforming to ASTM A536, Grade 70-5-5, and a cast steel retainer ring conforming to ASTM A148, Grade 90-60. Flanged fittings shall conform to ANSI A21.15 and in accordance with ANSI A21.51 be coated on the exterior with a 1.0 mil thick bituminous coat in accordance with ANSI A21.51.

All pipe and fittings for potable water service shall have a cement mortar lining and a bituminous seal coat on the inside in accordance with ANSI A21.4 and be coated on the exterior with a 1.0 mil thick bituminous coat in accordance with ANSI A21.51.

Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 as otherwise provided herein. Trench excavation, backfill and compaction shall meet the requirements of Excavating, Backfilling and Compacting contained in this document.

All DIP water mains shall be laid with a minimum 10-gauge solid copper insulated wire to provide for location by metallic pipe locators. When a splice is required on the tracer wire, a "King Technology, Inc., One-Step" waterproof wirenut shall be used in accordance to manufacturer specifications.

Tracer wires shall be routed to the surface through valve boxes so as to extend 6" to 12" beyond valve box. Excess tracer wire shall be coiled under box lid and arranged so as not to interfere with valve operation. Tracer wire runs shall not exceed 1,000'. Extra valve boxes shall be provided where distance between valves exceed 1,000'.

All pipe shall be sound and clean before laying. When laying is not in progress including lunchtime, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by manufacturer. Fittings in addition to those shown on the plans shall be provided, if required, in crossing utilities, which may be encountered upon opening the trench.

When cutting pipe is required, the cutting shall be done in accordance with approved methods stated in "Installation Guide-D.I.P." leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a Tyton bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

All $\frac{3}{4}$ " or 1" taps on ductile iron pipe shall be direct taps. Saddles or tapping sleeves shall be used on $1\frac{1}{2}$ " or greater taps on ductile iron pipe.

Push-on joints shall be made in strict accordance with the manufacturer's instructions. A rubber gasket supplied by the pipe manufacturer shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe is to be aligned with the bell of the pipe to which it is to be joined and pushed home with a jack or other means. If a backhoe is used to bell the pipe, a timber header will be used between the pipe and backhoe bucket to avoid damage to the pipe. Care shall be taken to avoid overbelling the pipe. Contractor shall note the position of the painted gauge lines so as to properly position the plain end in the bell socket.

Mechanical joint at valves, fittings, and where designated on the drawings and/or as specified shall be in accordance with the "Notes on Method of Installation" under ANSI Specification A21.11, AWWA C600 Section 3.4, and the instructions of the manufacturer. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tightened in a uniformed manner to the specified torque as noted below.

Mechanical-Joint Bolt Torque

Pipe Size	Bolt Size	Torque
Inches	Inches (mm)	Ft.-Lbs. (N-m)
3	5/8 (16)	45-60 (61-81)
4 – 24	$\frac{3}{4}$ (19)	75-90 (102-122)
30-36	1 (25)	100-120 (136-163)
42 – 48	1 $\frac{1}{4}$ (32)	120-150 (163-203)

Ball joints, where designated on the drawings and/or as specified, shall be installed in strict accordance with the manufacturer's instructions. Where ball joint assemblies occur at the face of structures or tanks, the socket end shall be at the structure or tank and the ball end assembled to the socket.

Flanged joints shall be in accordance with ANSI/AWWA C115/A21.15 Specifications, including its Appendix A and the instructions of the manufacturer. Flanged joints shall be fitted so that the contact faces bear uniformly on the gasket and then are made up with relatively uniform bolt stress.

All valves, hydrants, fittings and other appurtenances needed upon the pipe lines shall be set and jointed as indicated on the Drawings or as required by the manufacturer.

Unless otherwise noted, underground piping shall be push-on or mechanical joint types with thrust restraints as required.

If joint deflection is required to construct the water main as shown on the plans, the maximum deflection shall not exceed the maximum recommended deflections in the latest AWWA or manufacturers written directions (whichever is more stringent).

Fittings shown on the drawings is shown only as an assistance in illustrating a preferred means of installation in specific locations and is not intended to indicate all fittings necessary to effect the installation as shown in plans and profile views. The cost of all fittings shall be included in the bid price for furnishing and installing the pipe.

Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. Pipe shall not be moved using a forklift in the end of the pipe. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired or replaced as directed by the Engineer.

All pipe and fittings shall be subjected to a careful inspection just prior to being laid or installed. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the City. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.

Unless specifically indicated otherwise, underground piping shall slope uniformly between shown elevations.

40. POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

A. Design Standards:

PVC pipe for potable water in sizes 4 inch through 8 inch shall conform to the latest version of AWWA Standard C900, (SDR 18 Class 150) "PVC Distribution Pipe for Water". Laying lengths shall be 20 feet $\pm$ 1 inch for all sizes. PVC is not approved for pipe larger than 8 inch.

Pipe shall have an integral wall thickened bell end or extended coupling with gasket seal, which is in compliance with the requirements of ASTM D 3139, "Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals". No solvent cement bell ends will be allowed.

Pipe shall be Class 150 (SDR 18 with cast iron outside dimensions). Each piece of pipe shall be hydrostatically tested to 600 psi by the manufacturer. Pipe color must be blue. Lettering and markings that shall include size and O.D. base (e.g., 6 inch C.I.), material code designation number (PVC 1120), dimension ratio number DR 18), AWWA pressure class (Class 150), AWWA designation C900, manufacturer's name, and production code. All PVC pipe shall be UL/FM approved. Approved PVC pressure pipe manufacturers are J.M. Eagle Corp., North American Pipe Corp., Diamond Plastics Corp. and National Pipe and Plastics.

Two-inch PVC pipe shall be 200 psi (SDR 21) in IPS dimensions manufactured from 1120 PVC resin. Pipe shall have integral wall bells or extruded couplings with gasket seals. Pipe shall be

marked with manufacturer's name, size, material code (PVC 1120), pressure rating (200 psi), DR number (DR 21).

B. Construction Standards:

PVC piping shall be installed to the requirements of the manufacturer. All PVC water mains shall be laid with a minimum 10 AWG high-strength copper-clad steel with a 30 mil high density polyethylene coated insulated wire to provide for location by metallic pipe locators. Tracer wire shall be rated for 30 volts and meet APWA color coding requirements. Tracer wire is to be wrapped two times around each joint of pipe. When a splice is required on the tracer wire, a UL 486D Listed direct burial waterproof wire nut shall be used to join the ends of the wire. Approved products include King Innovation DryConn King 6 Blue One-Step wire nuts, or approved equal.

Tracer wires shall be routed to the surface through valve boxes so as to extend 12" beyond the beyond valve box. Excess tracer wire shall be coiled under box lid and arranged so as not to interfere with valve operation. Tracer wire runs shall not exceed 1,000'. Extra valve box shall be provided where distances between valves exceed 1,000' so there is no run longer than 1,000'. Split the distance on runs over 1,000' for the extra valve box(s).

If joint deflection is required to construct the water main as shown on the plans, the maximum deflection shall not exceed the manufacturer's maximum recommended deflection. Deflected joint pipe shown on the drawings is shown only as an assistance in illustrating a preferred means of installation in specific locations and is not intended to indicate all deflected joint pipe necessary to effect the installation as shown in plan and profile views.

Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. Pipe shall not be moved using a forklift in the end of the pipe. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe lining or coating shall be repaired as directed by the Engineer.

All pipe and fittings shall be subjected to a careful inspection just prior to being laid or installed. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the City. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.

If restrained joints are shown on the plans, use manufacturer recommended fittings for PVC pipe. Under no circumstances shall setscrews be used on PVC pipe.

Unless specifically indicated otherwise, underground piping shall slope uniformly between shown elevations.

All taps on PVC pipe will be made through approved saddles or tapping sleeve and valve.

50. DRY BARREL FIRE HYDRANTS

A. Design Standards:

All fire hydrants shall fully comply with all provisions of AWWA C502 latest edition. Hydrants shall be the dry barrel type, which prevents the operating threads from coming into contact with the service water. Hydrants shall be of the compression type, opening against the line pressure and closing with the line pressure. Hydrant and piping shall be laid at accurate grade as specified on the Plans/drawings.

Approved models are Mueller A423, or M.H. Reliant 929, and Clow Medallion. No substitutes will be allowed.

1. Hydrant Specifications:

1. The hydrant shall be equipped with weather bonnet/shield to protect the operating nut.

2. A grease or oil reservoir and lubrication system that automatically circulates lubricant to all operating stem threads and bearing surfaces each time the hydrant is operated shall be provided. The system shall be completely sealed from the waterway by O-ring seals.
3. The hydrant barrel shall be the traffic breakaway type with a safety stem coupling and frangible segments that permit full 360 degree rotation of the nozzle.
4. Main valve opening of the hydrant shall not be less than 5 ¼ inches and shall open clockwise (turn to right looking from top).
5. Hose threads and steamer threads shall be national standard threads. Hydrants shall be supplied with a factory installed Storz coupling on the steamer. All nozzle caps shall be furnished with a flat gasket to prevent leaking.
6. The hydrant shall be designed to permit the removal of all working parts from the hydrant up through the barrel without disturbing the earth around the hydrant or disassembling the barrel.
7. An all-bronze hydrant valve seat ring shall thread directly into an all-bronze drain ring and shall be located between the lower hydrant barrel and base securely retained in the position, or it may be threaded into a heavy bronze bushing in the hydrant base. The valve seat ring and drain ring shall have no less than two bronze drain ports and two bronze drain outlets.
8. The hydrant shall be designed with an anti friction bearing, so located that it will reduce the torque required to operate the hydrant.
9. Operating nut and nozzle cap wrench nut shall be National Standard type.
10. All hydrants shall be shop tested in accordance with AWWA C502 (latest revision).
11. The interior of the hydrant shoes shall be located with a fusion-bonded epoxy coating of at least 6 mils.
12. Hydrant exterior shall be painted with two coats of high visibility yellow enamel paint.

B. Construction Standards:

Hydrants shall be installed with uppermost breakaway joint at ground level or at no more than 2" above ground level. The four-inch steamer shall face the nearest access roadway and shall be a minimum of 18" above grade. There shall not be any scallop or mound around the hydrant at finished grade.

Hydrant shall be provided with extension kit where necessary to adjust level of breakaway joint.

Connection between hydrant and main shall be straight ductile iron pipe except as approved by engineer. All joints shall be restrained from the main to the hydrant. A 10 gauge solid tracer wire shall be installed from the main to the breakaway flange on the hydrant and be visible. The tracer wire is to be a continuous loop and/or spliced per specifications to the tracer wire on the main.

Backfill around hydrant shall be compacted to 100% of maximum density as determined by ASTM D698 (Standard Proctor Density). Density testing shall meet the same requirements as backfill under roadway pavement.

55. RESILIENT WEDGE GATE VALVES

A. Design Standards:

Approved manufacturers: American Flow Control, Clow/M&H/Kennedy, U.S. Pipe/Mueller and EJ Foundry. No substitutes will be allowed.

1. Gate Valve Specifications

- a. All valves in size 4-inch through 12 inch shall be of the resilient wedge

gate type. Valves shall be manufactured to meet all applicable requirements of AWWA Standards for resilient seated gate valve C509 (cast iron or AWWA C515 (ductile iron), latest revisions. All valves of this type shall have a pressure rating of 250-psi.

- b. Valves shall have non-rising stems open by turning counter clockwise (left) and with 2-inch square operating nut with arrow cast in metal to indicate direction of opening.
- c. The inside of the valve body and bonnet shall be lined with an epoxy coating, complying with ANSI/AWWA C550, applied by the manufacturer prior to assembly.
- d. Each valve shall have the manufacturer's name, pressure rating and year manufactured cast on the body. Prior to shipment from the factory, each valve shall be tested to a hydrostatic pressure of 350 psi.
- e. Recommended Valve Placement:
 - 1. In line valves shall be placed every 1000' lineal feet of pipe maximum or placed to isolate sections to keep customer outage to a maximum of 50 meters (customers).
 - 2. Valves shall be provided for each direction of pipe at each tee or cross. Valve placement may be field adjusted by City Inspector. Valve boxes must be manufactured in the United States.
 - 3. Valves shall be placed at each end of crossings on streets classified as major collectors, arterial, or roads with 5 or more through lanes.
 - 4. A valve shall be placed at and restrained to the tee for every fire hydrant stub.
- f. Upon completion of work, all valves are to be left fully opened under the supervision of the City Inspector.

B. Construction Standards:

All valves and fittings shall be set and jointed to the pipe in the proper locations as specified on the Plan. An adjustable two-piece screw-type asphalt-dipped cast iron valve box and heavy-duty drop-in lid rated for HS25 loading shall be provided for all valves larger than 1-inch. Lids shall be manufactured in the U.S.A. Lids shall be labeled WATER, SEWER, or RECLAIMED, depending on valve application. Approved valve box products include Tylor Union Model 6850, Bingham and Taylor Model 4905, and EJ Foundry Model 8550. The valve box shall be installed so as not to transmit shock or stress to the valve. Valve boxes will be centered on the operating nut and plumb with the paved surface, unless otherwise indicated on the drawings. All valves shall have actuating nuts extended within 6 inches on the top of the valve box.

60. BUTTERFLY VALVES

A. Design Standards:

General: Butterfly valves shall only be used on 16" water main or larger or where called for on the plans. All butterfly valves shall be of the tight closing, rubber seat type with rubber seats that are recess-mounted and securely fastened to the valve body or attached to the valve disc. Valves shall be bubble tight at rated pressures and shall be satisfactory for applications involving valve operation after long periods of inactivity. Valve disc shall rotate 90 degrees from the full open position to the tight shut position. Valves shall meet the full structural requirements of the

applicable classes of AWWA Specification C504, latest edition. The manufacturer shall have manufactured tight closing rubber seated butterfly valves for a period of at least five years.

1. Butterfly Valve Specifications:

- a. Valve Bodies: Valve bodies shall be constructed of cast iron conforming to ASTM A126, Class B, and buried valves shall have integrally cast mechanical joints ends. Above ground valves shall be flanged and flange drilling shall be in accordance with ANSI B16.1, Class 125. Two trunnions for shaft bearings shall be integral with each valve body. Body thickness shall be strictly in accordance with AWWA C504.
- b. Valve Discs: Valve discs shall be constructed of Ni-Resist, Type 1 or of Ductile Iron ASTM A536 Grade 65-45-12 with stainless steel seating edges. All disc seating edges shall be smooth and polished.
- c. Valve Shafts: Valve shafts shall be "Stub Shaft" type or one piece, extending full size through the disc (or a minimum of 1½ diameter per "stub shaft" valve), bearings and into the operating mechanism and shall be constructed of ASTM A276, Type 304 stainless steel or a stainless steel with greater overall corrosion and oxidation resistance, or shall be high tensile steel with stainless steel shaft journals, teflon bushings and shaft seals.
- d. Valve Seats: Shall be of a natural rubber or a synthetic rubber compound. Bonded seats shall be simultaneously molded in, vulcanized and bonded into the valve body and seat bond must withstand 75 lbs. pull under test procedure ASTM D429, Method B. Provision for adjustment shall take the form of heavy corrosion resistant retaining segments which lock the seat rigidly in position after adjustment and which will effect a minimum of 1/8 inch change in seat rise at equal increments around the periphery. Seats attached to the valve disc shall be held in place by a stainless steel, ASTM A296, Grade CF8, retaining ring. Cap screws through the rubber seat and the seat-retaining ring must be provided for adjustment of the rubber seat. The mating body seat shall be constructed of Type 304 stainless steel.
- e. Valve Bearings: Valves shall be fitted with sleeve type bearings. Bearings shall be corrosion resistant and self-lubricating. Bearing load shall not exceed the published design load for the bearing material, or 1/5 of the compressive strength of the bearing or shaft material.
- f. Valve Operators: Manual valve operators shall be of the worm gear or traveling nut type and fully enclosed. Units furnished for buried service shall be fully gasketed and grease packed. Valves located above ground shall be equipped with hand wheel operator and shall have a suitable indicator arrow to give valve position from full open to fully closed. Buried valves, designated to be furnished with above ground operators, shall be equipped with hand wheel operators on extended bonnet. All other buried butterfly valves shall be furnished with 2-inch AWWA nut operator with valve box and cover. Operator components shall, at the extreme operator positions, withstand without damage a pull of 200 lbs. for hand wheel or chain wheel operators or an input torque of 450 ft. lbs. for operating nuts.
- g. Hydrostatic and Leakage Test: Hydrostatic and leakage test shall be conducted in strict accordance with AWWA C504, latest revision.

B. Construction Standards:

All valves and fittings shall be set and jointed to the pipe in the proper locations as specified on the Plan. A valve box rated for H2O loading shall be provided for every valve. The valve box

shall be manufactured by the Opilaka Foundry, use valve box model 19. The valve box shall be installed so as not to transmit shock or stress to the valve. Valve boxes will be centered on the operating nut and plumb with the paved surface, unless otherwise indicated on the drawings. All valves shall have actuating nuts extended within 6 inches of the top of the valve box.

65. TAPPING SLEEVES AND VALVES

A. Design Standards:

All valves used will be resilient wedge type and designed for use with tapping equipment. They will have a non-rising stem. All tapping valves will have an alignment ring to prevent misalignment with tapping sleeves. Valves will close clockwise (right), open counter clockwise (left), and be equipped with a standard 2-inch square-operating nut. Valve outlets will have a mechanical joint with the manufacturer's gasket. Valves will meet or exceed provisions of AWWA Standard C509.

All tapping sleeves for use on water mains 12" or less in diameter shall be constructed of 304 or 316 stainless steel for corrosion resistance. The leg of the tapping sleeve may be either extruded or welded to the tapping sleeve. All welds on the sleeve shall be fully passive to restore stainless steel characteristics. The flange shall be stainless steel with a recess to accept standard tapping valves. The flange shall conform to AWWA C207 Class D-ANSI 150 lb drilling. Boltholes shall straddle the pipe centerline. The sleeve will be equipped with a ¾" NPT 304 or 316 stainless steel plug with a standard square head for testing. The gasket shall be of a 360-degree design and manufactured of gridded virgin GPR compounded for water service and complying with ASTM requirements. A 304 or 316 stainless steel armor shall be vulcanized to the gasket to bridge the gap between securing lugs. All bolts and nuts shall be 304 or 316 stainless steel with ⅝" NC threads. The lifter bar shall be of adequate design to provide a heavy bearing surface for all nuts. Nlyatron GS washers shall be provided for lubrication. Approved types are the Ford - Fast Model, JCM Model 432, Romac Model SST, or Mueller Model H304.

Sleeves for use on pipe 14" in diameter and larger will be of r ductile iron, mechanical joint type. Approved types are Mueller H-615, American Series 2800, or U.S. Pipe T-9

B. Construction Standards:

All tapping valves and sleeves shall be air tested prior to the installation of the tap. Tap shall be installed horizontal to the water main. Proper equipment to install the tap shall be on-site prior to starting the tap. The contractor shall coordinate with the City Inspector regarding connection to the existing City water system with a minimum of 48 hours notification prior to tie-in. The City reserves the right to delay the tap if, in the City's opinion, the proper equipment is not on-site.

70. SERVICE VALVES

A. Design Standards:

All 1½" or 2" water service taps shall be made horizontally to the water main and 1½" or 2" ball valve with square operating nut shall be provided with a valve box.

Valves shall be bronze ball type with FIP inlet and outlet and 2" bronze operating nut. The approved models are Ford #B-11-77W and A.Y. McDonald #4134-135. No substitutes are allowed.

B. Construction Standards:

Valves shall be installed per manufacturers recommendations and according to the plans and specifications. A roadway valve box shall be provided for every valve larger than 1-inch corporation stops. The valve box shall be installed so as not to transmit shock or stress to the valve. Valve boxes will be centered on the operating nut and plumb with the paved surface, unless otherwise indicated on the drawings.

75. AIR RELEASE VALVES

A. Design Standards:

The valves shall have a cast iron body, cover and baffle, stainless steel float, bronze water diffuser Buna-N or Viton seat and stainless steel trim. Valves shall be provided with a vacuum check to prevent air from re-entering the line. The fittings shall be threaded. The air release valves shall be model 200 as manufactured by APCO Valve and Primer Corporation, Schaumburg, Illinois; Model 45 by Val-Matic Valve and Manufacturing Corporation, Lyons, Illinois; or Impire 922. No substitutes will be allowed.

B. Construction Standards:

Air release valves for use in water mains shall be installed as shown on the plans and specifications. The valves shall be constructed in accordance to the drawing labeled "air release assembly".

80. BRONZE ITEMS

A. Design Standards:

All corporation stops and curb stops shall be manufactured and dimensioned in accordance with ANSI/AWWA STANDARD C800-89. All compression fittings shall be designed for use with copper tubing size (CTS) service lines. "QUARTER TURN BALL TYPE" valves shall be used in all sizes. Either Ford (pack joint) or A. Y. McDonald (T-series), is approved for use. No substitutes are allowed.

B. Construction Standards:

All corporation stops and curb stops will conform to the inlet and outlet configuration as listed below:

CORPORATION STOPS

Service Size	¾"	1"	1- ½"	2"
inlet	cc thread	cc thread	Ball Valve with	Ball valve with
outlet	compression	compression	2" operating nut	2" operating nut

CURB STOPS

Service Size	¾"	1"	1- ½"	2"
inlet	compression	compression	compression	compression
outlet	fem. IP thread	fem. IP thread	fem. IP thread	fem. IP thread

If an existing service is to be replaced and the existing corporation stop is flaired, then a flaired to compression adapter is to be used. When a corporation stop is to be abandoned, a corporation plug is to be used.

85. SERVICE SADDLE & TAPS

A. Design Standards:

For ¾ inch and 1-inch taps on PVC pipe, a service saddle with a single 2-inch wide stainless steel band or strap shall be furnished. The saddle shall be of cast or ductile iron and shall be epoxy, nylon, or PE coated (10 mils minimum). Approved styles are Ford FC101, Romac 101N, Rockwell 315, JCM 405, or Cascade Model CNS1. No substitutes will be allowed.

For 1½ inch and 2-inch taps on PVC or Ductile Iron pipe, a more stable saddle is required. Saddles for these taps shall have either two each stainless steel 2-inch straps or a single stainless strap a minimum of 3¼ inches wide. The saddle body shall be cast or ductile iron and shall be coated with epoxy nylon or PE. Approved styles are Ford FC202, Romac 202N, Rockwell 317, JCM, and Cascade Model CNS2. No substitutes will be allowed.

B. Construction Standards:

All service taps shall be installed to manufacturer's recommended procedures. All 1" taps on ductile iron pipe shall be direct taps and shall be made to receive an AWWA Tapered (CC) thread pattern corporation stop. All other sizes and materials will be tapped with a saddle. All service taps on DI, PVC, AC, and CI, will be located at 3:00 or 9:00 on the circumference of the pipe. Service Taps on HDPE using electrofusion tapping tee will be located at 12:00 on the circumference of the pipe. All taps shall be made under pressure. Teflon tape for sealing and lubricating shall be used on all threaded connections.

90. WATER SERVICE PIPING

A. Design Standards:

Type "K" copper tubing with bronze compression fittings shall be used for ¾ inch through 2-inch services. Copper tubing size outside diameter with standard dimension ratio or - 9 (SDR-9). No substitutes will be allowed. No flared or solder joints (sweat) shall be allowed.

B. Construction Standards:

Torque on corporation stops will not exceed manufacturer's recommendations. Allowance for any possible movement in the main will be made by making a half loop in the service piping at the tap and compacting backfill to 100 percent standard proctor ASTM D698 under this loop.

If a meter is not going to be set at the time of construction of the service line, then an EMS 1250 water marker and a service marker will be placed at the end of the service line. This marker will be constructed out of 1/2" schedule 40 PVC or Fiberglass strips and will be blue in color, minimum 3' above grade, with a tee or anchor to hold it in place. All services shall be installed at the centerline of the lot where applicable unless approved by the City Inspector.

95. THRUST BLOCKS

Thrust along pressurized pipelines at bends, tees, reducers, and caps or plugs shall be counteracted by enough weight of concrete to counterbalance the vertical and horizontal thrust forces. Where undisturbed trench walls are not available for thrust blocking, the Contractor shall furnish and install suitable pipe harnesses or ties designed and manufactured specifically for this purpose. The Engineer shall approve harnesses and/or ties.

Thrust blocks shall be sized for 150-psi hydrostatic pressure. Restrained joints shall be used where directed by the drawings and may be used at other locations with prior approval by the Engineer. Joints shall be protected by felt roofing paper or plastic sheeting prior to placing concrete thrust block.

Bearing area of thrust blocks shall be adequate to prevent any movement of the fittings and shall be of the size and dimensions as shown on the drawings.

Concrete for thrust blocking shall comply with the requirements of Concrete and Concrete Reinforcement sections of in this document. Concrete shall be placed against undisturbed material, and shall not cover joints, bolts or nuts, or interfere with the removal of any joint. Wooden side forms shall be provided for thrust blocks.

In lieu of thrust blocking, the Engineer may approve, pipe harness and/or ties or restrained push-on or restrained mechanical joints.

100. RESTRAINED JOINTS

Sections of piping designated on the drawings as having restrained joints or those requiring restrained joints shall be constructed using pipe and fittings with restrained "locked-type" joints,

and the joints shall be capable of holding with line pressures up to 150 pounds per square inch (psi). The pipe and fittings shall be as shown for restrained push-on joints or restrained mechanical joints in Section V, in the latest edition of the Handbook of Ductile Iron Pipe, except that mechanical joint ductile iron pipe retainer glands will be permitted only with the Engineer's prior approval.

The minimum number of restrained joints required for resisting forces at fittings and changes in direction of pipe shall be determined from the length of restrained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil. The formula given in Section IX in the latest edition of Handbook of Ductile Iron Pipe shall be used to determine the minimum requirements.

Bolts and nuts for restrained joints shall be hot dipped galvanized, low alloy, high-strength steel. All-thread rods for restrained joints shall be Type 304 Stainless Steel.

The Contractor shall also provide restrained joints in accordance with the above criteria wherever thrust blocks are not used.

Sections of piping designated on the drawings as having restrained joints shall be as follows: 12" and smaller shall be restrained using a restraining gasket, such as U.S. Pipe Field Lok Gasket or an American Fast Grip Gasket.

Pipe sizes 14" and larger shall be restrained by either using Mechanical Joint pipe with megalug joint restraint made by Ebaa Iron or a Boltless Restrained Joint system such as Clow Superlock, U.S. Pipe's T R Flex or American Lok-Ring Pipe.

105. PRESSURE TESTS OF WATER DISTRIBUTION PIPING

Hydrostatic pressure tests shall conform to Section 4 of the AWWA C600 Specification (latest edition) with the exception that the Contractor shall furnish all gauges, meters, pressure pumps and other equipment needed to test the line.

The pressure required for the field hydrostatic pressure test shall be made at 150 psi. The Contractor shall provide temporary plugs and blocking necessary to maintain in the required test pressure. Wash stands at least 2 inches in diameter, pipe riser and angle globe valves shall be provided at each pipe dead-end in order to bleed air from the line. Duration of pressure test shall be at least two hours. All leaks evident shall be repaired. Lines, which fail to meet tests, shall be repaired and retested as necessary until test requirements are met. Defective materials, pipes, valves and accessories shall be removed and replaced.

The pipe lines shall be tested in such sections as may be directed by the Engineer by shutting valves or installing temporary plugs as required. The line shall be filled with water, all air removed, and the test pressure shall be maintained in the pipe for the entire test period by means of a force pump to be furnished by the Contractor.

The Contractor shall remove and adequately dispose of all blocking material and equipment after completion and acceptance by the field hydrostatic test, unless otherwise directed by the Engineer. The Contractor shall repair any damage to the pipe coating. Lines shall be totally flushed and clean prior to final acceptance. Inspector shall be notified 24 hours in advance of any testing.

110. DISINFECTING POTABLE WATER PIPELINES

Before being placed in service, all potable water pipelines shall be chlorinated in accordance with AWWA 651-86, "Standard Procedure for Disinfecting Water Mains". The procedure shall be approved by the Engineer. The location of the chlorination and sampling points will be determined by the Engineer in the field. Taps for chlorination and sampling shall be uncovered and backfilled by the Contractor as required.

The procedure for chlorination shall be first to flush all dirty or discolored water from the lines, and then introduce chlorine in approved dosages through a tap at one end, while water is being drawn at the other end of the line. The chlorine solution shall remain in the pipeline for 24 hours.

Ounces of Calcium Hypochlorite Granules to be Placed at Beginning of Main and at Each 500' Interval

Pipe Diameter	Calcium Hypochlorite
in.	Granules
	oz
4	0.5
6	1.0
8	2.0
12	4.0
16 and larger	8.0

Following the chlorination period, all treated water shall be flushed from the lines at their extremities and replaced with water from the distribution system. The Engineer shall then make bacteriological sampling and analysis of the replacement water in full accordance with AWWA Standard C601. The Contractor will be required to re-chlorinate, if necessary. The line shall not be placed in service until the requirements of the Florida Department Environmental Protection (FDEP) are met.

Special disinfecting procedures shall be used in connections to existing mains, and where the method outlined above is not practical.

Water line flushing will be limited to the amount shown in the following table:

Minutes of flow
Per 1,000' of pipe

line diameter in inches	fire hydrant 2.5" hose connection	fire hydrant 5.25" steamer connection
6	17	6
8	32	11
10	49	17
12	71 (1hr11min)	24
14	96 (1hr36min)	32
16	125 (2hr05min)	42
18	159 (2hr39min)	53
20	196 (3hr16min)	66 (1hr06min)
22	237 (3hr57min)	79 (1hr19min)
24	282 (4hr43min)	94 (1hr34min)

No flushing can begin until the City inspector has verified a chlorine residual of not less than 10.0 ppm after the line has been filled for at least 24 hours. A City inspector will monitor all flushing. Any flushing that the City inspector has not been notified of will be considered to be pirated. Any water use after this first flush will be paid for at standard City rates. No flow in excess of the above table is to be unmetered. City ordinance 87-0-0108 and state statute 812.14 will be enforced.

Should a contractor want a meter(s) attached after a chlorine residual of not less than 10.0 ppm has been verified (after the line has been filled for at least 24 hours), he may request same and flush thru the meter using any volume he may wish to use provided he, at a minimum, has flushed out all the super chlorinated water and obtained acceptable bacteriological tests. The contractor will pay for all water thru a meter at the standard rate.

END OF SECTION

**SECTION 330273
SANITARY SEWER**

PART 1 - GENERAL

1.1 RELATED WORK

Refer to City of Tallahassee Specifications for Water & Sewer Utilities, latest edition. City of Tallahassee specifications shall govern where there is a difference or conflict with these specifications.

1.2 SUMMARY

- A. This Section includes sanitary sewerage outside the building.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene-monomer rubber.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backwater valves and cleanouts.
- B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
 - 1. Precast concrete manholes, including frames and covers.
 - 2. Cast-in-place concrete manholes and other structures, including frames and covers.
- C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.
- D. Coordination Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1-inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- E. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. PVC Backwater Valves and Cleanouts:
 - a. Canplas, Inc.
 - b. IPS Corp.
 - c. NDS, Inc.
 - d. Plastic Oddities, Inc.
 - e. Sioux Chief Manufacturing Co., Inc.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 PIPES AND FITTINGS

- A. PVC Pressure Pipe: AWWA C900, Class 150, for gasketed joints.
 - 1. PVC Pressure Fittings: AWWA C907, for gasketed joints.
 - 2. Gaskets for PVC Piping: ASTM F 477, elastomeric seals.
 - 3. Gaskets for Ductile-Iron Fittings: AWWA C111, rubber.
- B. PVC Sewer Pipe and Fittings: According to the following:
 - 1. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.
 - 2. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.
- C. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794, open and closed profile, bell and spigot for gasketed joints.
 - 1. Gaskets: ASTM F 477, elastomeric seals.

2.4 SPECIAL PIPE COUPLINGS AND FITTINGS

- A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.
 - 1. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 - 2. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
 - 3. Bands: Stainless steel, at least one at each pipe insert.
- B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.
 - 1. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 - 2. Material for Dissimilar Pipe: Compatible with pipe materials being joined.
- C. Pressure-Type Pipe Couplings: AWWA C219, iron-body sleeve assembly matching OD of pipes to be joined, with AWWA C111 rubber gaskets, bolts, and nuts. Include PE film, pipe encasement.
- D. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.
- E. Ductile-Iron Deflection Fittings: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees deflection.
- F. Ductile-Iron Expansion Joints: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated.

2.5 MANHOLES

- A. Normal-Traffic Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
 - 1. Diameter: 48 inches minimum, unless otherwise indicated.
 - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 3. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section and having separate base slab or base section with integral floor.
 - 4. Riser Sections: 5-inch minimum thickness, and lengths to provide depth indicated.
 - 5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 - 6. Gaskets: ASTM C 443, rubber.
 - 7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and cover.
 - 8. Steps: ASTM C 478, individual steps or ladder. Omit steps for manholes less than 60 inches deep.

9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Heavy-Traffic Precast Concrete Manholes: ASTM C 913; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for rubber gasketed joints.
 1. Ballast: Increase thickness of one or more precast concrete sections or add concrete to structure, as required to prevent flotation.
 2. Gaskets: Rubber.
 3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and cover.
 4. Steps: Manufactured from deformed, 1/2-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
 5. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- C. Cast-in-Place Concrete Manholes: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
 1. Ballast: Increase thickness of concrete, as required to prevent flotation.
 2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and cover.
 3. Steps: Manufactured from deformed, 1/2-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
- D. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter cover. Include indented top design with lettering "SANITARY SEWER" cast into cover.

2.6 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

- C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - 2. Benches: Concrete, sloped to drain into channel.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.7 PROTECTIVE COATINGS

- A. Description: One- or two-coat, coal-tar epoxy containing no less than 72.99 by volume nonvolatile solids, approved equal or superior to Carboline Bitumastic 300 mil.; 16-mil minimum thickness, unless otherwise indicated; factory or field applied to the following surfaces:
 - 1. Concrete Manholes: On interior surface.

2.8 BACKWATER VALVES

- A. PVC Backwater Valves: Similar to ASME A112.14.1, horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.9 CLEANOUTS

- A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31, Section 31 02 20 - EARTHWORK.

3.2 IDENTIFICATION

- A. Materials and their installation are specified in Division 31, Section 31 02 20 - EARTHWORK. Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.
 - 1. Use detectable warning tape over ferrous piping, over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

- A. General: Include watertight joints.
- B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.
- C. Gravity-Flow Piping: Use the following:
 - 1. NPS 4 and NPS 6: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints.

2. NPS 8 and NPS 10: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints.
3. NPS 12 and NPS 15: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints.
4. Pipe Sizes NPS 18 to NPS 24: PVC sewer pipe and fittings, gaskets, and gasketed joints.
5. Pipe Sizes NPS 18 to NPS 24: PVC profile gravity sewer pipe and fittings, gaskets, and gasketed joints.

3.4 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

- A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
 1. Use the following pipe couplings for nonpressure applications:
 - a. Sleeve type to join piping, of same size, or with small difference in OD.
 - b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
 - c. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.5 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Contractor to coordinate all existing and proposed utilities.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.
 1. Install piping pitched down in direction of flow, at minimum slope of 2 percent, unless otherwise indicated.
 2. Install piping with 36-inch minimum cover.
- F. Extend sanitary sewerage piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.
- G. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

3.6 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.

- B. PVC Pressure Pipe and Fittings: Join and install according to AWWA M23.
- C. PVC Sewer Pipe and Fittings: As follows:
 - 1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
 - 2. Join profile sewer pipe fittings with gaskets according to ASTM D 2321 and manufacturer's written instructions.
 - 3. Install according to ASTM D 2321.
- D. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual." Use the following seals:
 - 1. Round Pipe and Fittings: ASTM C 443, rubber gaskets.
- E. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.
- F. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.
- G. Install with top surfaces of components, except piping, flush with finished surface.

3.7 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Form continuous concrete channels and benches between inlets and outlet.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished grade elsewhere, unless otherwise indicated.
- D. Install precast concrete manhole sections with gaskets according to ASTM C 891.
- E. Construct cast-in-place manholes as indicated.

3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.9 BACKWATER VALVE INSTALLATION

- A. Install horizontal units in piping where indicated.
- B. Install combination units in piping and in structures where indicated.
- C. Install terminal units on end of piping and in structures where indicated. Secure units to structure walls.

3.10 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.11 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.
- B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
- C. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
- D. Make branch connections from side into existing piping, NPS 21 or larger, or to underground structures by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - 1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - 2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
- E. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.12 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

3.13 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
 - 1. Place plug in end of incomplete piping at end of day and when work stops.
 - 2. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:

- a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.
- C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate reports for each test.
 5. If authorities having jurisdiction do not have published procedures, perform tests as follows:
 - a. Sanitary Sewerage: Perform hydrostatic test.
 - 1) Allowable leakage is maximum of 50 gal. per inch of nominal pipe size per mile of pipe, during 24-hour period.
 - 2) Close openings in system and fill with water.
 - 3) Purge air and refill with water.
 - 4) Disconnect water supply.
 - 5) Test and inspect joints for leaks.
 - b. Sanitary Sewerage: Perform air test according to UNI-B-6.
 6. Manholes: Perform hydraulic test according to ASTM C 969.
 7. Leaks and loss in test pressure constitute defects that must be repaired.
 8. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 334100 STORM UTILITY DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes storm drainage outside of building(s).
- B. Related Sections include the following:
 - 1. Section 33 46 00 - SUBDRAINAGE.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene-monomer rubber.
- C. HDPE: High-density Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Polymer-concrete, channel drainage systems.
 - 2. Plastic, channel drainage systems.
 - 3. Backwater valves, cleanouts, and drains.
- B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
 - 1. Precast concrete manholes and other structures, including frames, covers, and gates.
 - 2. Cast-in-place concrete manholes and other structures, including frames, covers, and grates.
- C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.
- D. Coordination Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1-inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- E. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Polymer-Concrete, Channel Drainage Systems:
 - a. ABT, Inc.
 - b. ACO Polymer Products, Inc.
 - c. Innovative Plastic Products, Inc.
 - d. Josam Co.; Mea-Josam Div.
 - e. Morrison Molded Fiber Glass Co.; Quazite Div.
 - 2. Plastic, Channel Drainage Systems:
 - a. ACO Polymer Products, Inc.
 - b. MultiDrain Corp.
 - c. NDS, Inc.
 - d. Tuf-Tite, Inc.
 - e. Zurn Industries, Inc.; Hydromechanics Div.
 - 3. Steel, Trench Drainage Systems:
 - a. Rockford Sanitary Systems, Inc.
 - 4. Gray-Iron Backwater Valves, Cleanouts, and Drains:
 - a. Josam Co.
 - b. McWane, Inc.; Tyler Pipe; Wade Div.
 - c. MIFAB.
 - d. Smith: Jay R. Smith Mfg. Co.
 - e. Watts Industries, Inc.; Ancon Drain Div.
 - f. Watts Industries, Inc.; Enpoco, Inc. Div.
 - g. Zurn Industries, Inc.; Hydromechanics Div.
 - 6. PVC Backwater Valves and Cleanouts:
 - a. Canplas, Inc.
 - b. IPS Corp.
 - c. NDS, Inc.
 - d. Plastic Oddities, Inc.
 - e. Sioux Chief Manufacturing Co., Inc.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 PIPES AND FITTINGS

- A. PVC Sewer Pipe and Fittings: According to the following:
1. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.
 2. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints.
 - a. Gaskets: ASTM F 477, elastomeric seals.
- B. PVC, Ribbed Drain Pipe: AASHTO M 304M, bell and spigot, with smooth waterway for bell-gasketed joints.
1. Fittings: AASHTO M 304M or ASTM F 794 for bell-gasketed joints.
 2. Gaskets: ASTM F 477, elastomeric seals to form soiltight joints.
- C. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class III, Wall B, for gasketed joints.
1. Gaskets: ASTM C 443, rubber.
- D. Reinforced-Concrete Arch Pipe: ASTM C 506, Class IV, for banded joints.
1. Sealing Bands: ASTM C 877, Type I.
- E. Reinforced-Concrete Elliptical Pipe: ASTM C 507, Class IV, for banded joints.
1. Pattern: Type HE, horizontal.
 2. Pattern: Type VE, vertical.
 3. Sealing Bands: ASTM C 877, Type I.

2.4 SPECIAL PIPE COUPLINGS AND FITTINGS

- A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.
1. Sleeve Material for Concrete Pipe: ASTM C 443, rubber.
 2. Sleeve Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
 3. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 4. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
 5. Bands: Stainless steel, at least one at each pipe insert.
- B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.
1. Material for Concrete Pipe: ASTM C 443, rubber.
 2. Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
 3. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
 4. Material for Dissimilar Pipe: Compatible with pipe materials being joined.
- C. Pressure-Type Pipe Couplings: AWWA C219, iron-body sleeve assembly matching OD of pipes to be joined, with AWWA C111 rubber gaskets, bolts, and nuts. Include PE film, pipe encasement.
- D. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum

working pressure and for offset and expansion indicated. Include PE film, pipe encasement.

- E. Ductile-Iron Deflection Fittings: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees deflection. Include PE film, pipe encasement.
- F. Ductile-Iron Expansion Joints: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated. Include PE film, pipe encasement.

2.5 MANHOLES

- A. Normal-Traffic Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
 - 1. Diameter: 48 inches minimum, unless otherwise indicated.
 - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 - 4. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
 - 5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 - 6. Gaskets: ASTM C 443, rubber.
 - 7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and cover.
 - 8. Steps: ASTM C 478, individual steps or ladder. Omit steps for manholes less than 60 inches deep.
 - 9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Heavy-Traffic Precast Concrete Manholes: ASTM C 913; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for rubber gasketed joints.
 - 1. Ballast: Increase thickness of one or more precast concrete sections or add concrete to structure, as required to prevent flotation.
 - 2. Gaskets: Rubber.
 - 3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and cover.
 - 4. Steps: Manufactured from deformed, 1/2-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
 - 5. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- C. Cast-in-Place Concrete Manholes: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.

1. Ballast: Increase thickness of concrete, as required to prevent flotation.
 2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and cover.
 3. Steps: Manufactured from deformed, 1/2-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
- D. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter cover. Include indented top design with lettering "STORM SEWER" cast into cover.

2.6 CATCH BASINS

- A. Normal-Traffic, Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 2. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 3. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 4. Gaskets: ASTM C 443, rubber.
 5. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
 6. Steps: ASTM C 478, individual steps or ladder. Omit steps for catch basins less than 60 inches deep.
 7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Heavy-Traffic, Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for rubber gasketed joints.
1. Gaskets: Rubber.
 2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
 3. Steps: Manufactured from deformed, 1/2-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
 4. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- C. Cast-in-Place Concrete, Catch Basins: Construct of reinforced concrete; designed according to ASTM C 890 for structural loading; of depth, shape, dimensions, and appurtenances indicated.
1. Bottom, Walls, and Top: Reinforced concrete.

2. Channels and Benches: Concrete.
 3. Steps: Manufactured from deformed, 1/2-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
- D. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for heavy-duty service. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 24 inches minimum, unless otherwise indicated.
 2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.7 STORMWATER INLETS

- A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.
- B. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
- C. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
- D. Frames and Grates: Heavy-duty frames and grates according to utility standards.
1. Material: ASTM A 536, Grade 60-40-18 minimum, ductile-iron casting.
 2. Material: ASTM A 48, Class 30 minimum, gray-iron casting.
 3. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

2.8 STORMWATER DETENTION STRUCTURES

- A. Cast-in-Place Concrete, Stormwater Detention Structures: Construct of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
1. Ballast: Increase thickness of concrete, as required to prevent flotation.
 2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and cover.
 3. Steps: Manufactured from deformed, 1/2-inch steel reinforcement rod complying with ASTM A 615 and encased in polypropylene complying with ASTM D 4101. Include pattern designed to prevent lateral slippage off step. Cast or anchor into sidewalls with steps at 12- to 16-inch intervals. Omit steps for structures less than 60 inches deep.
- B. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch-diameter cover. Include indented top design with lettering "STORM SEWER" cast into cover.

2.9 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.
- C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water-cementitious ratio.
 1. Include channels and benches in manholes.
 - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - b. Benches: Concrete, sloped to drain into channel.
 2. Include channels in catch basins.
 - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.10 POLYMER-CONCRETE, CHANNEL DRAINAGE SYSTEMS

- A. General: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include number of units required to form total lengths indicated.
- B. Sloped-Invert, Polymer-Concrete Systems: Include the following components:
 1. Channel Sections: Interlocking-joint, precast, modular units with end caps. Include 4-inch inside width and deep, rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.
 - a. Frame: Include gray-iron or steel frame for grate.
 2. Grates with manufacturer's designation "Medium Duty," with slots or perforations that fit recesses in channels.
 - a. Material: Galvanized steel.
 - b. Material: Gray iron.
 3. Grates with manufacturer's designation "Heavy Duty," with slots that fit recesses in channels.
 - a. Material: Galvanized steel.
 - b. Material: Gray iron.
 4. Covers: Solid gray iron, if indicated.
 5. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- C. Narrow-Width, Level-Invert, Polymer-Concrete Systems: Include the following components:
 1. Channel Sections: Interlocking-joint, precast, modular units with end caps. Include 5-inch inside width and 9-3/4-inch deep, rounded bottom, with level invert and with NPS 4 outlets in number and locations indicated.
 2. Grates with slots or perforations that fit recesses in channels.
 - a. Material: Galvanized steel.
 - b. Material: Gray iron.

3. Covers: Solid gray iron, if indicated.
 4. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- D. Wide-Width, Level-Invert, Polymer-Concrete Systems: Include the following components:
1. Channel Sections: Interlocking-joint, precast, modular units with end caps. Include 8-inch inside width and 13-3/4-inch deep, rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 2. Grates with slots or other openings that fit recesses in channels.
 - a. Material: Gray iron.
 3. Covers: Solid gray iron, if indicated.
 4. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- E. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
- F. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.12 PLASTIC, CHANNEL DRAINAGE SYSTEMS

- A. General: Modular system of plastic channel sections, grates, and appurtenances; designed so grates fit into frames without rocking or rattling. Include number of units required to form total lengths indicated.
- B. PE Systems: Include the following components:
1. Channel Sections: Interlocking-joint, PE modular units, 4 inches wide, with end caps. Include rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 2. Grates: PE, ladder shaped; with stainless-steel screws.
 3. Color: Gray, unless otherwise indicated.
 4. Drainage Specialties: Include the following PE components:
 - a. Drains: 4-inch-diameter, round, slotted top; with NPS 4 bottom outlet.
 - b. Drains: 8-inch-diameter, round, slotted top; with NPS 6 bottom outlet.
 - c. Drains: 4-inch-square, slotted top; with NPS 3 bottom outlet.
 - d. Drains: 8-inch-square, slotted top; with NPS 6 bottom outlet.
 - e. Catch Basins: 12-inch-square plastic body, with outlets in number and sizes indicated. Include PE slotted grate 11-3/4 inches square by 1-1/8 inches thick.
- C. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
- D. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.13 BACKWATER VALVES

- A. Gray-Iron Backwater Valves: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
1. Horizontal Type: With swing check valve and hub-and-spigot ends.
 2. Combination Horizontal and Manual Gate-Valve Type: With swing check valve, integral gate valve, and hub-and-spigot ends.
 3. Terminal Type: With bronze seat, swing check valve, and hub inlet.

- B. PVC Backwater Valves: Similar to ASME A112.14.1, horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

2.14 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications according to the following applications:
 - 1. Light Duty: In earth or grass foot-traffic areas.
 - 2. Medium Duty: In paved foot-traffic areas.
 - 3. Heavy Duty: In vehicle-traffic service areas.
 - 4. Extra-Heavy Duty: In roads.
 - 5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.15 DRAINS

- A. Gray-Iron Area Drains: ASME A112.21.1M, round, gray-iron body with anchor flange and round, secured, gray-iron grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated. Use units with top-loading classifications according to the following applications:
 - 1. Medium Duty: In paved foot-traffic areas.
 - 2. Heavy Duty: In vehicle-traffic service areas.
- B. Gray-Iron Trench Drains: ASME A112.21.1M, 6-inch-wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular, secured grate. Include units of total lengths indicated and number of bottom outlets with inside calk or spigot connections, of sizes indicated. Use units with top-loading classifications according to the following applications:
 - 1. Medium Duty: In paved foot-traffic areas.
 - 2. Heavy Duty: In vehicle-traffic service areas.
 - 3. Extra-Heavy Duty: In roads.
- C. Steel Trench Drains: Fabricated from ASTM A 242 steel plate, to form rectangular body with uniform bottom slope of 2 percent down toward outlet, anchor flange, and grate. Include units of total lengths indicated, bottom outlet of size indicated, outlet strainer, and acid-resistant enamel coating on inside and outside surfaces. Include grate openings with total free area at least two times outlet cross-sectional area.

2.16 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregular size and shape, graded stone, with a minimum size of 6 inches.
- C. Filter Stone: NSA No. FS-2, No. 4 screen opening, average-size, graded stone.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31, Section 31 00 00 - EARTHWORK.

3.2 IDENTIFICATION

- A. Materials and their installation are specified in Division 31, Section 31 00 00 - EARTHWORK. Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.
 - 1. Use detectable warning tape over ferrous piping, over nonferrous piping and over edges of underground structures.

3.3 PIPING APPLICATIONS

- A. General: Include watertight, silttight, or soiltight joints, unless watertight or silttight joints are indicated.
- B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.
- C. Gravity-Flow Piping: Use the following:
 - 1. NPS 4 and NPS 6: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints.
 - 2. NPS 8 to NPS 15: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints.
 - 3. NPS 8 to NPS 15: NPS 12 and NPS 15 reinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints. Do not use nonreinforced pipe instead of reinforced concrete pipe in NPS 8 and NPS 10.
 - 4. NPS 18 to NPS 36: PVC, ribbed drain pipe and fittings; gaskets; and gasketed joints.
 - 5. NPS 18 to NPS 36: PVC sewer pipe and fittings, gaskets, and gasketed joints.
 - 6. NPS 18 to NPS 36: Reinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints.
 - 7. NPS 18 to NPS 36: Reinforced-concrete arch pipe, sealing bands, and banded joints.
 - 8. NPS 18 to NPS 36: Reinforced-concrete, elliptical pipe, Type HE, horizontal; sealing bands; and banded joints.
 - 9. NPS 18 to NPS 36: Reinforced-concrete, elliptical pipe, Type VE, vertical; sealing bands; and banded joints.
 - 10. NPS 42 to NPS 144: Reinforced-concrete sewer pipe and fittings, gaskets, and gasketed joints.
 - 11. NPS 42 to NPS 132: Reinforced-concrete arch pipe, sealing bands, and banded joints.
 - 12. NPS 39 to NPS 144: Reinforced-concrete, Type HE, horizontal, elliptical pipe; sealing bands; and banded joints.
 - 13. NPS 39 to NPS 144: Reinforced-concrete, Type VE, vertical, elliptical pipe; sealing bands; and banded joints.

3.4 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

- A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
 - 1. Use the following pipe couplings for nonpressure applications:
 - a. Sleeve type to join piping, of same size, or with small difference in OD.
 - b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
 - c. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.5 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.
 - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
 - 2. Install piping with 36-inch minimum cover.
- F. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.
- G. Install PVC force-main piping according to AWWA M23.
- H. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

3.6 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.
- B. PVC Pressure Pipe and Fittings: Join and install according to AWWA M23.
- C. PVC Sewer Pipe and Fittings: As follows:
 - 1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
 - 2. Install according to ASTM D 2321.
- D. Concrete Pipe and Fittings: Install according to ACPA's "Concrete Pipe Installation Manual." Use the following seals:
 - 1. Round Pipe and Fittings: ASTM C 443, rubber gaskets.
 - 2. Elliptical Pipe: ASTM C 877, Type I, sealing bands.
 - 3. Arch Pipe: ASTM C 877, Type I, sealing bands.
- E. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.
- F. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.7 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Form continuous concrete channels and benches between inlets and outlet.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished grade elsewhere, unless otherwise indicated.

- D. Install precast concrete manhole sections with gaskets according to ASTM C 891.
- E. Construct cast-in-place manholes as indicated.

3.8 CATCH-BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.9 STORM DRAINAGE INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.10 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.11 DRAINAGE SYSTEM INSTALLATION

- A. Assemble and install components according to manufacturer's written instructions.
- B. Assemble and install stainless-steel drainage systems according to ASME A112.3.1 and manufacturer's written instructions.
- C. Install with top surfaces of components, except piping, flush with finished surface.
- D. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
- E. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides.
- F. Fasten grates to channel sections if indicated.
- G. Assemble trench sections with flanged joints.
- H. Embed trench sections and drainage specialties in 4-inch minimum concrete around bottom and sides.
- I. Make piping connections and install stainless-steel piping with gasketed joints between system components.

3.12 BACKWATER VALVE INSTALLATION

- A. Install horizontal units in piping where indicated.
- B. Install combination units in piping and in structures where indicated.
- C. Install terminal units on end of piping and in structures where indicated. Secure units to structure walls.

3.13 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.14 DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
- B. Embed drains in 4-inch minimum depth of concrete around bottom and sides.

- C. Fasten grates to drains if indicated.
- D. Set drain frames and covers with tops flush with pavement surface.

3.15 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.
- B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
- C. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
- D. Make branch connections from side into existing piping, NPS 21 or larger, or to underground structures by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - 1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - 2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
- E. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.16 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place plug in end of incomplete piping at end of day and when work stops.
 - 3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- C. Test new piping systems, and parts of existing systems that have been altered, extended, or

repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.
5. Leaks and loss in test pressure constitute defects that must be repaired.
6. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 334600 SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes subdrainage systems for the following:
 - 1. Foundations.
 - 2. Retaining walls.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene.
- B. HDPE: High-density polyethylene.
- C. PE: Polyethylene.
- D. PP: Polypropylene.
- E. PS: Polystyrene.
- F. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

- A. Product Data: For drainage conduit, drainage panels, and geotextile fabrics.
 - 1. Perforated pipe.
 - 2. Solid pipe.
 - 3. Pipe with open joints.
 - 4. Drainage conduits.
 - 5. Drainage panels.
 - 6. Geotextile fabrics.

1.5 COORDINATION

- A. Drainage panel materials and installation shall be compatible with waterproofing of walls below grade.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to various application articles in Part 3 for applications of pipe, tube, fitting, and joining materials.

2.3 UNDERSLAB HEADERS

- A. ABS Sewer Pipe and Fittings: ASTM D 2751.
 - 1. Solvent Cement: ASTM D 2235.
 - 2. Gaskets: ASTM F 477, elastomeric seal.

- B. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.
 - 1. Gaskets: ASTM F 477, elastomeric seal.

2.4 DRAINAGE PIPES AND FITTINGS

- A. Perforated, PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.
- B. Concrete Drain Tile: ASTM C 412; Standard-Quality; Extra-Quality; and Heavy-Duty, Extra-Quality classes, for open joints.

2.5 SPECIAL PIPE COUPLINGS

- A. Description: ASTM C 1173. Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.

2.6 CLEANOUTS

- A. PVC Pipe: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.7 DRAINAGE CONDUIT

- A. Pipe and Fittings: Perforated and corrugated, molded from HDPE complying with ASTM D 3350, with fittings and geotextile filter fabric jacket.
 - 1. Size: 12 inches diameter by approximately 3/4-inch-thick with a minimum flow rate of 30 gpm per foot.
 - 2. Size: 18 inches diameter by approximately 3/4-inch-thick with a minimum flow rate of 45 gpm per foot when tested according to ASTM D 4716.
 - 3. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.
 - 4. Couplings: Corrugated HDPE band.
- B. Pipe and Fittings: Perforated, molded from HDPE complying with ASTM D 1248 into shape of interconnected corrugated pipes, with fittings and geotextile filter fabric jacket.
 - 1. Size: 6 inches diameter by approximately 1-1/4 inches thick with a flow rate of 15 gpm per foot when tested according to ASTM D 4716.
 - 2. Size: 12 inches diameter by approximately 2-1/2 inches thick with a flow rate of 30 gpm per foot when tested according to ASTM D 4716.
 - 3. Size: 18 inches diameter by approximately 3-3/4 inches thick with a flow rate of 45 gpm per foot when tested according to ASTM D 4716.
 - 4. Fittings: HDPE with combination NPS 4 and NPS 6 outlet connection.
 - 5. Couplings: HDPE.
- C. Pipe and Fittings: Perforated, smooth PVC complying with ASTM D 4216 and ASTM D 2729.
 - 1. Size: 6 inches and 8 inches diameter by approximately 2-1/4 inches thick with a minimum flow rate equal to NPS 4 pipe.
 - 2. Fittings: PVC with NPS 4 outlet connection.
 - 3. Couplings: PVC.

2.8 MOLDED-SHEET DRAINAGE PANELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Wick Drain Corporation.
 - 2. Grace, W. R. & Co.; Construction Products Div.
 - 3. GREENSTREAK/Western Textile Products.

- 4. Ling Industrial Fabrics, Inc.
- 5. TC Mirafi.
- B. Description: Prefabricated, composite panels, 36 to 60 inches wide, and manufactured with geotextile facing laminated to molded-plastic drainage core.
- C. Drainage Core: Three-dimensional, nonbiodegradable, molded PP or PS.
- D. Geotextile: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288:
- E. Film Backing: Polymeric film bonded to drainage core surface.

2.9 FABRIC DRAINAGE PANELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Akzo Nobel Geosynthetics Co.
 - 2. GSE Lining Technology, Inc.
 - 3. JDR Enterprises, Inc.
 - 4. Strata Systems, Inc.
 - 5. Tensar Earth Technologies, Inc.
- C. Description: Prefabricated, composite drainage panels, made with drainage core and filter fabric, for use as part of foundation, underslab, plaza deck, and retaining-wall drainage system.
- D. Drainage Core: Open-construction, resilient, 0.8-inch-thick, nylon-filament mesh.
 - 1. Minimum Flow Rate: 2.4 gpm per foot at hydraulic gradient of 1.0 and normal pressure of 3600 psig when tested according to ASTM D 4716.
- E. Drainage Core: 3-dimensional, PE strand, 0.25-inch-thick, nonwoven net.
 - 1. Minimum Flow Rate: 5 gpm per foot at hydraulic gradient of 1.0 and normal pressure of 3600 psig when tested according to ASTM D 4716.
- F. Filter Fabric: Nonwoven geotextile filter fabric of PP or polyester fibers, or combination of both. Flow rates range from 120 to 200 gpm per sq. ft. when tested according to ASTM D 4491.

2.10 SOIL MATERIALS

- A. Impervious Fill: Clay, gravel, and sand mixture.
- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate, Size No. 57, with 100 percent passing 1-1/2-inch sieve and not more than 5 percent passing No. 8 sieve.

2.11 GEOTEXTILE FILTER FABRICS

- A. Woven or nonwoven geotextile filter fabric of PP or polyester fibers, or combination of both. Flow rates range from 110 to 330 gpm per sq. ft. when tested according to ASTM D 4491. Available styles are flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

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

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31, Section 31 02 20 - EARTHWORK.

3.3 SUBDRAINAGE SYSTEM APPLICATIONS

- A. NPS 4 through NPS 10 Piping:
 - 1. Perforated, PVC sewer pipe and fittings for loose, bell-and-spigot joints.
 - 2. Concrete drain tile, Extra-Quality class; and open joints.

3.4 IDENTIFICATION

- A. Materials and their installation are specified in Division 31, Section 31 02 20 - EARTHWORK. Arrange for installation of green warning tapes directly over piping.
 - 1. Install detectable warning tape over ferrous piping, nonferrous piping and over edges of underground structures.

3.5 FOUNDATION DRAINAGE INSTALLATION

- A. Bottom Impervious Fill: Place impervious fill material on subgrade adjacent to bottom of footing after concrete footings have been cured and forms removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.
- B. Drainage Fill: Place supporting layer of drainage fill over compacted subgrade to compacted depth of not less than 4 inches. After installing drainage piping, add drainage fill to width of at least 6 inches on side away from wall and to top of pipe to perform tests. After satisfactory testing, cover piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade. Place drainage fill in layers not exceeding 3 inches in loose depth; compact each layer placed.
 - 1. Before installing drainage fill, lay flat-style geotextile filter fabric in trench and overlap trench sides. After installing drainage fill, wrap top of drainage fill with flat-style geotextile filter fabric.
 - 2. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with electrical tape.
 - 3. After installing drainage fill, place one layer of flat-style geotextile filter fabric over top of drainage fill, overlapping edges at least 4 inches.
- C. Install vertical drainage panel as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated, PVC drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
 - 3. Mark horizontal chalk line on wall at a point 6 inches less than panel width above footing bottom. Before marking wall, subtract footing width.
 - 4. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
 - 5. Wrap bottom of panel around drainage pipe.
 - 6. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Some manufacturers use construction adhesives, metal stick pins, or double-sided tape. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
 - 7. If another panel is required on the same row, cut away 4 inches of installed panel core and wrap fabric over new panel.

8. If additional rows of panel are required, overlap lower panel with 4 inches of fabric.
 9. Cut panel as necessary to keep top 12 inches below finish grade.
 10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
 11. Do not use drainage panels as protection over waterproof membrane, unless otherwise approved by waterproofing membrane manufacturer.
- D. Fill to Grade: Place native fill material over compacted drainage fill. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish elevations and slope away from building.

3.6 RETAINING-WALL DRAINAGE INSTALLATION

- A. Drainage Fill: Place supporting layer of drainage fill over compacted subgrade to compacted depth of not less than 4 inches. After installing drainage piping, add drainage fill to width of at least 6 inches on side away from wall and to top of pipe to perform tests. After satisfactory testing, cover piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade. Place drainage fill in layers not exceeding 3 inches in loose depth; compact each layer placed.
1. Before installing drainage fill, lay flat-style geotextile filter fabric in trench and overlap trench sides. After installing drainage fill, wrap top of drainage fill with flat-style geotextile filter fabric.
 2. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with electrical tape.
 3. After installing drainage fill, place one layer of flat-style geotextile filter fabric over top of drainage fill, overlapping edges at least 4 inches.
- B. Install vertical drainage panels as follows:
1. Coordinate placement with other drainage materials.
 2. Lay perforated, PVC drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
 3. If weep holes are used in lieu of drainage pipe, cut 1/2-inch-diameter holes on core side at weep-hole locations. Do not cut fabric.
 4. Mark horizontal chalk line on wall at a point 6 inches less than panel width above footing bottom. Before marking wall, subtract footing width.
 5. Separate 4 inches of fabric at beginning of roll and cut away 4 inches of core. Wrap fabric around end of remaining core.
 6. Wrap bottom of panel around drainage pipe.
 7. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Use nails from 2 to 6 inches below top of panel, approximately 48 inches apart. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
 8. If another panel is required on the same row, cut away 4 inches of installed panel core and wrap fabric over new panel.
 9. If additional rows of panel are required, overlap lower panel with 4 inches of fabric.
 10. Cut panel as necessary to keep top 12 inches below finish grade.
 11. For inside corners, bend panel. For outside corners, cut core to provide 3 inches for overlap.
 12. Do not use drainage panels as protection over waterproof membrane, unless otherwise approved by waterproofing membrane manufacturer.

- C. Fill to Grade: Place native fill material over compacted drainage fill. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.7 LANDSCAPING DRAINAGE INSTALLATION

- A. Install drainage pipe with a horizontal distance of at least 6 inches between pipe and trench walls. Grade bottom of trench excavations to required slope and compact to firm, solid bed for drainage system.
- B. Drainage Fill: Place supporting layer of drainage fill over trench bottom to compacted depth of not less than 4 inches. After installing drainage piping, add drainage fill to top of pipe to perform tests. After satisfactory testing, cover piping to within 12 inches of finish grade. Place drainage fill in layers not exceeding 3 inches in loose depth; compact each layer placed.
 - 1. After installing drainage fill, place one layer of flat-style geotextile filter fabric over top of drainage fill, overlapping edges at least 4 inches.
 - 2. Before installing drainage fill, lay flat-style geotextile filter fabric in trench and overlap trench sides. After installing drainage fill, wrap top of drainage fill with flat-style geotextile filter fabric.
 - 3. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with electrical tape.
- C. Drainage Conduit: Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope and compact to firm, solid bed for drainage system.
- D. Fill to Grade: Place native fill material over drainage fill or conduit. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.8 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 - 1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 - 2. Plaza Deck Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 1.0 percent.
 - 3. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated. However, when water discharges through wall weep holes, pipe may be installed with a minimum slope of zero percent.
 - 4. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 - 5. Lay perforated pipe with perforations down.
 - 6. Lay open-joint pipe spaced as indicated on Drawings or, if not indicated, with 1/4-inch space between ends. Cover top two-thirds of joint opening with open-joint screening material and tie with corrosion-resistant wire.
 - 7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and

fittings being connected. Reduction of pipe size in direction of flow is prohibited.

- C. Install PVC piping according to ASTM D 2321.
- D. Install concrete piping according to ACPA's "Concrete Pipe Handbook."

3.9 PIPE JOINT CONSTRUCTION

- A. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.
- B. Join perforated, PVC pipe and fittings according to ASTM D 2729, with loose, bell-and-spigot joints.
- C. Join perforated, concrete pipe and fittings with gaskets according to ASTM C 443.
- D. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and that fit both pipe materials and dimensions.

3.10 FOUNDATION RETAINING-WALL AND LANDSCAPING SUBDRAINAGE CLEANOUT INSTALLATION

- A. Install cleanouts from subdrainage piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
- B. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for subdrainage piping branch fittings and riser extensions to cleanout plug. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches in depth. Set top of cleanout plug flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
- C. In nonvehicular-traffic areas, use NPS 4 PVC pipe and fittings for subdrainage piping branch fittings and riser extensions to cleanout plug. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches in depth. Set top of cleanout plug 1 inch above grade.

3.11 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.12 FIELD QUALITY CONTROL

- A. Testing: After installing drainage fill to top of pipe, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.13 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION