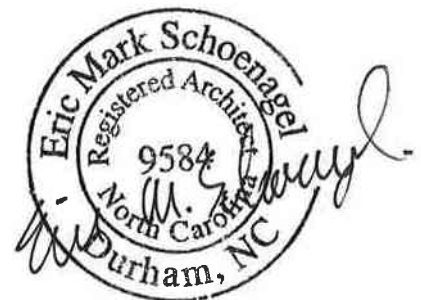


PROJECT MANUAL

UNIVERSITY OF NORTH CAROLINA
AT WILMINGTON
HOUSING VILLAGE PHASE 3
601 SOUTH COLLEGE ROAD
WILMINGTON, NORTH CAROLINA 28403
COMPLETE PACKAGE
CONSTRUCTION DOCUMENTS

5142301800 / SCO 22-29053-02D

VOLUME 2
JANUARY 15, 2026



01.15.2026

ESTIMATED
EMBODIED
CARBON

445 kgCO₂e/m²

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

January 15, 2026

University of North Carolina at Wilmington
Housing Village Phase 3
Complete Package - Construction Documents

5142301800
SCO 24-29053-02D

DOCUMENT 00 01 07 - SEALS PAGE

This document includes the Professional Seals of Design Professionals responsible for preparing the Construction Documents.

ARCHITECTURAL:

SEAL LOCATION:

NAME:

Eric Schoenagel
(Print)

Eric M. Schoenagel

(Signature)

9584

(Professional Number)



January 15, 2026

University of North Carolina at Wilmington
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STRUCTURAL:

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NAME:

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Carl Schuett

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(Professional Number)



January 15, 2026

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PLUMBING:

SEAL LOCATION:

NAME:

James L. Currie

(Print)

(Signature)

031478

(Professional Number)



January 15, 2026

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January 15, 2026

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CIVIL:

SEAL LOCATION:

NAME:

Steven J. Miller

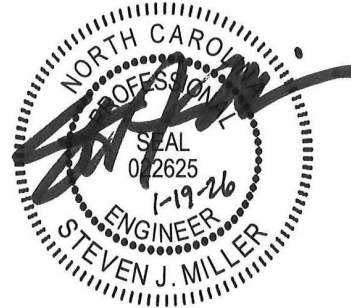
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(Signature)

NCPE 022625

(Professional Number)



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LANDSCAPE:

SEAL LOCATION:

NAME:

Charles Bradley

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NC 1717

(Professional Number)



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PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work to be done under Division 21 contracts shall include the furnishing of all labor, materials, equipment, and services necessary for and reasonably incidental to the proper completion of all work as shown on the plans and herein specified, excepting only work materials specified or noted as being furnished or installed by others.
- B. All work shown in the drawings and specifications shall be included under the base bid, except where there is specific reference to exclusion and incorporation in other quotation.
- C. The Fire Protection contractor for this single prime contract may hereinafter also be referred to as "This Contractor, "FP", or Division 21 Contractor.
- D. Drawings shall not be scaled. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule or architectural drawings for material, finish and construction method of walls, floor and ceiling in order to ensure proper rough-in and installation of work.
- E. Division of the Specification into sections is for the purpose of simplification alone. Responsibility for the work of various trades shall rest with the Contractor. Various sections of this Division are related to each other as well as the mechanical drawings. Examine all drawings and read all applicable parts of the project manual in order to ensure complete execution of all work in this Division, coordinating where required with other trades in order to avoid conflicts.
- F. These specifications and accompanying drawings are intended to cover the furnishing of all labor, materials, equipment and services necessary for the complete installation and acceptable performance of the mechanical systems. Small items of material, equipment and appurtenances not mentioned in detail or shown on the drawings, but necessary for complete and operating systems, shall be provided by this contractor without additional charge to the Owner and shall be included under this contract.
- G. In general, specifications establish the quality of material, equipment and workmanship. The contract documents are intended to secure for the Owner, a first class installation in every respect. Labor shall be ready for satisfactory and efficient operation.
- H. The contractor shall carefully examine the drawings and specifications before accepting the contract. He shall call attention to any changes or additions which, in his opinion, are necessary to make possible the fulfillment of any guarantee called for by these specifications; failing which, it shall be deemed that he has accepted full responsibility for all such guarantees.
- I. The contractor shall put his work in place as fast as is reasonably possible. He shall, at all times, keep a competent foreman in charge of the work, to make decisions necessary for the diligent advancement of the work. The Contractor shall facilitate the inspection of the work by the Owner's Representative.

- J. The Contractor shall coordinate all Fire Protection related work in the building in order to facilitate intelligent execution of the work. He shall also remove any rubbish as expeditiously as possible.
- K. Materials or products specified herein and/or indicated on the drawings by trade names, manufacturer's names or catalog numbers establish the quality of materials or products to be furnished.
- L. Points of connection or continuation of work under this contract are so marked on drawings or herein specified. In case of any doubt as to the required exact location of such points, the Owner's Representative shall decide and direct.

1.2 SPECIALTY SCOPE OF WORK INCLUDED:

- A. The fire protection contractor shall include in the base bid and alternate bids all costs and time for himself, and any required subcontractors to accomplish the scope of work. Work under the fire protection contract shall include, but shall not be limited to, the furnishing, unloading, handling, distribution, setting and installation of all components required for the following systems:
 - 1. All interior wet sprinkler systems.
 - 2. Sprinkler head locations as required per code.
 - 3. Shop Drawings

1.3 RELATED WORK WHICH IS A PART OF SECTION 21 01 00

- A. All work done under this section of the specification is subject to the Architect's instructions to bidders, general conditions and their corresponding supplements.
- B. Refer to the supplementary general conditions of these specifications for temporary services and facilities that shall be provided.

1.4 DEFINITIONS:

- A. "Piping": Pipe, fittings, flanges, valves, controls, hangers, traps, drains, insulation, vents, and items customarily required in connection with the transfer of fluids.
- B. "Ductwork": All air delivery, recirculation and exhaust ducts, whether of sheet metal or other material, and includes all connections, accessories, and appurtenances necessary for and incidental to a complete system.
- C. "Provide" (P): Furnish and install complete ready for use.
- D. "Furnish" (F): Purchase and deliver to the project site complete with every necessary appurtenance and support.
- E. "Install"(I): Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation of the proper location in the project.
- F. "Concealed": Embedded in masonry or other construction, installed behind wall furring, within double piping off of all utilities shall be provided by the General Contractor.

- G. "By Other Trades": Shall mean by persons or parties who are not anticipated to be the Contractor of this trade working together with the general contractor. In this context the words "by other trades" shall not be interpreted to mean not included in the overall contract.

1.5 INTERPRETATION OF CONTRACT DOCUMENTS:

- A. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.
- B. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Exceptions are that notes on the drawings, which refer to an individual element of work, take precedence over the specifications where they conflict with same.
- C. No exclusions from, or limitations in, the language used in the drawings or specifications shall be interpreted as meaning that the appurtenances or accessories necessary to complete any required system or item of equipment are to be omitted.
- D. The drawings of necessity utilize symbols as schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended diagrammatic intent expressed on the drawings, and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings.
- E. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.
- F. Certain details appear on the drawings which are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the intended work.
- G. Information as to the general construction shall be derived from structural and architectural drawings and specification only.
- H. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

1.6 DELINEATION OF WORK:

- A. The Division 21 contractors is required to supply all necessary supervision and coordination of information to any others who are performing work to accommodate the fire protection installation.
- B. The specifications for the overall construction delineate various items of work under separate section headings. The list below set forth this delineation to the extent that it affects the fire protection work category. In the absence of more detailed information, this list shall be taken as a specific instruction to the fire protection contractor to include the work assigned to him. Indications that each contractor is to perform the work mean that it is to perform the work for its own accommodation only, except as specifically noted otherwise.

"P" indicates Provide, "F" indicates Furnish, "I" indicates Install					
ITEM	"GENERAL"	"PLBG"	"MECH"	"FP"	REMARKS
Fire protection				P	Refer to Section 21 01 04 & Electrical Dwg.
Wiring for fire protection equipment					Refer to Section 21 01 04 & Electrical Dwg.
Hoisting				P	
Rigging				P	
Cutting and Patching				P	
EXCEPTION: Cost where due to late installation or improper coordination of work is the responsibility of the delinquent contractor. Locations shall be approved by structural engineer.					
For new construction, framed slots and openings in walls, decks and slabs	P				
EXCEPTION: Coordination drawings are required from fire protection contractor.					
Sleeves through non-membraned slabs, decks and walls				P	
EXCEPTION: Refer to Division 3 for coordination of installation.					
Sleeves through membraned slabs, decks and walls				P	
EXCEPTION: Refer to Division 3 for coordination of installation.					
Fireproof sealing of excess opening in slabs, decks and fire rate walls				P	
Fastenings				P	
Supports				P	
Concrete foundations, pads & bases inside buildings				P	
Field touch-up painting damaged shop coats				P	
Finish painting of exposed work				P	
EXCEPTION: Painting of equipment, piping, etc. in mechanical spaces provided by fire protection contractor.					
Finished wall and ceiling access doors, panels and support frames				P	
Removal of spray on proofing from fire protection equipment	P				
Rubbish removal				P	
EXCEPTION: Where one trade furnishes and another installs, the installing trade removes the shipping and packing material which accumulate.					
Special tools for equipment maintenance				P	
Fire protection piping and associated work at 12" aff and interior to the building				P	

1.7 STANDARDS AND CODES:

- A. Nothing in this specification shall be interpreted to conflict with any City or State law, regulation, code, ordinance, ruling or Fire Underwriters requirement applicable to this class of work.
- B. All installations for construction purposes shall conform with the Department of Labor "Safety and Health Regulations for Construction."
- C. All equipment with electrical components shall bear the UL label.
- D. The following minimum standards apply wherever applicable:

ANS	American National Standards
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act

1.8 INSPECTION AND COOPERATION:

- A. All work shall be done under the periodic observation of and to the complete satisfaction of the Architect. No deviations from the Drawings and Specifications will be allowed without prior written approval of the Architect. The fire protection contractor shall each cooperate with the other contractors to allow for the installation of their work as well as his own.
- B. The fire protection contractor shall be responsible for his work fitting in place without conflict with the other trades, where proper planning could avoid interference. Any work installed by this contractor without regard for other work, or if a conflict results, must be changed if directed by the Architect or Engineer without additional cost to Owner or his agents.
- C. Relocation of equipment, system connections or rough-in locations up to ten feet (10'), if necessary, shall be done at no additional cost to the Owner or his agents if done before roughing-in.
- D. All concealed work shall be inspected by the Architect or his appointed representative before being concealed. Fire protection contractor shall each call for inspection at least two (2) work days before concealment.
- E. The Architect shall have the right to inspect the work whenever advisable in his judgment. The fire protection contractor shall have a representative present at each inspection and shall give such assistance as may be required.
- F. Recommendations made by the Architect shall be promptly carried out and all unsatisfactory material and workmanship replaced at once to the Architect's satisfaction at the fire protection contractor expense.
- G. The fire protection contractor shall be responsible for hoisting of all materials and equipment furnished under as part of his portion of the work in accordance with all City, State, and Federal rules and regulations.
- H. Engineer's Response to RFIs:

1. Due to the technical and aesthetic nature of this project, the fire protection contractor shall be pro-active in his understanding of work efforts to allow the engineer a minimum of 10 working days to respond to RFIs without consideration of time delay to the project schedule.

1.9 TEMPORARY SERVICES AND FACILITIES:

- A. Refer to general requirements for temporary services and facilities that shall be provided.

1.10 UNIT PRICES:

- A. Refer to general requirements relative to "Add" or "Deduct" prices relative to this contract.

1.11 ROCK EXCAVATION UNIT PRICES

- A. Refer to Section 01 22 00, as applicable.

1.12 SUBMITTALS:

LIST OF MANUFACTURERS: Within twenty days following award of contract, the fire protection subcontractor shall start submitting the required information pertaining to the equipment and materials he shall be furnishing, commencing with the list of manufacturers for approval by the Engineer. Following up in short order shall be the shop drawings, coordination documents and other documents. The Owner and his representatives reserve the right to reject as unacceptable any items for which, in their judgment, they have not been allowed adequate lead time in which to investigate suitability, or their experience has proved the service or equipment unsatisfactory.

ITEM	MANUFACTURERS		
Seismic Restraints	Mason	Unistrut	Grinnell
Piping	Allied	Grinnell	Ladish
Tamper Switches	System Sensor	Simplex	Potter Roemer
Alarm Check Valves	GEM	Viking	Reliable
Water Flow Switch	System Sensor	Simplex	Potter Roemer
Supervisory Switch	Potter-Roemer	Simplex	System Sensor
Globe Valve	United	Hammond	Jenkins
Pressure Gauge	Grinnell	Palmer	Wekler
Hangers	Grinnell	Tolco	PHD
Identification	Seton	Calpico	SSC

1.13 SHOP DRAWINGS:

- A. Equipment shop drawings shall include service space requirements, manufacturer's equipment installation brochure and all noise and vibration information.

- B. Prior to purchasing any equipment or materials, the approved list of the manufacturers shall be returned by the Engineer to the Contractor.
- C. Contractor-reviewed and stamped "Approved" shop drawings shall be submitted conforming to the requirements stated in supplementary conditions and Division I for the items indicated throughout the following specifications:
- D. Documents will not be accepted for approval unless:
 - 1. They comply with the requirements of the supplement to the General Conditions.
 - 2. They include complete information pertaining to appurtenances and accessories.
 - 3. They are submitted as a package where they pertain to related items.
 - 4. They are properly marked with service or function identification as related to the project, where they consist of catalog sheets displaying other items which are not applicable, and are marked with pertinent specification paragraph number.
 - 5. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.
- E. Approval of shop drawings does not invalidate the plans and specifications if in conflict unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

1.14 FABRICATION / COORDINATION DRAWINGS:

- A. Due to the complexity of the review, the fabrication/coordination drawings and controls and instrumentation shop drawings shall be submitted in not less than four (4) packages early enough to allow a 30-day review period followed by a second 30 day review period of shop drawings review and comments. Spacing of submittals shall be at no less than 15 working days.
- B. The contractor shall submit to the A/E all coordination drawings and fabrication drawings in packages as specified here. Hard copy documents will be reviewed by the A/E and returned with written comments.
- C. Following up within 5 working days after the return of these documents at the office of the construction manager, all parties will meet to resolve conflicts.
- D. Required Physical Constraints: The ceiling heights have been determined to be 9'-8" and 8'-6" in accordance with the reflected ceiling plans. To accomplish this effort the sequence of work and priority rating shall be as follows:
 - 1. Provide HVAC piping routed in the beam pockets of the structure.
 - 2. Provide ductwork routed in the beam pockets and ceiling cavity below with all associated duct rise and drop offsets.
 - 3. Provide plumbing piping in the beam pockets and ceiling cavity below.
 - 4. Provide fire protection mains routed below the structural beams.
 - 5. Provide the cable tray system and all conduits 2" and larger in diameter.
 - 6. Provide fire protection branch runouts for the mains to sprinkler heads.
 - 7. Provide conduits less than 2" in diameters.
 - 8. Provide ceiling grid and support system for lay-in and rigid ceilings.
 - 9. Provide light fixtures
 - 10. Provide sprinkler heads
 - 11. Provide Diffusers and grilles

1.15 RECORD DRAWINGS

- A. Purchase and maintain at the job site a complete and separate set of prints of the approved working Drawings on which to accurately indicate daily progress by coloring materials and apparatus as installed. Schedules shall be modified to reflect data consistent with that of the installed equipment. Clearly show all changes to the work as a result of change orders, instructions issued by the Architect or conditions encountered in the field. Accurately indicate the location, size, type and elevation of new utilities and their relationship to existing utilities.
- B. The marked-up and colored-in prints will be used as a guide for determining the progress of the work installed. They shall be inspected at the architect's discretion and shall be corrected immediately if found inaccurate or incomplete. Requisitions for payment may not be approved until the drawings are accurate and up-to-date.
- C. The fire protection contractor shall provide one set of marked plans to the Engineer for his review and approval of record drawings. The approved plans shall be returned to the Contractor for his CADD preparation of documents using AutoCad 2010 to indicate correct location of all equipment, piping, etc. as installed on project.
- D. The drawings shall provide an accurate and complete record of the work as installed.

PART 2 - PRODUCTS

2.1 MATERIALS AND MANUFACTURERS:

- A. All equipment and materials required for installation under these specifications shall be new and without blemish or defect. All equipment shall bear labels attesting to Underwriter Laboratories approval where subject to Underwriters Laboratory label service. Where no specific indication as to the type of material or equipment is indicated a first class standard article shall be furnished.
- B. Each major component of equipment shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent will not be acceptable. ASME Code ratings, UL label, or other data which is die-stamped into the surface of the equipment shall be stamped in a location easily visible. It is the intent of the specifications that wherever manufacturers of a product are specified any substituted item must conform in all respects to the specified item. Consideration will not be given to claims that the substituted item meets the performance requirements with lesser construction such as lesser heat exchange surface, etc.).
- C. Substituted equipment where permitted or approved, must conform to space requirements, whether approved or not or shall be replaced at the contractor's expense. Any modification of related systems as a result of substitutions shall be made at the contractor's expense.
- D. Note the approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not assure that the Engineer, Architect, or any other Owner's Representative, attests to the dimensional accuracy or the ability of the material or equipment involved or the mechanical performance of the equipment. Approval of shop drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

2.2 SUBSTITUTION OF SPECIFIED MATERIALS:

- A. It is the purpose of this specification not to exclude competition between manufacturers of similar equipment.
- B. Where items are specified as "or approved equivalent" prior approval must be obtained from the Engineer. Said approval does not intend to obligate the Engineer in the event shop drawings submitted do not indicate equality of materials, workmanship or function and the right to reject substitutes shall remain the prerogative of the Engineer.
- C. In all cases regardless of method of submission, the contractor shall be completely responsible for changes in dimension of other than first named manufacturer equipment, electrical changes, etc. required for proper function and final performance. Item shall comply with all requirements herein set forth and as required to perform as designed. Minor modifications to suit standard manufactured items are acceptable if approved by Engineer.
- D. Should contract documents fail to describe particular materials or goods to be used, then it shall be the duty of contractor to inquire of Engineer as to what is to be used and to supply it at contractor's expense or else thereafter or to require corrections.
- E. The fire protection contractor shall promptly remove, at own expense, rejected materials from site of work.
- F. When material has been approved, no change in brand or make will be permitted without approval of Engineer.
- G. The fire protection contractor shall include the requirements of the State of North Carolina - Instructions to Bidders and General Conditions (Form OC-15) Article 8 within his bid.

2.3 NAMEPLATES:

- A. All items of operation equipment used on the project shall be provided with a nameplate mounted in a conspicuous place on the unit. Plate shall be embossed metal or stamped metal securely fastened to the unit.
- B. The plate shall contain the following information:
 - 1. Manufacturer's name and address
 - 2. All approval stamps, AGA, UL, Etc. as hereinafter specified.
 - 3. Complete capacity and operating data as approved by Engineer
 - 4. Motor Characteristics
 - 5. Serial number and code numbers
 - 6. Date of manufacture

PART 3 - EXECUTION

3.1 WORKMANSHIP:

- A. Workmanship shall be of best quality. Good appearance of finished work shall be of equal importance with its mechanical efficiency. No make-shifts shall be permitted anywhere in work and all portions work shall be so laid out and installed that work as a whole is of uniform quality and appearance.

3.2 PROTECTION OF EQUIPMENT:

- A. Protect all materials and equipment from damage during storage at the site and throughout the construction period.
- B. Protection from damage from rain, dirt, sun and ground water shall be accomplished by storing the equipment on elevated supports and covering them on all sides with protective rigid or flexible waterproof coverings securely fastened.
- C. Piping shall be protected by storing it on elevated supports and capping the ends with suitable material to prevent dirt accumulation in the piping.
- D. The Division 21 contractor shall be responsible for the work damaged by him in executing this contract.

3.3 CONTIGUOUS WORK:

- A. If any part of the Fire Protection contractors work is dependent for its proper execution or for its subsequent efficiency or appearance on the character or conditions of contiguous work not executed by him, the contractor shall examine and measure such contiguous work and report to the Architect in writing any imperfection therein, or conditions that render it unsuitable for the reception of this work. Should the Division 21 contractor proceed without making such written report, he shall be held to have accepted such work and the existing conditions and he shall be responsible.

3.4 CERTIFICATES OF INSPECTION AND APPROVAL:

- A. Upon completion of work, the fire protection contractor shall furnish to the Owner certificates of inspection or approval from the authorities having jurisdiction if certificates of inspection or approval are required by law or regulation.

3.5 SLEEVES AND OPENINGS:

- A. All sleeves and openings required shall be located and provided for by the Division 21 contractor for his portion of the work. Core drilling for missed sleeves shall be provided by this contractor.
- B. In order to minimize liquid leakage or transfer of air between floors, it is the intent that pipe penetrations of floors be held to a minimum. Where it is necessary to penetrate floors, the pipe shall pass through sleeves set in the concrete, and the space between the pipe and sleeve shall be caulked to make it air tight.

3.6 ACCESS TO EQUIPMENT AND VALVES:

- A. All control devices, specialties, valves and removable panels on equipment shall be so located as to provide easy access for inspection and maintenance, including removal of any interior components.

- B. Should any work, such as piping, ducts, conduit, etc. be installed without due regard to the accessibility of devices installed by other contractors, the installation shall be relocated, offset or rerouted without cost to the Owner.
- C. Where devices are to be concealed in walls or above nonremovable ceilings, this contractor shall provide the required access panels to the GC for installation for their respective equipment.
- D. Size of panels shall be larger than the devices for accessibility and shall be 12" x 12" square for all wall panels and 24" x 24" for ceiling panels.

3.7 COORDINATION:

- A. The fire protection contractor is cautioned that portions of the building has an unusually high quantity of piping, ducts, conduits, and other mechanical equipment, and space is limited. Offset pipes as required to avoid interference at no additional cost to the Owner. Generally pipes in which grade must be maintained, such as waste and storm drain piping, and sprinkler piping, shall have first priority. Other pipes shall be offset as required to avoid those items. The mechanical contractor will be required to prepare coordinated shop drawings of the ductwork. The fire protection contractor will be furnished copies of these drawings and shall use them in determining pipe routing. Generally, service piping (water, gas, air, etc.) shall be run below ductwork to allow access to the piping. Where pipes of two trades conflict, (e.g. domestic water pipe vs. chilled water pipe), generally the smaller pipe shall be offset.
- B. The Mechanical contractor will make the basic duct drawings and send sepias to the fire protection contractor. Within 30 days after receiving the sepias, the fire protection contractor shall return them to the mechanical contractor, marked to show how fire protection pipes cross the ducts, and with suggested pipe elevation for each pipe. The mechanical contractor will use this information plus similar information received from other contractors to prepare the finished coordination drawings.

3.8 CHASES, CUTTING AND PATCHING:

- A. In new construction, chases in walls for any work to be installed by this contractor will be provided by the general contractor provided full information as to the location and size of such chases and the necessary frames for openings is given to him by this contractor in such time as to cause no delay in the general contractor's work.
- B. If this contractor should neglect to furnish the required information and by reason of his neglect chases and openings are not provided, he shall, at his own expense, cut the required chases and openings and make such repairs as shall be necessary to restore the work to its original finish.
- C. The cutting of chases, openings, or holes in floors and ceilings shall be done in a manner as not to endanger the stability of the structure or any part thereof. This contractor shall not in any case cut or alter the work of any other contractor without the approval and under the direction of the Architect or Engineer. All repairs resulting from cutting shall be under the supervision of the Superintendent of the General Contractor.

END OF SECTION 21 01 00

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SECTION 21 01 04 - DIVISION OF WORK (21/26)

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. This section delineates the DIVISION OF WORK between Division 21 and Division 26.
- B. Specific work to be done under Division 26 is herein after listed or described. All other work necessary for the operation of Division 21 equipment shall be performed under Division 21.

1.2 DIVISION OF WORK:

- A. Under Division 26, power wiring rough-in shall be provided with junction box, trough, starter or disconnect switch, as required by the specific piece of equipment. Equipment final connections shall be provided under Division 26.
- B. All electric bells, flow switches and tamper switches required by Division 21 equipment, and other appurtenances associated with equipment under Division 21 shall be furnished and installed under Division 21.
- C. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 21.
- D. Additional power wiring required for fire protection equipment over and above what is shown on electrical drawings shall be provided under Division 21 work.
- E. Power wiring and final connection to the equipment shall be provided under Division 26 work.

END OF SECTION 21 01 04

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SECTION 21 02 08 - FIRE PROTECTION IDENTIFICATION AND PAINTING

PART 1 - GENERAL

1.1 SCOPE:

- A. All exposed pipe, hangers, and equipment installed by this fire protection contractor shall be painted unless they have a factory finish or are noted otherwise. Exposed chromeplated brass, stainless steel, or galvanized piping will not be painted.
- B. Type of identification devices specified in this section include the following:
 - 1. Plastic Pipe Markers
 - 2. Plastic Tape
 - 3. Valve Tags
 - 4. Valve Schedule Frames
 - 5. Engraved Plastic-Laminate Signs

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.3 SUBMITTALS:

- A. Product Data: Submit product specifications and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags," in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE MARKERS:

- A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers, complying with ANSI A13.1.
- B. Small Pipes: For external diameters less than 6", provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe.
- C. Large Pipes: For external diameters of 6" and larger, provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
1. Laminated or bonded application of pipe marker to pipe.
 2. Strapped-to-pipe application of semi-rigid type, with manufacturer's standard stainless steel bands.
- D. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
- E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.2 PLASTIC TAPE:

- A. Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.3 VALVE TAGS: (PROVIDE ONE OF THE FOLLOWING):

- A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Provide 1-1/2" diameter tags, except as otherwise indicated.
- B. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.4 VALVE SCHEDULE FRAMES:

- A. For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on walls. Provide frames of rigid plastic or metal, with plastic glazing.

2.5 ENGRAVED PLASTIC-LAMINATE SIGNS:

- A. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.6 LETTERING AND GRAPHICS:

- A. Coordinate names, abbreviations and other designations used in fire protection identification work with corresponding designations shown pre-existing, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer's or as required for proper identification and operation/maintenance of fire protection systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Alarm Check Valve, etc.).

2.7 PAINT:

- A. All products shall be in accordance with the specifications for painting in the general contract.

PART 3 - EXECUTION**3.1 GENERAL:**

- A. Any equipment shipped with a factory applied finish shall be touched up to repair any damage to the finish so that it is the same as new.
- B. In the mechanical equipment rooms the fire protection contractor shall be responsible for painting all piping, equipment, and accessories installed under their respective contract.
- C. In other parts of the buildings items which are in place in finished areas when general building painting is done will be painted by the General Contractor. Items installed after painting is completed shall be painted by the fire protection contractor, as directed by the architect.
- D. All exposed nongalvanized ferrous metal hangers and miscellaneous metal used in connection with the fire protection system shall be painted with two coats of enamel.
- E. All exposed piping including insulated piping, insulated by this sub-contractor shall be painted two coats of lead and oil paint.
- F. Do not field paint exposed copper pipe, brass valves, or brass trim on iron body valves, or machinery or equipment that has a factory applied finish unless otherwise specified. Do not paint plastic pipe.
- G. All paint shall be delivered to the project in unbroken containers. Containers shall be labeled to indicate color, directions for use, manufacture, and date of manufacturer. Directions for use of the paint shall be carefully followed in the mixing and general application. All paint shall be applied under dry and dust free conditions. Sufficient time shall elapse between paint coats to permit satisfactory recoating. Once started all painting shall be completed without delay.

3.2 PIPING SYSTEM IDENTIFICATION:

- A. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), exterior non-concealed locations and above removable acoustical ceilings.
 - 1. Near each valve and control device.

2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings.

3.3 PAINT SCHEDULE:

- A. All exposed equipment, pipes, conduits, or other appurtenances shall be painted by this contractor with materials and application as specified in the general contract specifications and as directed by the architect.
- B. All concealed pipe covering shall be identified by colored bands and legends. The direction of flow shall be indicated by flow arrows.
- C. All exposed pipe covering shall be totally painted the color of the band color listed below. All exposed pipe hangers, rods, supports, channels, etc. shall be painted flat black.
- D. Color coding strips shall be painted no less than every 15 linear feet plus wherever entering or leaving a space and near valves. (Tape is acceptable). Width of strip shall be approximately 1/5 of the diameter of pipe plus covering if any, but in no case less than 1/2 inch. Color coding shall conform OSHA requirement.
- E. Directions arrow and fluid name shall be applied by sticker at same spacing as above. The stickers shall be secured by color coded tape wrapped two times around the pipe at each end of the label or spring cords.

- F. Standard colors and legends are as follows: (Fire Protection)

PIPING SYSTEM	COLOR	STENCIL IDENTIFICATION
Sprinkler	Safety Red	SPKR
Fire Line	Safety Red	FIRE
Supports, Hangers	Black	

- G. Pipe identification should contrast in color to the pipe colors and be easily readable. The width of color bands should be equal to the size of the stencil indicated below.
- H. Stencil sizes should be as follows:
 1. For pipe diameters up to 1", use 1/2" letters
 2. For pipe diameters from 1" to 2", use 1" letters
 3. For pipe diameters from 2" to 6", use 2" letters
 4. For pipe diameters over 6", use 3" letters

END OF SECTION 21 02 08

SECTION 21 02 10 - CONCRETE AND MASONRY WORK

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. Provide all concrete and masonry work as indicated on the fire protection contract drawings, unless it is indicated that it will be by the general contractor. This includes bases for equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All cement, gravel, sand, reinforcing rod, brick, block and other materials comply with the requirements for those materials in the specifications for the general contractor.

PART 3 - EXECUTION

3.1 GENERAL

- A. The workmanship and manner of placing the materials shall comply with the requirements for those items in the specifications for the general contract.
- B. Bases shall have smooth tops and cambered edges.

END OF SECTION 21 02 10

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SECTION 21 05 00 - FIRE PROTECTION

PART 1 - GENERAL

1.1 DEFINITION:

- A. Work under this section of the specifications shall include but not necessarily be limited to items common to sections:
 - 1. 210515 – Fire Pump - Electric
 - 2. 210530 – Manual Wet Standpipe and Sprinkler Systems
- B. In all cases, work specified in this section of the specifications shall be compatible with the above listed specification sections and the requirements of the North Carolina State Construction Office.

1.2 SUBMITTALS:

- A. Shop drawings and system alarm diagrams shall be submitted on all items in accordance with the provisions of Specification Section 21 01 00.
- B. Submit shop drawings on the following.
 - 1. Piping materials
 - 2. Fire protection accessories
 - 3. Water flow indicators
 - 4. Sprinkler heads
 - 5. Valves
 - 6. Hangers
- C. The contract drawings show the general arrangement of the areas to receive fire protection. The fire protection subcontractor shall review the drawings so that all items that will affect the operation of the fire protection system (such as fire detection equipment, air diffuser openings, door openings, lights, fire and smoke dampers, etc) are considered in the design of the system. The shop drawings and associated hydraulic calculations required by the fire protection subcontractor shall be prepared by a NICET level 3 designer using a computer program for sizing of pipes, etc.
- D. Submittal and Reviews of Contractor's Shop Drawings and Hydraulic Calculations - Include the following procedures and requirements: Fire Sprinkler Contractor: The Fire Sprinkler Contractor should submit working shop drawings, hydraulic calculations, and product data to the design engineer of record – number of copies as determined by the design engineer. Shop drawings should include and be in accordance with working plan requirements of chapter 22 of NFPA 13. Product data should include and identify all material, equipment, and accessory selections to be installed. The hydraulic calculations and shop drawings should be signed by the fire sprinkler designer and include the NC Fire Sprinkler Contractor (FS) license number. Project Engineer: The specifying engineer (PE) has primary responsibility for review and approval of fire suppression system shop drawings and hydraulic calculations. Specifying Engineer review shall determine compliance with applicable codes and standards and the project contract documentation.
- E. After Engineer-Of-Record review, the fire protection contractor shall submit to local fire marshal

through code review for final approval.

- F. Final Inspection: At the final inspection, the fire sprinkler contractor should have for review and closeout documentation all pertinent NFPA paperwork properly filled out on NFPA forms as applicable. The shop drawing approval letter from this office should be available. A set of as-built fire sprinkler shop drawings and hydraulic calculations shall be placed in a white PVC tube marked 'Fire Sprinkler Shop Drawings' and securely fixed in the fire sprinkler riser room. A CD shall be provided including shop drawings and calculations.

1.3 COORDINATION:

- A. This subcontractor shall coordinate with the other contractors as required to produce workable, controllable systems. Generally, all controls and equipment shall be furnished and installed by this contractor unless otherwise noted. This contractor shall be licensed for sprinkler work. Specific examples of coordination and cooperation include:

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 STANDPIPE PIPING SYSTEMS:

- A. Comply with requirements of ANSI/NFPA, latest edition for installation of piping materials. Install standpipe piping products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to insure that standpipe piping systems comply with requirements and serves its intended purpose.
- B. Coordinate with other trades as necessary to interface components of standby piping properly with other work.
- C. Install drain piping at low points of piping systems.
- D. Install hose outlet valves in piping where hose outlets are indicated.
- E. Install sectional valves in inlet piping, at bottom of each riser, and in loops as indicated.
- F. Install Fire Department connection valves in piping where Fire Department connections are indicated.
- G. Mount supervisory switches on each sectional valve.

3.2 FIRE SPRINKLER PIPING SYSTEMS:

- A. Comply with requirements of ANSI/NFPA 13, latest edition, for installation of fire sprinkler piping materials. Install fire sprinkler piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that fire sprinkler piping complies with requirements and serves intended purposes.
- B. Coordinate with other work, including plumbing piping, as necessary to interface components of fire sprinkler piping properly with other work.

- C. Install sectional valves in inlet piping at bottom of each riser and in loops as indicated.
- D. Mount supervisory switches on each sectional valve.
- E. Install valved hose connections of sizes indicated, or 3/4" size if not otherwise indicated, on sprinkler at ends of branch lines and cross mains at locations where required.
- F. Install drain piping at low points of fire sprinkler piping.

3.3 ADJUST AND CLEAN:

- A. Sprinkler Piping Flushing: Prior to connecting sprinkler risers for flushing, flush water feed mains, lead-in connections and control portions of sprinkler piping. After fire sprinkler piping installation has been completed and before piping is placed in service, flush entire sprinkler system, as required to remove foreign substances, under pressure as specified in ANSI/NFPA 13. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

3.4 FIELD QUALITY CONTROL:

- A. Hydrostatic Testing: After flushing system, test fire sprinkler piping hydrostatically, for period of 2 hours, at not less than 200 psi or at 50 psi in excess of maximum static pressure when maximum static pressure is in excess of 150 psi. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.
- B. Repair or replace piping system as required to eliminate leakage in accordance with ANSI/NFPA standards for "little or no leakage," and retest as specified to demonstrate compliance.

3.5 EXTRA STOCK:

- A. General: For each style and temperature range required, furnish additional sprinkler heads, in cabinet according to NFPA 13.

END OF SECTION 21 05 00

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SECTION 21 05 93 - TESTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section describes the requirements for testing and balancing of all piping and equipment installed under this contract in the presence of the Engineer and the proper Fire Protection Inspector and prove tight for the periods stated below or longer if required for inspection.
- B. Test in section if deemed advisable.
- C. Disconnect the apparatus for developing the required pressures during the stated periods.
- D. Completely disconnect and remake joints that leak.
- E. No fire protection system or part thereof shall be covered or concealed until after it has been tested and approved.
- F. If such work has been covered or concealed before testing, it shall be exposed for testing.
- G. If tests described in the specifications for fire protection systems differ from requirements or the local inspector, the more rigid requirements shall govern.

PART 2 - PRODUCTS

2.1 SPRINKLER SYSTEM:

- A. Fill and subject to 200 PSIG hydrostatic pressure at the lowest level for (2) hours.

END OF SECTION 21 05 93

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SECTION 21 90 00 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 RECORD DRAWINGS - BUILDING:

- A. Submit as-built drawings as required by General Conditions and obtain written receipt from engineer.

1.2 DEMONSTRATION OF COMPLETE FIRE PROTECTION SYSTEMS:

- A. The following systems shall be put into operation by the fire protection subcontractor furnishing the equipment, and operated for the length of time required to prove proper operation and control.
 - 1. Fire protection systems.
- B. Thoroughly demonstrate and instruct (3) three designated representatives of the Owner in the care and operation of all the fire protection systems and equipment furnished and installed in the contract.
- C. Manufacturers of certain equipment specified herein shall provide technically qualified factory representatives to train the Owner's representative in the care and maintenance and operation of their product. This instruction and service of the factory representative shall be furnished as specified elsewhere in the specifications. This time is in addition to what is specified above and will not be counted as part of this subcontractor's instructions.
- D. The time and place of all training shall be coordinated and scheduled by the subcontractor at the convenience of the Owner and as approved by the architect.
- E. Submit letters signed by the Owner's representatives attesting to the satisfactory completion of all instructions.
- F. System installer shall submit NFPA required Contractor's Material and Test Certificate(s) to the Engineer of Records.

1.3 OWNER'S RIGHT TO TEST SYSTEM:

- A. Should, in the opinion of the architect, and during the guarantee period, reasonable doubt exist as to the proper functioning of any equipment installed under this contract, the right is reserved for the Owner and architect to perform any test deemed practical to determine whether such equipment is functioning properly and performing at required capacity. If such tests show proper functioning, the cost of the test will be paid by the Owner. If the tests indicate a deficiency in equipment capacity or performance, the subcontractor shall pay the cost of the test and also make good any deficiencies shown by the test to the full satisfaction of the Owner and the architect.

1.4 OPERATING AND MAINTENANCE MANUALS:

- A. This Division 21 Subcontractor shall carefully prepare an operating instructions and maintenance manual for each fire protection system, including all equipment furnished. The manual shall be submitted to the engineer for approval before final inspection and acceptance is made.
- B. The form in which the operating maintenance manual is to be presented shall be subject to approval by the architect. Three copies of the manual shall be provided.
- C. The following items together with any other necessary and pertinent data shall be included in the manual. This list is not necessarily complete and is only to be used as a guide.
 - 1. Suggested settings of all control and switches for normal operation with description of control and its location.
 - 2. A check list for periodic maintenance of all equipment.
 - 3. As-built wiring, interlock, and control diagrams for the equipment, with color coding shown on wiring and interlock diagrams.
 - 4. Part numbers of all replaceable items.
 - 5. Manufacturer's cuts and rating tables for all equipment.
 - 6. Oiling, lubricating and greasing data.
 - 7. Complete electrical load data from operation tests.
 - 8. Test data on all equipment
 - 9. Belt sizes, types, and lengths
 - 10. Serial number of all principal pieces of equipment
 - 11. Valve tag schedule
 - 12. Manufacturers', suppliers' and subcontractors' names, addresses and telephone numbers.

1.5 WARRANTIES:

- A. Deliver to Owner all warranties, etc., and obtain written receipts.

1.6 OBSERVATION REPORTS:

- A. During construction period the engineer will issue observation reports. These items shall be completed before engineer will approve next application for payment. Final punch list work shall be complete before acceptance.

1.7 FINAL INSPECTION AND ACCEPTANCE:

- A. The architect or his authorized representative will entertain the request for final inspection and acceptance only after the following items are done.
 - 1. Submit a list of uncompleted items, if any, and advise when the items will be done.
 - 2. Clean, test, and adjust all systems and equipment.
 - 3. Lubricate all motors.
 - 4. Complete all items on architect's or engineer's pre-final punch list.

- B. Final inspection and tests of the completed construction shall be performed in the presence of the architect or his representative and shall be at such times as are convenient to the architect. Final tests shall show conclusively that all equipment performs its intended and specified function and that all work complies with the provisions of these specifications. All material, equipment, and instruments required for these tests shall be furnished by the subcontractor at his own expense.
- C. Final Clean-up. During construction the subcontractor shall keep the site clear of debris and upon completion of construction he shall clean up the premises to remove all evidence of his work. In addition, upon completion of construction he shall clean, wash, and/or polish all fixtures, equipment, and exposed material and leave them bright and clean.

END OF SECTION 21 90 00

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SECTION 22 01 00 – GENERAL PROVISIONS - PLUMBING

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. The work to be done under Division 22 sub-contracts shall include the furnishing of all labor, materials, equipment, and services necessary for and reasonably incidental to the proper completion of all work as shown on the plans and herein specified, only excepting work materials specified or noted as being furnished or installed by others.
- B. All work shown in the drawings and specifications shall be included under the base bid, except where there is specific reference to exclusion or incorporation in alternate quotation.
- C. The Plumbing subcontractor (plumbing contractor) may hereinafter also be referred to as "This Sub-contractor," "subcontractor", "PC", Division 22 sub-contractor.
- D. Drawings shall not be scaled. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule or architectural drawings for material, finish and construction method of walls, floor and ceiling in order to insure proper rough-in and installation of work.

1.2 WORK INCLUDED:

- A. The plumbing subcontractor shall be responsible for including the cost of all labor, accessories, tools, equipment and materials required to completely execute installation of the entire plumbing for all systems as shown on the drawings and as specified. Work under the plumbing contract shall include, but shall not be limited to, the furnishing, unloading, handling, distribution, setting and installation of all components required for the following systems:
 - 1. Sanitary sewers (interior and exterior to the building)
 - 2. Vent and waste systems
 - 3. Special drainage work as hereinafter specified
 - 4. Piping Specialties
 - 5. Storm sewer to designated points outside building
 - 6. Plumbing fixtures
 - 7. Rough-in and final connections
 - 8. Miscellaneous items as specified, required and/or shown on drawings

1.3 RELATED WORK WHICH IS A PART OF SECTION 22 00 50:

- A. All work done under this section of the specification is subject to the Architect's instructions to bidders, general conditions and their corresponding supplements.
- B. Refer to the supplementary general conditions of these specifications for temporary services and facilities that shall be provided.

1.4 DEFINITIONS:

- A. "Piping": Pipe, fittings, flanges, traps, drains, vents, and items customarily required in connection with the transfer of fluids.

- B. "Provide" (P): Furnish and install complete ready for use.
- C. "Furnish" (F): Purchase and deliver to the project site complete with every necessary appurtenance and support.
- D. "Install"(I): Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation of the proper location in the project.
- E. "Concealed": Embedded in masonry or other construction, installed behind wall furring, within double partitions of hung ceilings, in crawl spaces, in shafts.
- F. "By Other Trades": Shall mean by persons or parties who are not anticipated to be the Contractor whose work is specified in this section but shall mean other contractors or subcontractors who along with this trade shall be working together with the general contractor. In this context the words "by other trades" shall not be interpreted to mean not included in the overall contract.

1.5 ABBREVIATIONS:

AFF	Above Finish Floor
AMP	Amperes
BO	By Others
CI	Cast Iron
CL	Ceiling
CO	Clean Out (F-Floor)(W-Wall) (Y-Yard)
CONTR	Contractor
DB	Decibels
DIS.SW	Disconnect Switch
DN	Down
ELEC	Electrical
F	Furnish or Filter
FD	Floor Drain
FL	Floor
FS	Floor Sink
HB	Hose Bibb
IE	Invert Elevation
NC	Noise Criteria
ORD	Overflow Roof Drain
P	Provided (Furnished & Installed)
PH	Current Phase
PLBG	Plumbing
RD	Roof Drain
UF	Underfloor
UG	Underground
Ø or PH	Current Phase

1.6 INTERPRETATION OF CONTRACT DOCUMENTS:

- A. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.
- B. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Exceptions are that notes on the drawings, which refer to an individual element of work, take precedence over the specifications where they conflict with same.
- C. No exclusions from, or limitations in, the language used in the drawings or specifications shall be interpreted as meaning that the appurtenances or accessories necessary to complete any required system or item of equipment are to be omitted.
- D. The drawings of necessity utilize symbols as schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed in accordance with the diagrammatic intent expressed on the drawings, and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings.
- E. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.
- F. Certain details appear on the drawings which are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the intended work.
- G. Information as to the general construction shall be derived from structural and architectural drawings and specification only.
- H. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

1.7 DELINEATION OF WORK:

- A. The sub-contractor is required to supply all necessary supervision and coordination of information to any others who are performing work to accommodate plumbing installations. Where the plumbing subcontractor is required to install items which he does not purchase, he shall include for such items:
 - 1. The coordination of their delivery.
 - 2. Their unloading from delivery trucks driven in to any designated point on the property line.
 - 3. Their safe handling and field storage up to the time of permanent placement in the project.
 - 4. The correction of any damage, defacement or corrosion to which they may have been subjected.
 - 5. Their field assembly and internal connections as may be necessary for their proper operation.
 - 6. Their mounting in place including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
 - 7. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

- B. Items which are to be installed but not purchased as part of the work of the mechanical or plumbing contractors shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation shall require procedures beyond the reasonable scope of the work shall be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The work under this contract shall include all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.
- C. The specifications for the overall construction delineate various items of work under separate section headings. The list below sets forth this delineation to the extent that it affects the mechanical work category. In the absence of more detailed information, this list shall be taken as a specific instruction to the mechanical subcontractor to include the work assigned to him. Indications that each subcontractor is to perform the work means that it is to perform the work for its own accommodation only, except as specifically noted otherwise.
1. "P" indicates Provide
 2. "F" indicates Furnish
 3. "I" indicates Install

ITEM	"OTHER"	"PLBG"	"MECH"	"ELECT"
Hoisting		P		
Rigging		P		
Cutting and Patching		P		
EXCEPTION: Cost where due to late installation or improper coordination of work is the responsibility of the delinquent sub-contractor. Locations shall be approved by structural engineer.				
Framed slots and openings in walls, decks and slabs	P			
EXCEPTION: Coordination drawings are required from the plumbing subcontractor.				
Sleeves through non- membraned slabs, decks and walls		P		
EXCEPTION: Refer to Division 3 for coordination of installation.				
Excavation and backfill inside building		P		
EXCEPTION: Specifications and drawings delineate exceptions.				
Blasting	P			
EXCEPTION: Only with permission of Architect.				
Keeping Site and Excavations free from Surface Water During Construction	P			
EXCEPTION: To accommodate the overall project general contractor.				
Rubbish Removal	P			
EXCEPTION: Where one trade furnishes and another installs, the installing trade removes the shipping and packing material which accumulate.				
Special tools for equipment maintenance		P		
Piping and Associated Work Outside of the Building Line	P			
Kitchen Related Equipment	P			
EXCEPTION: Rough-in and final connection shall be provided by the plumbing subcontractor providing specified services.				

- D. This contractor is required to supply all necessary supervision and coordination of information to any others who are supplying work to accommodate Plumbing Contractor installation.

1.8 STANDARDS AND CODES:

- A. Nothing in this specification shall be interpreted to conflict with any City or State law, regulation, code, ordinance, ruling or Fire Underwriters requirement applicable to this class of work.
- B. All installations for construction purposes shall conform with the Department of Labor "Safety and Health Regulations for Construction."
- C. All equipment with electrical components shall bear the UL label.
- D. The following minimum standards apply wherever applicable:

ANS	American National Standards
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
SMACNA	Sheet Metal and Air Conditioning Contractors National Assoc., Inc.
AGA	American Gas Association
ASA	American Standards Association
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
NBFU	National Board of Fire Underwriters
PDI	Plumbing and Drainage Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning, Engineers, Inc.

1.9 INSPECTION AND COOPERATION:

- A. All work shall be done under the periodic observation of and to the complete satisfaction of the Architect. No deviations from the Drawings and Specifications shall be allowed without prior written approval of the Architect. The Plumbing subcontractor shall cooperate with the other contractors to allow for the installation of their work as well as his own.
- B. The Plumbing subcontractor shall be responsible for his work fitting in place without conflict with the other trades, where proper planning could avoid interference. Any work installed by this subcontractor without regard for other work, or if a conflict results, shall be changed if directed by the Architect or Engineer without additional cost to Owner or his agents.
- C. Relocation of equipment, system connections or rough-in locations up to ten feet (10'), if necessary, shall be done at no additional cost to the Owner or his agents if done before roughing-in.
- D. All concealed work shall be inspected by the Architect/Engineer or his appointed representative before being concealed. The Plumbing subcontractor shall call for inspection at least two (2) work days before concealment.
- E. The Architect shall have the right to inspect the work whenever advisable in his judgment. The plumbing subcontractor shall have a representative present at each inspection and shall give such assistance as may be required.

- F. Recommendations made by the Architect shall be promptly carried out and all unsatisfactory material and workmanship replaced at once to the Architect's satisfaction at the appropriate subcontractor expense.
- G. The plumbing sub-contractor shall be responsible for hoisting of all materials and equipment furnished under as part of his portion of the work in accordance with all City, State, and Federal rules and regulations.

1.10 TEMPORARY SERVICES AND FACILITIES:

- A. Refer to general requirements for temporary services and facilities that shall be provided.

1.11 UNIT PRICES:

- A. Refer to general requirements relative to "Add" or "Deduct" prices relative to this contract.

1.12 ROCK DEFINITION:

- A. Refer to Division 02 for definitions and requirements relative to rock encountered during excavation.

1.13 SUBMITTALS:

- A. LIST OF MANUFACTURERS: Within twenty days following award of contract, the plumbing subcontractor shall submit the required information pertaining to the equipment and materials he shall be furnishing, commencing with the list of manufacturers for approval by the Engineer. Following up in short order shall be the shop drawings and other documents. The Owner and his representatives reserve the right to reject as unacceptable any items for which, in their judgment, they have not been allowed adequate lead time in which to investigate suitability, or their experience has proved the service or equipment unsatisfactory.

1.14 SHOP DRAWINGS:

- A. Prior to purchasing any equipment or materials, the approved list of the manufacturers shall be returned by the Engineer to the Contractor.
- B. Shop drawings shall be submitted conforming to the requirements stated in supplementary conditions and Division 01 for the items indicated throughout the following specifications:
 - 1. Documents shall not be accepted for approval unless:
 - a. They comply with the requirements of the supplement to the General Conditions.
 - b. They include complete information pertaining to appurtenances and accessories.
 - c. They are submitted as a package where they pertain to related items.
 - d. They are properly marked with service or function identification as related to the project, where they consist of catalog sheets displaying other items which are not applicable, and are marked with pertinent specification paragraph number.
 - e. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.

2. Approval of shop drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

PART 2 - PRODUCTS

2.1 MATERIALS AND MANUFACTURERS:

- A. All equipment and materials required for installation under these specifications shall be new manufactured and without blemish or defect. All equipment shall bear labels attesting to Underwriter Laboratories approval where subject to Underwriters Laboratory label service. Where no specific indication as to the type of material or equipment is indicated a first class standard article shall be furnished.
- B. Each major component of equipment shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent shall not be acceptable. ASME Code ratings, UL label, or other data which is die-stamped into the surface of the equipment shall be stamped in a location easily visible. It is the intent of the specifications that wherever manufacturers of a product are specified any substituted item must conform in all respects to the specified item. Consideration shall not be given to claims that the substituted item meets the performance requirements with lesser construction. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance.
- C. Substituted equipment where permitted or approved, must conform to space requirements, whether approved or not or shall be replaced at the contractor's expense. Any modification of related systems as a result of substitutions shall be made at the subcontractor's expense.
- D. Note the approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not assure that the Engineer, Architect, or any other Owner's Representative, attests to the dimensional accuracy or the ability of the material or equipment involved or the mechanical performance of the equipment. Approval of shop drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

2.2 SUBSTITUTION OF SPECIFIED MATERIALS:

- A. It is the purpose of this specification not to exclude competition between manufacturers of similar equipment.
- B. Where items are specified as "or approved equivalent" prior approval must be obtained from the Engineer. Said approval does not intend to obligate the Engineer in the event shop drawings submitted do not indicate equality of materials, workmanship or function and the right to reject substitutes shall remain the prerogative of the Engineer.
- C. In all cases regardless of method of submission, the contractor shall be completely responsible for changes in dimension of other than first named manufacturer equipment, electrical changes, etc. required for proper function and final performance. Item shall comply with all requirements herein set forth and as required to perform as designed. Minor modifications to suit standard manufactured items are acceptable if approved by Engineer.

- D. Should contract documents fail to describe particular materials or goods to be used, then it shall be the duty of subcontractor to inquire of Engineer as to what is to be used and to supply it at contractor's expense or else thereafter or to require corrections.
- E. Plumbing subcontractor shall promptly remove, at own expense, rejected materials from site of work.
- F. When material has been approved, no change in brand or make shall be permitted without approval of Engineer.

PART 3 - EXECUTION

3.1 WORKMANSHIP:

- A. Workmanship shall be of best quality. Good appearance of finished work shall be of equal importance with its mechanical efficiency. No make-shifts shall be permitted anywhere in work and all portions work shall be so laid out and installed that work as a whole is of uniform quality and appearance.

3.2 PROTECTION OF EQUIPMENT:

- A. Protect all materials and equipment from damage during storage at the site and throughout the construction period.
- B. Protection from damage from rain, dirt, sun and ground water shall be accomplished by storing the equipment on elevated supports and covering them on all sides with protective rigid or flexible water proof coverings securely fastened.
- C. Piping shall be protected by storing it on elevated supports and capping the ends with suitable material to prevent dirt accumulation in the piping.
- D. These subcontractors shall be responsible for the work damaged by him in executing this contract. Any work damaged by the Plumbing Contractor shall be replaced by him and placed in perfect condition without extra cost.

3.3 CONTIGUOUS WORK:

- A. If any part of the Plumbing subcontractor work is dependent for its proper execution or for its subsequent efficiency or appearance on the character or conditions of contiguous work not executed by him, this subcontractor shall examine and measure such contiguous work and report to the Architect in writing any imperfection therein, or conditions that render it unsuitable for the reception of his work. Should this subcontractor proceed without making such written report, he shall be held to have accepted such work and the existing conditions and he shall be responsible.

3.4 CERTIFICATES OF INSPECTION AND APPROVAL:

- A. Upon completion of work, plumbing subcontractor shall each furnish to the Owner certificates of inspection or approval from the authorities having jurisdiction if certificates of inspection or approval are required by law or regulation.

3.5 SLEEVES AND OPENINGS:

- A. All sleeves and openings required shall be located and provided by the subcontractor for his portion of the work. Core drilling for missed sleeves shall be provided by the delinquent subcontractor.

3.6 COORDINATION:

- A. The plumbing contractor is cautioned that the building has an unusually high quantity of piping, conduits, and other mechanical equipment, and space may be limited. This subcontractor shall offset pipes as required to avoid interference at no additional cost to the Owner. Generally pipes in which grade must be maintained, such as waste and storm drain piping, shall have first priority. Other pipes shall be offset as required to avoid those items.
- B. Minor changes required by Owner, and any incidental changes required to meet structural conditions or to match trim etc. shall be made by this subcontractor without extra cost to the Owner.
- C. The HVAC contractor will make the basic duct drawings and send sepias to the plumbing contractor. Within 30 days after receiving the sepias and "CADD disk", the plumbing contractor shall return them to the mechanical subcontractor, marked to show how plumbing pipes cross the ducts, and with suggested pipe elevation for each pipe. The HVAC contractor will use this information plus similar information received from other contractors to prepare the finished coordination drawings.
- D. The HVAC contractor shall provide manufacturers installation drawings as shipped with equipment, field working and location drawings, coordination drawings, wiring diagrams as required to show information required for information and coordination of the work for other trades. This includes locations of equipment, sleeves, foundations, curbs, pipe connections, wiring connections, etc. These drawings shall be provided in advance of work in the area so that the necessary coordination can be done at the proper time. The drawings shall be submitted to the A/E for record only and other subcontractors involved in the work.
- E. The HVAC contractor shall coordinate the work of his trade and other trades in order that interference between plumbing, mechanical, electrical, architectural and structural work will be avoided. Piping, ducts, conduits, etc. shall be kept as close as possible to ceiling, walls, columns, etc. in order to take up the minimum amount of space; and all offsets, fittings, etc. required shall be furnished without additional cost to the Owner. In case interferences develop, the Engineer will decide which equipment shall be relocated regardless of which was first installed.
- F. The plumbing subcontractor shall cooperate closely with the General Contractor and all other contractors on the job in order that the job will progress smoothly to its completion. He shall lay out his pipe in advance of pouring floors, or installing walls, shall provide to the General Contractor the location and size of any openings he may require, and shall furnish for the installation by the General Contractor any sleeves, forms, or inserts required for his work. In the event of failure to do these things at the proper time, or improper location of the required items, the cutting and patching required to rectify the errors shall be done by the subcontractor who installed the original material being cut but shall be paid by the subcontractor at fault, as determined by the Engineer, and at no additional cost to the Owner.
- G. All equipment shall be installed with sufficient access and clearance for maintenance, repairs, and replacement. In the event that it appears necessary to install equipment without proper access or clearance, the work shall be stopped until written permission is received from the Engineer to install the equipment.

- H. The following general rules shall apply to the preceding items:
 - 1. Storm drain piping and sanitary waste piping, in which the grade must be maintained, shall have first priority.

3.7 AS-BUILT DRAWINGS:

- A. These subcontractors shall provide one set of marked plans to the Engineer for his preparation of as-built drawings. The marked plans shall indicate correct location of all equipment, piping, etc. as installed on the project.
- B. The drawings shall provide an accurate and complete record of the work as installed.

3.8 PHASING OF WORK:

- A. All work connected to systems in use, utilities or services presently in use by Owner or Utility Company shall be cleared for shutdown with Owner 72 hours before disruption of services is desired. The Owner reserves the right to postpone any work of this nature to coincide with his operational procedure. The maximum shutdown period for any services is 8 hours unless previous approval for a longer period is obtained from the Owner. Any damage incurred in facilities by extended shutdown beyond period allowed shall be repaired by this subcontractor at no expense to the Owner. Request for a shutdown shall be in writing stating utility to be taken out of service, required length of shutdown period, and desired date and hour of shutdown.

END OF SECTION 22 01 00

SECTION 22 01 04 - DIVISION OF WORK (DIVISION 22 AND 26)

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. This section delineates the DIVISION OF WORK between Division 22 and Division 26.
- B. Refer to typical diagram on Sheet E4.02 covering the items specified here. Specific work to be done under Division 26 is here in after listed or described. All other work necessary for the operation of Division 22 equipment shall be performed under Division 22.

1.2 DIVISION OF WORK:

- A. All individual motor starters for mechanical equipment (fans, pumps, etc.), shall be furnished and installed under Division 22. Motor starters for mechanical equipment which are scheduled as part of motor control centers, if any, shall be provided under Division 26 - Electrical.
- B. Under Division 22, generally, power wiring, including line power wiring to some Division 22 control panels, shall be provided up to a termination point consisting of junction box, trough, starter, VFD, or disconnect switch. Under Division 26, line side terminations shall also be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 26, as shown on the electrical drawings. Whenever a direct connection to Division 22 equipment is shown, electrical contractor shall provide final connection.
- C. Power and control wiring for equipment rated at less than 115 volts, and for all relays, actuators, including motorized dampers, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote push-button stations, emergency break-glass stations, and interlocking devices, shall be provided by the contractor or subcontractor furnishing the equipment or control item. Power wiring of disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 22 shall be furnished, installed and wired under Division 26.
- D. All wiring required for power, controls and instrumentation for Division 26 systems, not indicated on the electrical drawings, shall be furnished and installed by Division 22.
- E. Additional power wiring required for Plumbing equipment over and above what the electrical drawings show shall be provided by the Plumbing contractor.
- F. 120 Volts, 60 Hz power supply for Division 22 control functions, if not shown on electrical drawings being directly provided, or provided in adjacent junction box by Division 26, shall be provided under Division 22 utilizing spare circuit breakers in branch circuit panelboard with type of power compatible with the control function. Use standby emergency power panelboards for control of plumbing equipment on standby emergency power; use legal emergency power for HVAC smoke control functions; use normal power panelboards for control of plumbing equipment on normal power system.

END OF SECTION 22 01 04

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SECTION 22 02 06 - ROUGH-IN AND CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. Rough in for all items of equipment that require waste, vent or water connections, regardless of which contractor furnished the equipment.
- B. Make final connections to those items for equipment furnished by others except where specifically designated on the drawings or in these specifications otherwise.
- C. Generally, final connections to equipment shall be by the plumbing contractor.
- D. Generally, final connections to water heaters, and other equipment of this type will be by the plumbing contractor.
- E. The plumbing contractor shall be responsible for verifying that any shut-off, pressure regulator and backflow prevention devices is included with equipment or furnishing the same if is not, when connecting services to any specialized equipment.

1.2 ROUGH-IN DRAWINGS:

- A. The plumbing contractor shall secure from each contractor furnishing items of equipment (requiring plumbing connections) roughing-in prints and complete detail shop drawings of all equipment, and review at the job each area with the respective contractor before roughing-in. Make all adjustments as required. In the event that the plumbing contractor fails to obtain the roughing-in prints for whatever reason, and roughs in the pipes at the wrong location, the pipes shall be relocated as required at the expense of the plumbing contractor. In the event that the plumbing contractor roughs in the pipes in accordance with prints furnished by the respective contractor, and it turns out that the pipes are in the wrong locations, any costs of relocating the roughed-in pipes will be paid by the contractor furnishing that item of equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall be the same as are described in the specifications for the various piping systems.

END OF SECTION 22 02 06

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SECTION 22 02 08 - PLUMBING IDENTIFICATION AND PAINTING

PART 1 - GENERAL

1.1 SCOPE:

- A. All exposed pipe, hangers, and equipment in the equipment platform level installed by this subcontractor shall be painted unless it has a factory finish or is noted otherwise. Exposed chromeplated brass, stainless steel, or plastic piping will not be painted.
- B. Type of identification devices specified in this section include the following:
 - 1. Plastic Pipe Markers
 - 2. Plastic Tape
 - 3. Valve Tags
 - 4. Valve Schedule Frames
 - 5. Engraved Plastic-Laminate Signs

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.3 SUBMITTALS:

- A. Product Data: Submit product specifications and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags," in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 22.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE MARKERS:

- A. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color-coded, plastic-sheet pipe markers, complying with ANSI A13.1.

- B. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- C. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
1. Laminated or bonded application of pipe marker to pipe (or insulation).
 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- D. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
- E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.2 PLASTIC TAPE:

- A. Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.3 VALVE TAGS:

- A. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener. Provide 1-1/2" diameter tags, except as otherwise indicated.
- B. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Provide ceiling mounted valve tag buttons to identify valve locations above lay-in ceilings.

2.4 VALVE SCHEDULE FRAMES:

- A. For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on walls. Provide frames of rigid plastic or metal, with plastic glazing.

2.5 ENGRAVED PLASTIC-LAMINATE SIGNS:

- A. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.6 LETTERING AND GRAPHICS:

- A. Coordinate names, abbreviations and other designations used in mechanical identification work with corresponding designations shown pre-existing, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer's or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H).

2.7 PAINT:

- A. All products shall be in accordance with the specifications for painting in the general contract.

PART 3 - EXECUTION**3.1 GENERAL:**

- A. Any equipment shipped with a factory applied finish shall be touched up to repair any damage to the finish so that it is the same as new.
- B. In the mechanical equipment rooms the plumbing contractor shall be responsible for painting all piping, equipment, and accessories installed under their respective contract.
- C. In other parts of the buildings items which are in place in finished areas when general building painting is done will be painted by the General Contractor. Items installed after painting is completed shall be painted by the plumbing contractor, as directed by the architect.
- D. All exposed nongalvanized ferrous metal hangers and miscellaneous metal used in connection with the plumbing systems shall be painted with two coats of enamel.
- E. All exposed piping including insulated piping, insulated by this contractor shall be painted two coats of lead and oil paint. Elastomeric pipe insulation shall have two coats of enamel of the type recommended by the insulation manufacturer.
- F. Do not field paint exposed copper pipe, brass valves, or brass trim on iron body valves, or machinery or equipment that has a factory applied finish unless otherwise specified. Do not paint plastic pipe.

- G. Painted pipes which are buried in earth, shall be allowed to dry before backfilling.
- H. All paint shall be delivered to the project in unbroken containers. Containers shall be labeled to indicate color, directions for use, manufacture, and date of manufacturer. Directions for use of the paint shall be carefully followed in the mixing and general application. All paint shall be applied under dry and dust free conditions. Sufficient time shall elapse between paint coats to permit satisfactory recoating. Once started all painting shall be completed without delay.

3.2 PIPING SYSTEM IDENTIFICATION:

- A. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), exterior non-concealed locations and above removable acoustical ceilings.
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
 - 7. On piping above removable acoustical ceilings.

3.3 PAINT SCHEDULE:

- A. All exposed equipment, pipes, conduits, or other appurtenances shall be painted by this sub-contractor with materials and application as specified in the general contract specifications and as directed by the architect.
- B. All concealed pipe covering shall be identified by colored bands and legends. The direction of flow shall be indicated by flow arrows.
- C. All exposed pipe covering shall be totally painted the color of the band color listed below. All exposed pipe hangers, rods, supports, channels, etc. shall be painted flat black.
- D. Color coding strips shall be painted no less than every 15 linear feet plus wherever entering or leaving a space and near valves. (Tape is acceptable). Width of strip shall be approximately 1/5 of the diameter of pipe plus covering if any, but in no case less than 1/2 inch. Color coding shall conform OSHA requirement.
- E. Directions arrow and fluid name shall be applied by sticker at same spacing as above. The stickers shall be secured by color coded tape wrapped two times around the pipe at each end of the label or spring cords.
- F. Standard colors and legends are as follows: (Plumbing)

3.4 PIPE IDENTIFICATION

- A. Piping systems in mechanical rooms shall be completely painted with the applicable colors listed below and have appropriate self-sticking or strap-on identifications and arrows indicating direction of flow. Piping and ducts in chases above ceiling, etc. shall be color banded and have stencil markings at appropriate intervals. On straight runs of piping, markings should be no further than 30 feet apart; and stencil identifications, color bands, and direction arrows shall be near each valve, pressure reducing valve, heat exchanger, etc. Where pipe passes through walls or floors, marking shall be near the penetration on both sides. Markings shall be at each directional change of all piping systems. Mechanical room pipe color and the color of bands are to be as follows:

PIPING SYSTEMS AND CONTENTS	STENCIL COLOR	IDENTIFICATION
Condensate Drain	Medium Blue	COND
Water, Chilled Supply	Safety Blue	CHWS
Water, Chilled Return	Safety Blue	CHWR
Water, Cold Domestic	Med. Green	DOM CW
Hot Water Heating Supply	Oxide Yellow	HWS
Hot Water Heating Return	Oxide Yellow	HWR
Natural Gas	Med. Yellow	2-PSI G, 5-PSI G
Ductwork	White	
Supports, Hangers	Flat Black	

- B. Pipe identification should contrast in color to the pipe colors and be easily readable. The width of color bands should be equal to the size of the stencil indicated below.
- C. For insulated pipe systems, stencil sizes should be as follows:
- For pipes up to 1 inch, use 1 inch letters.
 - For pipes 1 inch to 2 inches, use 2 inch letters.
 - For pipes 2 inches to 6 inches, use 3 inch letters.
 - For pipes above 6 inches, use 4 inch letters.
- D. For un-insulated systems, stencil sizes should be as follows:
- For pipe diameters up to 1 inch, use 1/2 inch letters.
 - For pipe diameters from 1 inch to 2 inches, use 1 inch letters.
 - For pipe diameters from 2 inches to 6 inches, use 2 inch letters.
- E. Valve handle shall be painted the same color as the stripes on the pipe.

3.5 VALVE IDENTIFICATION:

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
- B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

3.6 PLUMBING EQUIPMENT IDENTIFICATION:

- A. Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Pumps and similar motor-driven units.
- B. Lettering Size: Minimum 3/8" high lettering for name of unit where viewing distance is less than 2'-0", 3/4" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 the size of principal lettering.
- C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, and warn of hazards and improper operations.
- D. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

END OF SECTION 22 02 08

SECTION 22 02 10 - CONCRETE & MASONRY WORK

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. Provide all concrete and masonry work as indicated on the plumbing contract drawings, unless it is indicated that it will be by the general contractor. This includes bases for equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All cement, gravel, sand, reinforcing rod, brick, block and other materials comply with the requirements for those materials in the specifications for the general contract as part of Section 03 30 00.

PART 3 - EXECUTION

3.1 GENERAL

- A. The workmanship and manner of placing the materials shall comply with the requirements for those items in the specifications for the general contract.
- B. Bases shall have smooth tops and cambered edges.

END OF SECTION 22 02 10

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SECTION 22 05 00 – BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DEFINITION:

- A. Work under this section of the specifications shall include but not necessarily be limited to items common to sections:
 - 1. 220600 Underground Pipe and Pipe Fittings
 - 2. 220610 Above Ground Pipe and Pipe Fittings
 - 3. 220800 Piping Specialties and Accessories
- B. In all cases, work specified in this section of the specifications shall be compatible with all other specification sections.

1.2 SUBMITTALS:

- A. Shop drawings shall be submitted on all items in accordance with the provisions of specification Section.
- B. Submit shop drawings on the following:
 - 1. Piping
 - 2. Floor Drains

1.3 COORDINATION:

- A. The plumbing sub-contractor shall coordinate with each and the other sub-contractors as required to produce workable, controllable systems.

END OF SECTION 22 05 00

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SECTION 22 05 50 - NOISE AND VIBRATION CONTROL FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this section.

1.2 WORK INCLUDED

- A. Provide complete noise control systems as shown or specified and in accordance with the requirements of the Contract Documents. System shall be complete with:
 - 1. Foundations and supports for rigidly supported equipment.
 - 2. Vibration Isolation Equipment
 - 3. Sealing Around Services Penetrations Through Walls and Slabs

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Consult all other Sections to determine the extent of work specified elsewhere but related to this Section. This work shall be properly coordinated to produce an installation satisfactory to the Owner. This work includes, but is not limited to the following:
 - 1. Pumps
 - 2. Piping
 - 3. Plumbing Fixtures
 - 4. Concrete Housekeeping Pads
 - 5. Noise and Vibration Control for Plumbing Systems
 - 6. Sealant
 - 7. Plumbing Equipment

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1.4 CONTRACTOR'S RESPONSIBILITY

- A. The Contractor shall be responsible for verifying the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. The Contractor, even if not specifically mentioned herein or in the Contract Documents, shall supply any additional equipment needed to meet the intent of this specification, without claim for additional payment.
- B. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly to the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.
- C. The intent of the designers is that there are no conflicts between this and other sections of the specification. If conflicts are discovered between this section and any other section or subsection of Division 22, it shall be the contractor's responsibility to immediately bring this fact to the architect's attention and request instruction. Absent that instruction, the contractor shall assume that this current section shall overrule in any conflicts.

1.5 MANUFACTURER'S RESPONSIBILITIES

- A. Manufacturer of vibration isolation equipment shall have the following responsibilities:
 - 1. Provide piping and equipment isolation systems as scheduled or specified.
 - 2. Guarantee specified isolation system deflection.
 - 3. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
 - 4. The vibration isolation systems shall be guaranteed to have deflection indicated on the schedule on the drawings. The mounting manufacturer shall determine mounting sizes and the sizes shall be installed in accordance with the manufacturer's instructions.
 - 5. The vibration isolator vendor shall ensure that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators. Where additional support structure is required, vibration isolator vendor shall provide this.

1.6 BID PROPOSALS

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- A. The Contractor shall submit at the time of bidding the names and qualifications of the noise and vibration control supplier(s). If a supplier is not one of the pre-approved vendors, then the submittal shall be accompanied by a complete catalog of that supplier's products and samples of each proposed vibration isolator.

1.7 SUBMITTALS

- A. Contractor shall submit fully coordinated shop drawings for all vibration and noise control equipment. These submittals shall state the acoustical performance of the products as described below.
1. Isolators: Submittal to the Architect shall include drawings prepared by the *isolation materials* manufacturer showing the construction of the isolation devices to be used, including specific selection of isolators for the equipment to be furnished for this project.
- B. Submittal of vibration isolation system schedule indicating the following:
1. Manufacturer, type, model number, size
 2. Height when uncompressed and static deflection of each isolation element
 3. Spring constant of each isolation element
 4. Estimated imposed load on each isolation element
 5. Spring o. d., free operating and solid heights
 6. Design of supplementary bases, if any
 7. Layout of isolator hangers, mounts and other elements shown on an outline of the isolated equipment, including complete details of attachment to load-bearing structure or supplementary framing
 8. Piping isolators shown and identified on piping layout drawing
- C. All concrete foundations and supports (and required reinforcing and forms) will be furnished and installed by another trade. However, this trade shall furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports and all required hanger bolts and other accessories necessary for the proper installation of his equipment. Although another trade will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by this trade which drawings shall be submitted showing the complete details of all foundations including necessary concrete and steel work, vibration isolation devices, etc.

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1.8 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to NC levels per ASHRAE handbook as indicated.

B. Noise Critical Spaces

SPACE	NC LEVEL
Multipurpose Room	NC 25
Offices	NC 35
Classrooms	NC 35
Lobby	NC 30

- C. Penetrations by pipes into or between noise critical spaces should be avoided. Where they are necessary, they shall be sleeved, packed and sealed airtight with non-hardening sealant as described herein.

1.9 DESCRIPTION OF SYSTEMS

A. VIBRATION ISOLATION

1. Building structure can provide a direct path for mechanically induced vibration to travel from mechanical equipment to noise critical spaces. Rotating or vibrating equipment such as pumps and pipes shall be mounted on or suspended from vibration isolators to attenuate the vibration transfer from equipment into the building structure.

B. SEALING OF PENETRATIONS

1. Building structures meant to isolate air-borne noise surround noise critical spaces and spaces that contain noise, i.e. mechanical equipment rooms. These building structures must be massive, airtight constructions. The effectiveness of sound isolating structures can be severely compromised by penetrations for piping. Proper sealing and/or lagging (enclosure) around mechanical services penetrating these structures will maintain the integrity of the isolating structure.

1.10 QUALITY ASSURANCE

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- A. It is the objective of this Specification to provide for the control of noise and vibration due to the operation of machinery or equipment, and/or due to interconnected piping.
- B. The installation of all noise and vibration control systems shall be under the supervision of the manufacturer's representative.
- C. A single manufacturer shall provide all vibration isolation equipment and materials. The following manufacturers are approved provided systems are in compliance with the specified design and performance requirements. The project acoustics consultant must approve any others.
 - 1. Mason Industries, Inc., Hauppauge, New York
 - 2. Vibration Mountings and Controls, New Hyde Park, NY
 - 3. Kinetics Noise Control, Dublin, Ohio

PART 2 - PRODUCTS

2.1 GENERAL

- A. All equipment provided for vibration isolation or noise control shall be new and manufactured specifically for the purpose intended.

2.2 FOAM ROD

- A. Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

2.3 NON-HARDENING SEALANT

- A. Sealant for penetrations shall be non-hardening polysulphide type.
- B. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.

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2.4 PACKING MATERIAL FOR PENETRATIONS

- A. Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m³).

2.5 VIBRATION ISOLATION SYSTEMS

- A. The static deflection of isolators shall be as given in the equipment schedule and specified below. The isolator schedule shall take precedence.
- B. The vibration isolator supplier shall determine vibration isolator sizes and layout.
- C. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- D. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of not less than 50% above the design deflection.
- E. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than $\pm 10\%$.
- F. All neoprene mountings shall have a Shore hardness of 30 to 60 ± 5 , or as specified herein, after minimum aging of 20 days or corresponding over-aging.
- G. Housed or caged spring isolators are not acceptable.
- H. Where steel spring isolation systems are described in the specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation. All isolators shall operate in the linear portion of their load versus deflection curve and have 50% excess capacity without becoming coil bound.

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- I. All mounting systems exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized. Springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated.
- J. ISOLATOR TYPE WP
1. Type WP (Waffle Pads) shall be 5/16 inch thick neoprene pads ribbed or waffled on both sides. The pads shall be manufactured with bridge bearing quality neoprene and selected for a maximum durometer of 50 and designed for 15% strain. Where required, steel load-spreading plates shall be incorporated between the equipment and the neoprene pad.
 2. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
 3. (Type WP: Mason Industries Type W or as approved.)
- K. ISOLATOR TYPE MWP
1. Type MWP (Metal and Waffle Sandwich Pads) shall consist of two 5/16 inch thick ribbed or waffle neoprene pads sandwiching a 16 gauge stainless steel shim plate. The pad shall be manufactured with bridge bearing quality neoprene and selected for a maximum durometer of 50 and designed for 15% strain.
 2. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660, or as approved) shall be installed under the bolt head between the steel washer and the base plate.
 3. (Type MWP: Mason Industries Type WSW or as approved.)
- L. ISOLATOR TYPE DDNM
1. Type DDNM (Double Deflection Neoprene Mounts) shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.
 2. The isolator shall be manufactured with bridge bearing quality neoprene and selected for a maximum durometer of 50 and designed for 15% strain. DDNM mounts shall be selected for a static deflection of 3/8 inch unless otherwise specified.
 3. (Type DDNM: Mason Industries Type ND or as approved.)
- M. ISOLATOR TYPE DDNH

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1. Type DDNH (Double Deflection Neoprene Hangers) shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4 inch larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed, the hanger box shall be allowed to rotate through a full 360 degrees without encountering any obstructions.
2. The isolator shall be manufactured with bridge bearing quality neoprene and selected for a maximum durometer of 50 and designed for 15% strain. Unless otherwise specified, the static deflection of DDNH hangers shall be 0.3 inches.
3. (Type DDNH: Mason Industries Type HD or as approved.)

N. ISOLATOR TYPE RBA

1. Type RBA isolators shall be designed with a neoprene element to provide isolation in tension, shear or compression. Neoprene to bridge bearing quality with a maximum durometer of 50.
2. (Type RBA: Mason Industries Type RBA or as approved)

O. ISOLATOR TYPE SPNM

1. Type SPNM (Spring and Neoprene Mounts) shall have a free-standing and laterally stable steel spring without any housing. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall be not less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.
2. Unless otherwise specified, the minimum static deflection of SPNM isolators for equipment mounted on grade slabs shall be 1 inch and the minimum static deflection for equipment mounted above grade level shall be 2 inches.
3. Two Type WP isolation pads sandwiching a 16 gauge stainless or galvanized steel separator plate shall be bonded to the isolator baseplate.
4. Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If the base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
5. (Type SPNM: Mason Industries Type SLFSW or as approved.)

P. ISOLATOR TYPE SPNH

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1. Type SPNH (Spring and Neoprene Hangers) shall consist of a steel spring in series with a neoprene isolating element. The spring shall have a minimum additional travel to solid equal to 50% of the specified deflection. The neoprene element shall have a static deflection of not less than 0.3 inches with a strain not exceeding 15%.
2. Unless otherwise specified, the static deflection of SPNH hangers shall be 2 inches.
3. Spring diameter and hanger box hole size shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4 inch larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions. When installed and loaded, if the threaded rod touches the neoprene at the bottom of the hanger box, instructions shall be given to make an adjustment.
4. (Type SPNH: Mason Industries Type 30N or as approved.)

Q. ISOLATOR TYPE CSNM

1. Type CSNM (Constrained Spring and Neoprene Mounts) shall be a spring and neoprene mount that incorporates a housing which incorporates unrestrained stable springs with built-in leveling device and resilient vertical limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind loading.
2. A minimum clearance of 1 inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Limit stops shall provide minimum 1/4" clearance under normal operation and a neoprene washer shall be installed beneath the bolt head/ washer used to restrain the isolator.
3. In installations subject to wind load, provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene mounting sleeve.
4. Provide minimum 1/4" inch thick neoprene acoustical base pad on underside of mount unless designated otherwise.
5. Mount shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
6. Unless otherwise specified, the minimum static deflection for Type CSNM mounts shall be 2 inches.
7. Spring diameter and hanger box hole size shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact

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the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4 inch larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions. When installed and loaded, if the threaded rod touches the neoprene at the bottom of the hanger box, instructions shall be given to make an adjustment.

8. (Type CSNM: Mason Industries Type SLR or as approved)

R. BASE TYPE CB

1. Inertia base Type CB (Concrete Base) shall have an integral rectangular structural steel form into which concrete is poured.
2. Perimeter members shall be beams of depth equal to 10% of the longest span of the base, but not more than 12 inches nor less than 6 inches deep. Forms shall include motor slide base and all reinforcing steel. Where anchor bolt locations fall in concrete, the reinforcing steel shall include drilled members with sleeves welded below the steel to accept the anchor bolts. Height saving steel brackets shall be used in all mounting locations.
3. When the concrete base is "T" shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.
4. The structural perimeter frame, mounting templates, height saving brackets and spring system shall be provided as an assembly by the vibration control vendor.
5. (Base Type CB: Mason Industries Type KSLFSW or as approved)

2.6 NEOPRENE MOUNTING SLEEVES

- A. Neoprene mounting sleeves for hold-down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.

2.7 PIPE FLEXIBLE CONNECTORS

- A. Flexible connectors for pipes shall be neoprene Mason Type MFNEC, MFTNC or as approved. Do not use control rods.

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PART 3 - EXECUTION

3.1 GENERAL

- A. All equipment, piping, etc. shall be mounted on or suspended from approved foundations and supports, all as specified herein, or as shown on the drawings.
- B. All floor-mounted equipment shall be erected on 4" thick concrete housekeeping pads over the complete floor area of the equipment, unless otherwise specified to the contrary herein. These pads shall be integrally keyed to structural slab. Wherever vibration eliminating devices and/or concrete inertia blocks are specified, these items shall, in all cases, be in turn mounted on concrete housekeeping pads unless otherwise specified to the contrary herein.
- C. Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.
- D. All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 1/4" maximum, under all operating conditions. Lateral restraining isolators shall have the same having the same static deflection as equipment being isolated,
- E. Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 2 inches between the bottom of the equipment or inertia base (and height-saving bracket) and the concrete housekeeping pad (or bolt heads) beneath the equipment. The clearance shall be checked by the Contractor to ensure that no material has been left to short- circuit the vibration isolators. There shall be a minimum 4 inch clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.
- F. Piping plumbing equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.
- G. Equipment connected to water piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping and blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.
- H. All plumbing equipment not specifically identified in this specification that contains rotating or vibrating elements and any associated electrical apparatus installed by this division that

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contains transformers or inductors shall be installed on Type DDNM or RBA neoprene isolators as appropriate.

- I. All wiring connections to plumbing equipment on isolators shall be made with a minimum 36 inch long flexible conduit in a 180 degree "U" shaped loop.
- J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated from natural rubber instead of neoprene.
- K. Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
- L. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
- M. Refer to Vibration Isolation Schedule at the end of this Section.

3.2 INLINE PUMPS

- A. Inline pumps shall be supported on Type SPNM spring isolators under supports. Use elbow-type neoprene flexible pipe couplings on each side of pump. The vertical load is to be carried by the supports, not by the flexible couplings.

3.3 MOUNTING OF CENTRIFUGAL PUMPS - UNDER 2 HP

- A. Pumps under 1.5 hp shall be installed on a 4" minimum thickness concrete housekeeping pad and shall be supported on at least four Type DDNM isolators.
- B. Expansion TANKS and water heaters without pumps or motors
- C. Each floor-mounted unit shall be supported on Type MWP neoprene sandwich pads. Each suspended unit shall be supported on Type DDNH hangers. Where piping on isolators is connected to these units, the connection shall be made with a neoprene flexible connector.
- D. If an associated circulation pump is to be mounted on the unit and if the pump is 0.5 HP (0.4KW) or smaller, then the pump shall be mounted to the unit through Type RBA neoprene

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isolators. Such pumps larger than 0.5 HP (0.4KW) shall be supported from the building structure on Type DDNM mounts or Type DDNH hangers. Pumps larger than 1.5 HP shall be supported on Type CIB concrete inertia bases which are supported on Type SPNM isolators. All connection to these circulation pumps shall be with flexible connections.

3.4 SUPPORT OF PIPING

- A. The following water piping shall be resiliently supported:
 - 1. All piping in equipment rooms.
 - 2. Piping outside of equipment room within 75 feet of connected rotating equipment or 100 pipe diameters whichever is greater.
 - 3. All piping in shafts.
 - 4. All piping where exposed on roof.
- B. Resilient diagonal mountings or other approved devices shall be provided as required to limit piping motion due to equipment startup or shut down, to a maximum of 1/8".
- C. Water piping hanger rod isolators shall contain a steel spring in series with a 1/4" acoustical neoprene pad within a steel box retainer. The hanger rod isolator assembly shall be rigidly supported from the spring sub assembly shall not contact the steel box retainer and clearances in the isolator design shall be capable of accepting a 15 degree misalignment in any direction from the vertical.
- D. The steel spring element of the assembly shall be designed to have a minimum surge frequency of 340 HZ and a minimum deflection of 3/4".
- E. Where supplementary steel is required to support piping, the supplementary steel shall be sized so that maximum deflection between supports does not exceed 0.08" and shall be resiliently supported from the building structure with mountings as described above. Supported piping from the supplementary steel shall be rigidly suspended or supported.
- F. Where isolated water piping 6" and smaller is supported directly below exposed steel beams, attachment to the beam shall be made by means of welded channel beam attachments located directly under the web of the beam. Beam clamps may be used in lieu of welding subject to approval of beam clamp selection.

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3.5 SUPPORTS

- A. Piping supports within shafts shall be provided with suitable bearing plates and two layers 1/4" thick ribbed or waffled neoprene pad loaded for 50 psi maximum. The isolation pads shall be separated with 1/4" steel plate.
- B. The isolation pads shall be Mason Industries Type W or approved equal.
- C. Piping isolation supports at the base of risers shall be two layers of 1/2" thick heavy duty neoprene and canvas duct isolation pad separated by 1/4" thick steel plate. Suitable bearing plates sized to provide a pad loading of 500 psi maximum shall be provided. The stanchion between the pipe and isolation support shall be welded to the pipe and welded or bolted to the isolation support. The isolation support shall be bolted to the floor slab with resilient sleeves and washers.
- D. All pipe support resilient materials shall be HL Mason Industries, Inc., or as approved.

3.6 PIPES CONNECTED TO EQUIPMENT ON SPRING ISOLATORS

- A. All pipes connected to equipment installed on spring vibration isolators, except sprinkler piping, shall be suspended or, supported by Type SPNM or Type SPNH isolators. Provide vibration isolation anchors and guides as specified elsewhere in this specification.
- B. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to 1.5 times that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 1 inch.
- C. If pipes are supported on noise-critical structure, the 1.5 times spring deflection rule above applies throughout the pipe run.

3.7 PIPES CONNECTED TO EQUIPMENT ON NEOPRENE ISOLATORS

- A. Piping that is connected only to machinery installed on neoprene isolators shall be either supported from the floor on Type DDNM mounts or suspended from the structure on Type DDNH hangers.

3.8 PIPES WITH MULTIPLE CONNECTIONS

- A. Where a pipe run connects multiple items of equipment in the mechanical room the pipe isolators for the entire run shall be chosen to suit the connected equipment of greatest static deflection.

3.9 FLEXIBLE PIPING CONNECTORS

- A. Twin-sphere neoprene type flexible piping connectors shall be installed to connect piping to reciprocating or rotating equipment.

3.10 DRAIN PIPES, VENT PIPES AND SMALL DOMESTIC WATER PIPES

- A. Except as noted elsewhere on this specification, outside the mechanical room all domestic hot and cold water pipes with a diameter less than or equal to 2 inches shall be isolated from the structure with sponge neoprene, felt or glass /mineral fiber sleeves between the pipe and pipe clamp or with Type WP pads between the clamp and the structure. When it is compressed, the sleeve shall be not less than 1/8 inch in thickness.

3.11 PIPE RISERS

- A. Where pipes rise in a vertical chase and are supported from a structure with type SPNH or DDNH isolators and require lateral bracing, neoprene riser guides shall be mounted around the pipe to limit lateral movement and to prevent direct contact with the supporting structure.

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3.12 PIPE PENETRATIONS

- A. DOMESTIC WATER, SEWER, DRAIN AND VENT PIPING: Where a pipe passes through a wall, ceiling or floor slab, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Then the void shall be packed full depth with glass /mineral fiber and sealed at both ends, 1 inch deep, with sealant backed by foam rod.

3.13 WIRING

- A. All wiring connections to plumbing equipment on vibration isolators (either spring or neoprene type) shall be made with a minimum 36 inch (1m) long flexible conduit in a 180 degree "U" shaped loop. This Contractor shall coordinate wiring connections with the Electrical Contractor.

3.14 FIELD QUALITY

- A. Contractor shall work in accord with best trade practices, shall fabricate and install all items in accordance with manufacturer's recommendations and Architect's directions and shall consult with trades doing adjoining work in order to provide an installation of first class quality.

3.15 ADJUSTMENT AND TESTING

- A. SITE ACCESS: During installation of equipment, Contractor shall arrange for access as necessary for inspection of isolation and noise control equipment by Architect and his representatives.

3.16 CONTRACTOR'S REPORT

- A. The vibration isolation vendor shall inspect and approve the installation of the vibration isolators and shall submit a report to the Owner, which verifies that all of the isolation equipment has been properly installed and that the installation is in full conformance with the specification. The report shall record the vibration isolator identification and model or type. For isolators containing steel springs the report shall also record the size and uncompressed height, design static deflection and measured static deflection of the isolators provided.

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3.17 CONSULTANT'S INSPECTION

- A. Upon completing installation and adjustment for suitable operation of all work specified under this section, the Contractor shall notify the Architect in writing. The letter shall certify that all work specified under this section is complete, operational and adjusted in every respect and that all work is ready for the completion checkout. A copy of the vibration isolation report shall accompany the notification letter.
- B. Upon notification of completion, Architect will schedule an inspection by the Acoustics Consultant, who will measure the background noise level with all Plumbing Systems running.
- C. For each inspection, Contractor shall perform such functions as are necessary for inspection of the equipment. Background noise level testing must be carried out during late-night hours when ambient noise from outside is at a minimum and the site is otherwise not occupied and no work is under way. Contractor shall turn on and off any and all plumbing equipment during such background noise level testing.

3.18 GUARANTEE

- A. If, in the actual installation, any equipment fails to meet the noise or vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

VIBRATION ISOLATION SCHEDULE FOR PLUMBING EQUIPMENT				
EQUIPMENT	BASE TYPE	ISOLATOR TYPE	STATIC DEFLECTION	REFERENCE DETAIL
Base-mounted pumps	4" housekeeping pad	DDNM	4"	
Piping	4" housekeeping pad	Isolation as per specification	2" default	

END OF SECTION 22 05 50

SECTION 22 05 93 - TESTING AND BALANCING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section describes the requirements for testing and balancing of all piping and equipment installed under this contract in the presence of the Engineer and the State Inspector and prove tight for the periods stated below or longer if required for inspection.
 - 1. Disconnect the apparatus for developing the required pressures during the stated periods.
 - 2. Completely disconnect and remake joints that leak.
 - 3. No plumbing system or part thereof shall be covered or concealed until after it has been tested and approved.
 - 4. If such work has been covered or concealed before testing, it shall be exposed for testing.
 - 5. If tests described in the specifications for plumbing systems differ from requirements or the local inspector, the more rigid requirements shall govern.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Testing:
 - 1. Rough sanitary, vent and storm water piping:
 - 2. Stop all openings and fill with water to the top of the highest vent.
 - 3. Water level shall hold constant for two hours.
 - 4. Soil, storm waste, and vent systems: May be tested in sections using the water pressure test. Test pressure shall be equal to at least 10 ft. water column at all points. Retest at least the upper 10 feet of the lower section.

2.2 WATER SUPPLY SYSTEM:

- A. Fill and subject to 150 PSIG hydrostatic pressure at the lowest level for (2) hours. Fixtures shall not be connected, test the system for two hours at 75 PSIG or the prevailing water pressure, whichever is higher.

2.3 BALANCING:

- A. Regulate the flow of water to each fixture so that the faucets and flush valves operate satisfactorily without waste of water and without objectionable noise.
- B. All piping shall be free from objectionable noise or vibration and the circulation through same free and easy under normal operation and peak loads.
- C. Adjust the hot water recirculation balancing valves to obtain approximately equal temperature drops through each section of the mains.

END OF SECTION 22 05 93

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SECTION 22 06 00 – UNDERGROUND PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 SCOPE OF DIVISION 22 WORK:

- A. This work shall consist of furnishing all labor, material, equipment and services necessary for the installation of all equipment specified hereinafter.
- B. Systems, piping and components principally relevant to this section include:
 - 1. Sanitary Piping
 - 2. Vent Piping
 - 3. Storm Water Piping
 - 4. Domestic Water Piping
 - 5. Other items where shown on the drawings or as specified.

PART 2 - PRODUCTS

2.1 SANITARY PIPING:

- A. Where noted on the construction drawings, waste and vent piping below grade up to a point five (5) feet from the building shall be PVC Schedule 40 solid wall pipe with DWV fittings. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D1785 and ASTM D2665. Injection molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866.
- B. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and local code requirements. Solvent cements shall conform to ASTM D2564. Primer shall conform to ASTM F 656.
- C. All cast iron piping and fittings shall meet the latest standard and specifications of the Cast Iron Soil Pipe Institute (CISPI) and of the American Society for Testing and Materials (ASTM).
- D. All interior waste piping 2" and larger above grade shall be no-hub service weight cast iron pipe. Fittings shall be service weight cast iron no-hub.
- E. All interior waste piping 1 1/2" and smaller, above grade shall be galvanized cast iron with galvanized cast-iron drainage fittings or type DWV copper.
- F. Long turn drainage fittings shall be used in all cases except where space limitations make their use impractical.

2.2 VENT PIPING:

- A. Vent piping 2 inches and larger shall be service weight cast iron soil pipe with service weight cast iron fittings.

- B. Vent piping below grade shall be the same as sanitary piping listed in sections 2.1A and 2.1B. Minimum vent pipe size below grade shall be two (2) inches in diameter.

2.3 STORM WATER PIPING:

- A. Where noted on the construction drawings, all storm piping below grade up to a point five (5) feet from the building shall be PVC Schedule 40 solid wall pipe with DWV fittings. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D1785 and ASTM D2665. Injection molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866.
- B. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and local code requirements. Solvent cements shall conform to ASTM D2564. Primer shall conform to ASTM F 656.
- C. All interior roof drain piping above grade shall be no-hub service weight cast iron pipe with service weight no-hub cast iron fittings, or galvanized steel with galvanized malleable iron screw fittings.
- D. All cast iron piping and fittings shall meet the latest standards and specifications of the Cast Iron Soil Pipe Institute (CISPI) and of the American Society for Testing and Materials (ASTM).

2.4 DOMESTIC WATER AND FORCED MAIN PIPING:

- A. Pipe material for above ground installation shall be type "L" hard drawn copper tubing with 125 psi solder joint wrought copper fittings.
- B. Underground service outside the building shall be ductile iron with 250 PSI joints and fittings or type "K" hard drawn copper tubing.
- C. Pipe material for below ground installation, inside the building shall be Type "K" hard drawn copper tubing without fittings or joints or ductile iron.
- D. Green water supply piping shall be provided per the domestic water specification.

PART 3 - EXECUTION

3.1 GENERAL:

- A. For purposes of clearances and legibility, the contract documents are essentially diagrammatic and, although size and location of piping 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 building site.
- B. The contract documents indicate required size and points of termination of pipes and suggest proper routes of piping to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that the contract documents indicate all necessary offsets, and it shall be the work of this section to install piping 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. The contractor shall fully inform himself regarding any

and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under the contract. The contractor shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. Although the locations of the equipment and piping may be shown on the contract documents in certain positions, the contractor shall be guided by the architectural details and conditions existing at the job, correlating this work with that of others. Provide all offsets as required to produce a neat, workmanlike arrangement.

- C. The contractor shall study all drawings and specifications to determine any conflict with ordinances and statutes. Any errors or omissions shall be reported, and any changes shall be shown in drawings made by this section, and any additional work performed at no additional cost to the Owner.
- D. Submittal of bid shall indicate the contractor has examined the site and contract documents and has included all required allowances in his bid. No allowance shall be made for any error resulting from contractor's failure to visit job sites and to review contract documents and bid shall include costs for all required drawings and changes as outlined above, all at no additional cost to the Owner.
- E. Springing, bending or forcing of pipe shall not be allowed. Use fittings for all offsets or changes in alignment of piping. Center hubs so cast iron pipe shall lay straight without pinched joints.
- F. All changes in directions shall be made with approved fittings. Mitering, saddling or welding of smaller pipe and larger piping is prohibited.
- G. Pipe openings shall be closed with caps or plugs during installation. Rags and tin cans are not considered suitable closures.
- H. Damage by leaks - This sub-contractor shall be responsible for damage to the grounds, walks, road, buildings, pipe systems, electrical systems and their equipment and contents, caused by leaks in the piping system being installed or having been installed herein. He shall repair at his expense all damage so caused. All repair work shall be performed as directed by the Architect.
- I. The use of chemicals or so-called "Stop-Leak" compounds shall not be permitted at any time.

3.2 PIPE JOINING METHODS:

- A. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- B. Solder copper tube-and-fitting joints where indicated, in accordance with ANSI B31. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- C. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
- D. Hubless Cast-Iron Joints: Comply with CISPI 310.

- E. Install gray and ductile cast-iron water mains and appurtenances in accordance with ANSI/AWWA C600.

3.3 WASTE PIPING:

- A. Joints above grade shall be no-hub coupling consisting of an approved (ASTM A-48 & ASTM C-564) elastomeric sealing sleeve and stainless steel clamp, clamping screws and housing. Piping shall be supported at one side of joint at all joints made with coupling. MG coupling or Clamp-All will be acceptable.
- B. All joints for bell and spigot piping shall be made with factory molded flexible neoprene compression couplings, factory formed, integral with the bell and spigot of the pipe. Piping joints at the joining of partial sections of pipe not equipped with compressions couplings shall be made with Carey Sewertite or approved equal compound. Joints shall meet all applicable codes.
- C. Minimum size of soil or waste piping below grade shall be (2) inches in diameter.
- D. Install horizontal and waste piping to a uniform grade of not less than 1/4 inch per foot for two (2) inch diameter and less, and not less than 1/8 inch per foot for diameters of two (2) inches or larger.
- E. Piping shall be supported at one side of joint and all joints made with no-hub couplings.
- F. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- G. Cleanouts: Install in waste piping as indicated, as required by the North Carolina State Plumbing Code; at each change in direction of piping greater than 45 degrees, at minimum intervals of 50' for piping 3" and smaller and 80' for larger piping; and at base of each vertical waste or waste stack. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.
- H. Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membrane.
- I. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions. Coordinate installation with roofing contractor.
- J. Installation of underground PVC sanitary and vent piping shall comply with the latest installation instructions published by the manufacturer and shall conform to all applicable plumbing, fire, and building code requirements. Buried pipe shall be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cement joints shall be made in a two-step process with primer conforming to ASTM F 656 and solvent cement conforming to ASTM D 2564. The system shall be protected from chemical agents, fire-stopping materials, thread sealant, plasticized-vinyl products or other aggressive chemical agents not compatible with PVC compounds. The system shall be hydrostatically tested after installation.

3.4 VENT PIPING:

- A. Plumbing contractor shall provide a complete venting system for the waste system as shown on the contract documents, and as described herein.
- B. The vent system shall not be used for purposes other than venting of the plumbing system.
- C. Piping shall be supported at one side of joints and all joints.
- D. Minimum diameter of an individual vent above grade shall be at least one half-(1/2) the diameter of the drain served, except that no vent pipe shall be less than one and one quarter (1-1/4) inches in diameter.
- E. All vent and branch vent pipes shall be sloped a minimum of one eighth (1/8) inch per foot and so connected as to drain back to the soil or waste pipe by gravity.

3.5 STORM PIPING:

- A. The storm system shall not be used for any purpose other than the removal of rainwater from the roof, sidewalks and paved areas. Storm water shall not drain into the sanitary sewer system.
- B. All joints above grade shall be no-hub coupling type consisting of an approved elastomeric sealing sleeve and stainless steel clamp, clamping screens and housing. Piping shall be supported at both sides of joint at all joints made with this coupling.
- C. Pitch all horizontal storm piping above grade a minimum of 1/8" per foot unless noted otherwise. All horizontal piping below grade shall be pitched to meet invert elevations shown on the contract documents.
- D. Lay storm piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- E. Installation of underground PVC storm piping shall comply with the latest installation instructions published by the manufacturer and shall conform to all applicable plumbing, fire, and building code requirements. Buried pipe shall be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cement joints shall be made in a two-step process with primer conforming to ASTM F 656 and solvent cement conforming to ASTM D 2564. The system shall be protected from chemical agents, fire-stopping materials, thread sealant, plasticized-vinyl products or other aggressive chemical agents not compatible with PVC compounds. The system shall be hydrostatically tested after installation.

3.6 DOMESTIC WATER PIPING:

- A. Potable water piping shall include all domestic cold water piping.
- B. All copper piping shall have sweat joints, except at valves where sweat to threaded adapters shall be used. All pipe shall be reamed to full diameter before jointing. Ends of pipe and inside of fittings shall be cleaned and flux applied to entire area of pipe end to be soldered. On pipe 1-

1/2 inches and larger, flux shall be applied to pipe and fittings. Solder for piping 4" and smaller shall be 95-5 solder.

- C. Chlorination of Water System: After water system is completed, the entire system shall be chlorinated by injecting a strong solution of chlorine into the system of not less than 50 ppm. Valves shall be opened and closed to gain complete coverage of system. Let system stand for twenty-four (24) hours, then flush system to leave a minimum permissible concentration as recommended by the Health Department having jurisdiction. After flushing, satisfactory bacteriological results must be obtained or the mains must be rechlorinated until satisfactory results are obtained.

END OF SECTION 22 06 00

SECTION 22 06 10 – ABOVE GROUND PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. This work shall consist of furnishing all labor, material, equipment and services necessary for the installation of all equipment specified hereinafter.
- B. Systems, piping and components principally relevant to this section include:
 - 1. Sanitary Piping
 - 2. Vent Piping
 - 3. Storm Water Piping
 - 4. Domestic Water Piping/Forced Main Piping
 - 5. Other items where shown on the drawings or as specified.

1.2 SUBMITTALS:

- A. Shop drawings shall be submitted on all items in accordance with the provisions of specification section 22 01 00.

PART 2 - PRODUCTS

2.1 SANITARY AND STORM WASTE PIPING:

- A. All interior waste and storm piping 2" and larger above grade shall be non-hub or hub & spigot service weight cast iron pipe. Fittings shall be service weight cast iron. Schedule 40 Solid Wall PVC with DWV fittings is an acceptable alternate.
- B. All interior waste and storm piping 1 1/2" and smaller above grade shall be galvanized wrought iron with galvanized cast-iron drainage fittings. Copper DWV piping and fittings will be acceptable. Schedule 40 Solid Wall PVC with DWV fittings is an acceptable alternate.
- C. Long turn drainage fittings shall be used in all cases except where space limitations make their use impractical.

2.2 VENT PIPING:

- A. Vent piping 2 inches and larger shall be service weight cast iron soil pipe with service weight cast iron fittings. Schedule 40 Solid Wall PVC with DWV fittings is an acceptable alternate.
- B. Vent piping below grade shall be Schedule 40 PVC with matched fittings. Minimum vent pipe size below grade shall be two (2) inches in diameter.

2.3 DOMESTIC WATER PIPING/FORCED MAIN PIPING:

- A. Pipe material for above ground installation, larger than 2", shall be type "L" hard drawn copper tubing with 125 psi solder joint wrought copper fittings.
- B. Pipe material for above ground installation, 2" and smaller, shall be PEX Type A with cold-expansion PEX Type A compression-sleeve fittings. Flow through fittings shall be maintained for full size of line.
- C. Pipe material for below ground installation, inside the building shall be Type "K" hard drawn copper tubing without fittings or joints. Solder and flux shall be lead free.
- D. Solder for joints 1½" and larger shall be silver soldered joints. Smaller than 1½" shall be soldered with 95-5. Joints for potable water piping shall use lead free solder and flux.
- E. Fittings for copper pipe shall be wrought copper.
- F. All exposed piping in finished room (including cabinets) used in connection with plumbing fixtures shall be chromium plated brass pipe with plated cast brass fittings.

2.4 COMPOUNDS, SOLDER AND LEAD:

- A. Pipe Thread Compound:
 - 1. Crane, Dixon, Rutland, or equal, or Teflon tape type.
 - 2. Solder-joint solder: 95% tin and 5% antimony. Joints on larger pipe shall be made with a high-temperature brazing solder, Sil-phos or equal, except use 95-5 at valves.
- B. Asphaltic Joint Compound:
 - 1. G-K Jointite, Korite or equal.

PART 3 - EXECUTION**3.1 GENERAL:**

- A. For purposes of clearances and legibility, the contract documents are essentially diagrammatic and, although size and location of piping 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 building site.

- B. The contract documents indicate required size and points of termination of pipes and suggest proper routes of piping to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that the contract documents indicate all necessary offsets, and it shall be the work of this section to install piping 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. The contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under the contract. He shall exercise due and particular caution to determine that all parts of his work are made quickly and easily accessible. Although the locations of the equipment and piping may be shown on the contract documents in certain positions, the contractor shall be guided by the architectural details and conditions existing at the job, correlating this work with that of others. Provide all offsets as required to produce a neat, workmanlike arrangement.
- C. The contractor shall study all drawings and specifications to determine any conflict with ordinances and statutes. Any errors or omissions shall be reported, and any changes shall be shown in drawings made by this section, and any additional work performed at no additional cost to the Owner.
- D. Submittal of bid shall indicate the contractor has examined the site and contract documents and has included all required allowances in his bid. No allowance shall be made for any error resulting from contractor's failure to visit job sites and to review contract documents and bid shall include costs for all required drawings and changes as outlined above, all at no additional cost to the Owner.
- E. All piping shall be installed to prevent unusual noise from the flow of water under normal conditions. Insert one (1) inch strip of hair felt to isolate all piping from any direct contact with any part of the building, framing, conduit, etc.
- F. Springing, bending or forcing of pipe shall not be allowed. Use fittings for all offsets or changes in alignment of piping. Center hubs so cast iron or clay pipe shall lay straight without pinched joints.
- G. All changes in directions shall be made with approved fittings. Mitering, saddling or welding of smaller pipe and larger piping is prohibited.
- H. Pipe openings shall be closed with caps or plugs during installation. Rags and tin cans are not considered suitable closures. Pipe openings in terrazzo floors shall have semi-permanent closures during construction.
- I. Damage by leaks - These contractor's shall be responsible for damage to the grounds, walks, road, buildings, pipe systems, electrical systems and their equipment and contents, caused by leaks in the piping system being installed or having been installed herein. He shall repair at his expense all damage so caused. All repair work shall be performed as directed by the Architect.
- J. The use of chemicals or so-called "Stop-Leak" compounds shall not be permitted at any time.
- K. Unions shall be provided at connection to all equipment.
- L. Escutcheon plates shall be provided at all penetrations of walls, ceilings, floors, etc.

- M. All items of equipment and plumbing fixtures shall be provided with approved vacuum breakers to prevent backflow, as required by State Health Department and local authorities having jurisdiction. All waste connections shall be installed with approved airbreak fittings to comply with the above requirements. Vacuum breakers where shown on Drawings or required shall be angle pattern with built-in lift type check valves as manufactured by Bidoro Manufacturing Company or approved equal.
- N. Bypass Piping: Except as otherwise indicated, fabricate and install bypass piping using same materials and in same plane as connected piping, but one pipe size smaller. Include valve in bypass piping. Install bypass piping around control valves, PRV stations and as shown on drawings.

3.2 PIPE JOINING METHODS:

- A. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- B. Braze copper tube-and-fitting joints where indicated, in accordance with ANSI B31. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- C. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
- D. Hubless Cast-Iron Joints: Comply with CISPI 310.
- E. Install gray and ductile cast-iron water mains and appurtenances in accordance with ANSI/AWWA C600.
- F. Install Schedule 40 PVC in accordance with manufacturer's installations and current plumbing code.

3.3 SANITARY WASTE PIPING:

- A. Coat all piping with tar pitch or similar bituminous material, if not applied in factory.
- B. Joints above grade shall be no-hub coupling consisting of an approved (ASTM C-1540) elastomeric sealing sleeve and Type 304 stainless steel clamp, clamping screws and housing. Piping shall be supported at one side of joint at all joints made with coupling. Husky SD4000, MG coupling, Clamp-All 125 or equal will be acceptable.
- C. All joints for bell and spigot piping shall be made with factory molded flexible compression couplings, factory formed, integral with the bell and spigot of the pipe. Piping joints at the joining of partial sections of pipe not equipped with compressions couplings shall be made with firmly packed hemp, oakum, jute and Carey Sewertite or approved equal compound. Joints shall meet all applicable codes.

- D. Minimum size of waste piping below grade shall be (2) inches in diameter.
- E. Piping shall be supported at one side of joint and all joints made with no-hub couplings.
- F. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- G. Install waste piping pitched to drain at minimum slope of 1/4" per foot (2%) for piping 2 1/2" and smaller, and 1/8" per foot (1%) for piping 3" and larger.
- H. Install 1" thick extruded polystyrene over underground building drain piping not under building. Provide width to extend minimum of 12" beyond each side of pipe. Install directly over pipe, centered on pipe center line.
- I. Cleanouts: Install in sanitary above ground piping and sanitary building drain piping as indicated, as required by the International Plumbing Code; at each change in direction of piping greater than 45°, at minimum intervals of 50' for piping 3" and smaller and 80' for larger piping; and at base of each vertical waste or waste stack. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.
- J. Flashing Flanges: Install flashing flange and clamping device with each stack and cleanout passing through waterproof membrane.
- K. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions. Coordinate installation with roofing contractor.
- L. Installation of underground PVC sanitary and vent piping shall comply with the latest installation instructions published by the manufacturer and shall conform to all applicable plumbing, fire, and building code requirements. Buried pipe shall be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cement joints shall be made in a two-step process with primer conforming to ASTM F 656 and solvent cement conforming to ASTM D 2564. The system shall be protected from chemical agents, fire-stopping materials, thread sealant, plasticized-vinyl products or other aggressive chemical agents not compatible with PVC compounds. The system shall be hydrostatically tested after installation.

3.4 VENT PIPING:

- A. Plumbing contractor shall provide a complete venting system for the sanitary system as shown on the contract documents, and as described herein.
- B. The vent system shall not be used for purposes other than venting of the plumbing system.
- C. Piping shall be supported at one side of joints and all joints.
- D. Minimum diameter of an individual vent above grade shall be at least one half-(1/2) the diameter of the drain served, except that no vent pipe shall be less than one and one quarter (1-1/4) inches in diameter.
- E. All vent and branch vent pipes shall be sloped a minimum of one eighth (1/8) inch per foot and so connected as to drain back to the soil or waste pipe by gravity.

- F. Extension of vent pipes through a roof shall be terminated at least twelve (12) inches above the roof.
- G. Minimum size vent through the roof shall be three (3) inches in diameter. When it is found necessary to increase the size of the vent extension to meet this requirement, the change in diameter shall be made inside the building at least one foot below the roof with an approved fitting.
- H. The vents must be through the roofs before the final roofing is applied. Where necessary, the vents shall be offset in the roof construction so that they come through the roof at least 18" from walls and other objects projecting above roof surface.

3.5 DOMESTIC WATER PIPING / FORCED MAIN PIPING:

- A. Potable water piping shall include all domestic cold, hot, circulating and Rainwater Harvesting supply piping.
- B. The water service to the building shall maintain a minimum depth of 36" below the finished grade to the top of pipe.
- C. All copper piping shall have sweat joints, except at valves where sweat to threaded adapters shall be used. All pipes shall be reamed to full diameter before jointing. Ends of pipe and inside of fittings shall be cleaned and flux applied to entire area of pipe end to be soldered. On pipe 1-1/2 inches and larger, flux shall be applied to pipe and fittings. Solder shall be of the composition indicated below.
 - 1. 1-1/2" and larger - Silver Solder
 - 2. 1-1/4" and lower - 95-5 Solder
- D. All cold-expansion PEXa compression-sleeve fittings shall be assembled using the manufacturer's approved tools and must consist of the following process 1. Make a clean, square cut of the PEXa pipe 2. Slide the PEXa compression sleeve over the PEXa pipe 3. Expand the PEXa pipe twice with a rotation between expansions 4. Insert the cold-expansion compression-sleeve fitting into the expanded PEXa pipe 5. Compress the PEXa compression sleeve over the PEXa pipe and fitting using only tools from the manufacturer's cataloged program.
- E. All water piping shall be pitched approximately one (1) inch per sixty (60) feet upward from source to facilitate drainage. Where water piping must change elevation to avoid structural or other obstructions, drain valves and air vents shall be provided.
- F. Provide three quarter (3/4) inch hose end valve at all low points in system for drainage.
- G. Dielectric unions or insulated couplings shall be installed between copper or brass piping material and steel piping material. Unions or insulated couplings shall be used for pipe sizes 2" and smaller, and dielectrically gasketed flanges and sleeves for pipes 2-1/2" and larger.
- H. Provide unions on inlet and outlet of all apparatus and equipment having connections 2" and smaller. Where valves are adjacent to equipment, union shall be on the downstream side of valves. For piping over 2" flanged points shall be used.
- I. Chlorination of Domestic Water Supply System:

1. After water system is completed, the entire system shall be chlorinated by injecting a strong solution of chlorine into the system of not less than 50 ppm. Valves shall be opened and closed to gain complete coverage of system. Let system stand for twenty-four (24) hours, then flush system to leave a minimum permissible concentration as recommended by the Health Department having jurisdiction. After flushing, satisfactory bacteriological results must be obtained or the mains must be re-chlorinated until satisfactory results are obtained.
 2. After disinfection the water supply shall not be placed into a service until bacteriological test results of representative water samples analyzed in approved laboratory are found to be satisfactory. Certification of bacteriological testing for quality of the domestic water shall be conducted, accepted by the Project Engineer and submitted to Authorities Having Jurisdiction prior of request for final inspection.
- J. Tests of domestic plumbing systems shall comply with authorities having jurisdiction, and, where required, shall be witnessed by the building official.
- K. Air Test:
1. Charge the completed, yet unconcealed pipes with air at a minimum of 40 psig.
 2. Do not exceed amount of pressure required by the local jurisdiction. Contractor responsible for ensuring all proper and safe procedures are followed per manufacturer's instructions.
- L. Water Test
1. Purge air from pipes.
 2. Charge the completed, yet unconcealed pipes with water.
 3. Take necessary precautions to prevent water from freezing.
 4. Check the system for leakage, especially at all pipe joints.
- M. Perform pressure test per manufacturer's technical guidelines.

END OF SECTION 22 06 10

SECTION 22 07 00 - INSULATION

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. Provide insulation as specified for: Piping systems including valves, couplings, fittings, flanges, strainers, and expansion joints.
 - 1. Equipment, including tanks, and components subject to heat loss or heat gain.
 - 2. Other items where shown on drawings and/or specified.

1.2 SUBMITTALS:

- A. Shop drawings shall be submitted on all items in accordance with the provisions of specification Section 22 01 00.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

- A. In addition to this Section, this sub-contractor shall refer to other specification sections and drawings to ascertain the extent of work, including: All Division 22 Sections.

1.4 DEFINITION:

- A. Work under this Division 22 of the specifications shall include but not necessarily be limited to items common to Sections:
 - 1. 220702 Potable Cold Water and Storm Piping Insulation

1.5 QUALITY ASSURANCE:

- A. Provide piping insulation products produced by one of the following manufacturers for each type and temperature range of insulation.
 - 1. Certainteed Corporation
 - 2. Owens-Corning Fiberglass Corporation
 - 3. Knauff Corporation
 - 4. Armstrong Cork Company

1.6 SUBMITTALS:

- A. Shop drawings shall be submitted on all items in accordance with the provisions of specification Section 22 01 00.
- B. Submit shop drawings on the following:
 - 1. Insulation
 - 2. Fitting covers

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Protect insulation against dirt, water and chemical and mechanical damage. Do not install damaged insulation; remove from project site.
- B. Delivery insulation, covering, cements, adhesives and coatings to the site in factory-fabricated containers with the manufacturer's stamp, or label, affixed showing fire hazard ratings of the products.
- C. Store insulation in original wrappings and protect from weather and construction traffic.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS - PIPING INSULATION:

- A. Insulation shall have composite (insulation jacket or facing, and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure ASTM E84, NEPA 255 or UL 723 not exceeding:
 - 1. Flame Spread-25
 - 2. Smoke Developed 50
- B. Accessories such as adhesives, mastics, cements, tapes and cloth for fittings shall have the same component rating as listed above. All products or their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed requirements. Treatment of jackets or facings to impart flame and smoke-safety shall be permanent. The use of water-soluble treatments is prohibited.
- C. Where Benjamin-Foster adhesives are specified equal products manufactured by 3M Company, or the manufacturer of the insulation are acceptable upon approval by the Engineer. Armstrong 520 adhesive shall be used for Armstrong insulation.
- D. In lieu of the insulation wrap specified for fittings, valves, mechanical couplings and flanges, unitary type insulation products similar to J-M Unifit shall be acceptable.
 - 1. Underground piping shall be directed buried pre-insulated piping.

PART 3 - EXECUTION

3.1 GENERAL EXECUTION REQUIREMENTS - PIPING:

- A. Insulation shall be applied on clean dry surfaces, after inspection and release for insulation application. Items that are factory insulated shall not receive additional insulation.
- B. Insulation shall be continuous through non-rated wall and ceiling openings and sleeves.
- C. Insulation on cold surfaces where vapor barrier jackets are used shall be applied with a continuous, unbroken vapor seal. Anchors, etc., that are secured directly to cold services shall be adequately insulated and vapor sealed to prevent condensation.

- D. Where insulation is specified for piping, insulate similarly all connections, vents, drains, and any appurtenances and piping connected to system subject to heat loss or gain. Unions, couplings, or flanges provided at equipment for removal of heat exchanger, etc., shall be insulated with removable molded blocks.
- E. Where inserts occur at pipe supports and guides, provide the following:
 - 1. On cold pipe apply a wet coat of vapor barrier lap cement on all butt joints and seal all joints with 3" wide vapor barrier tape or band.
- F. Fittings, valves, mechanical couplings and flanges shall be insulated with the same material and of the same thickness as the adjoining piping, except where otherwise specified.
- G. Concealed piping insulate with glass fiber insulation types shall be banded in place with three aluminum bands per section, one over each end of the joint sealing strip, and one in the middle of the section.
- H. All exposed piping within the mechanical rooms, and equipment platforms shall be finished with an 8 ounce canvas jacket posted to the insulation and if within 8'-0" of the floor shall be finished with an additional aluminum jacket (.016" preformed). Exposed fittings, etc. shall be finished with fitting cloth smoothly adhered and coated with Benjamin-Foster 30-36. Lap the cloth on itself and adjoining pipe insulation. Lap to be at least 1" on pipe insulation below 4" and 2" on sizes 4" and above.
- I. On pipe sizes 4" and larger, fittings, mechanical couplings, and valves shall be insulated with molded fitting covers. Flanges shall be insulated with sectional pipe insulation extending a minimum of 1" beyond the end of the bolts. Bolt area shall be fitted with insulating and finishing cement.
- J. All piping subject to freezing such as in outdoor air or discharge plenums or outdoors shall be insulated with twice the insulation thickness specified.

3.2 GENERAL EXECUTION REQUIREMENTS - EQUIPMENT:

- A. Insulation shall be firmly held in place with galvanized steel wire or galvanized steel bands on 12" centers.

3.3 PROTECTION AND REPLACEMENT:

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation installer shall advise plumbing contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 22 07 00

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SECTION 22 07 02 - POTABLE COLD WATER AND STORM WATER PIPING INSULATION

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. Provide insulation as specified for cold water piping systems, including valves, mechanical coupling, fittings, flanges and strainers.
1. Other items where shown on drawings or as specified.

PART 2 - PRODUCTS

2.1 PIPING INSULATION TYPES:

A. Type P-1 Pipe Insulation:

1. Insulation shall be glass fiber with a maximum K factor of .24 at 75°F mean temperature with factory applied fire resistant vapor barrier jacket.
2. For fittings and valve bodies 3" and smaller, insulation shall be one-pound density glass fiber blanket wrapped firmly under compression with No. 20 gauge galvanized annealed steel wire and given a smoothing coat of finishing cement.

B. Insulation Thickness Schedule:

PIPING SYSTEM	THICKNESS
Potable Cold, Water Piping	1" Min.

C. Type P-2 Pipe Insulation:

1. Insulation shall be the same as Type 1 except fittings and valves 3" and smaller shall be insulated and finished with insulation and finishing cement to a thickness equal to the adjoining pipe insulation.

INSULATION THICKNESS SCHEDULE:	THICKNESS
Piping System All horizontal storm drain above ground (primary and secondary)	1"
All roof drain bodies(primary and secondary)	1"

D. Drainage Piping Within A Ceiling Cavity From Ice Machines:

1. Insulate the drain body, p-trap and the first 10'-0" of piping.

PART 3 - EXECUTION

3.1 PIPING INSULATION:

A. Type P-1 Insulation:

1. Longitudinal lap and 4" wide vapor barrier joint seal strips shall be adhered neatly in place with BF 85-20 adhesive or approved equal.
2. The ends of pipe insulation shall be sealed off with BF 30-35 coatings at all open ends, flanges, valves and fittings and at intervals of not more than 21 feet on continuous runs of pipe.

3. Fittings shall be vapor sealed by applying a layer of white open weave glass fabric (20 x 20) between two 1/16" thick coats of BF 30-35.
- B. Type P-2 Insulation:
1. Type P-2 insulation shall be installed as P-1 above exception that insulation end not be vapor sealed.

END OF SECTION 22 07 02

SECTION 22 07 04 - POTABLE HOT WATER AND RECIRCULATING PIPING INSULATION

PART 1 - GENERAL:

1.1 SCOPE OF WORK:

- A. Provide insulation as specified for hot water piping systems, including valves, mechanical coupling, fittings, flanges and strainers.
- B. Equipment and components subject to heat transfer including:
 - 1. Other items where shown on drawings or as specified.

PART 2 - PRODUCTS

2.1 PIPING INSULATION TYPES:

- A. Type P-3 Pipe Insulation:
 - 1. Insulation shall be molded glass fiber with a maximum K factor of 0.24 at 75°F mean temperature with factory applied Fire Retardant Jacket.
 - 2. For fittings and valves bodies 3" and smaller, insulation shall be one-pound density glass fiber blanket wrapped firmly under compression with No. 20 gauge galvanized annealed steel wire and given a smoothing coat of finishing cement.
 - 3. Insulation Thickness Schedule:

PIPING SYSTEM	PIPE SIZE	THICKNESS
Potable Hot Water Supply	0 - 2½"	1"
Recirculating Return (100°F to 290°F), Tempered Water and Tempered, Water Return	3" & larger	1½"

2.2 EQUIPMENT INSULATION TYPES:

- A. Type E-2 Equipment Insulation:
 - 1. Insulation shall be 6# per cubic foot density glass fiber with fire retardant vapor barrier facing and having a maximum K factor of 0.24 at 75°F mean temperature.
 - 2. Sections of equipment requiring periodic servicing shall be insulated with removable ArmourCote covers as manufactured by Insulcoustic Corp. or by Sheet Metal Casing with insulation applied to the interior surface of the casing.

END OF SECTION 22 07 04

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SECTION 22 08 00 – PIPING SPECIALITIES AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. This work shall consist of furnishing all labor, material, equipment, and services necessary for the installation of all equipment specified hereinafter.
- B. Equipment and components principally relevant to this section include:
 - 1. Sleeves
 - 2. Other items where shown on the drawings or as specified.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Provide sleeves for each pipe passing through walls and floors.
- B. Sleeve Material:

TYPE	DESIGNATION
1	Deleted
2	Standard weight galvanized steel pipe.
3	Standard weight galvanized steel pipe with a continuous welded stop of 1/4" steel plate extending outside of sleeve a minimum all around, similar to R&S Manufacturing Corp. Fig. 204.
4	Cast iron pipe sleeve with center flange, similar to James B. Clow and Sons No. F-1430 and F-1435.
5	Standard weight galvanized steel pipe with flashing clamp device welded to pipe sleeve or watertight sleeves, similar to Josam 1870-A2, 1870, 1940-C with approved caulking compound.

- C. Sleeve Sizes: Sleeves for uninsulated pipe shall be two pipe sizes larger than pipe passing through a minimum of 1/2" clearance between inside of sleeve and outside of pipe.
- D. Sleeve Lengths:

LOCATION	SLEEVE LENGTH
Floors	Equal to depth of floor construction including finish. In waterproof floor construction sleeves to extend minimum of 2" above finished floor level.
Walls and Partitions	Equal to thickness of construction and terminated with surfaces.

E. Sleeve and Caulking and Packing:

TYPE DESIGNATION	CAULKING AND PACKING REQUIREMENTS
A	Space between pipe and sleeve packed with oakum or hemp and caulked watertight with lead.
B	Space between pipe or pipe covering and sleeve shall be caulked with a fire resistant foam sealant.

F. Sleeve Application:

SLEEVE TYPE	LOCATION	SLEEVE CAULKING AND PACKING TYPE DESIGNATION
3 or 4	Exterior walls	A

G. Mechanical Sleeve Seals:

1. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering mechanical sleeve seals which may be incorporated in the work include, but are not limited to, the following:
 - a. Thunderline Corp.

PART 3 - EXECUTION

3.1 INSTALLATION OF MECHANICAL SLEEVE SEALS:

- A. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

END OF SECTION 22 08 00

SECTION 22 11 23.21 - INLINE DOMESTIC WATER PUMPS

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Horizontally mounted, in-line, close-coupled centrifugal pumps.

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, without amendments, Section 7 - "Service Water Heating."

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.

- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bell & Gossett.
 - 2. Grundfos
 - 3. TACO Incorporated.
 - 4. Watts
- B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.
- C. Pump Construction:
 - 1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
 - 2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
 - 3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
 - 4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
 - 5. Bearings: Oil-lubricated; bronze-journal or ball type.
 - 6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
- D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 CONTROLS

- A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - 1. Type: Water-immersion temperature sensor, for installation in piping.
 - 2. Range: 65 to 200 deg F
 - 3. Enclosure: NEMA 1, Type 4X.
 - 4. Operation of Pump: On or off.
 - 5. Transformer: Provide if required.
 - 6. Power Requirement: 120 V, ac.
 - 7. Settings: Start pump temperature indicated on schedule and stop pump as indicated on schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install in-line, seal-less centrifugal pumps with shaft horizontal unless otherwise indicated.
- C. Install horizontally mounted, in-line, close-coupled centrifugal pumps with shaft(s) horizontal.
- D. Pump Mounting: Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted to wall.
 - 1. Minimum Deflection: 1/4 inch.
- E. Install continuous-thread hanger rods and spring hangers of size required to support pump weight.
 - 1. Comply with requirements for vibration isolation devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
 - 2. Comply with requirements for hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- F. Install pressure switches in water supply piping.
- G. Install thermostats in hot-water return piping.
- H. Install with electrical disconnect.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
 - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
 - a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
 - b. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."
 - 2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 22 11 19 "Domestic Water Piping Specialties."
 - 3. Install pressure gage at suction of each pump and pressure gage at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."
- D. Connect thermostats to pumps that they control.

3.4 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Set thermostats for automatic starting and stopping operation of pumps.
 - 5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 7. Start motor.
 - 8. Open discharge valve slowly.
 - 9. Adjust temperature settings on thermostats.
 - 10. Adjust timer settings.

3.6 ADJUSTING

- A. Adjust domestic water pumps to function smoothly and lubricate as recommended by manufacturer.

- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23.21

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SECTION 22 15 16 – NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The Contractor's attention is directed to the General and Special Conditions, COMMON WORK RESULTS FOR PLUMBING and to all other Contract Documents as they apply to this branch of the work. Attention is also directed to all other sections of the Contract Documents which affect the work of this section, and which are hereby made a part of the work specified in this section.
- B. Each Contractor's attention is also directed to Specification Section HANGERS, CLAMPS, ATTACHMENTS, ETC.

1.2 SCOPE:

- A. Unless otherwise indicated, all materials shall be new and of the best grade and quality for the type specified. Materials shall comply with the "Buy American Act".
- B. Where piping is not indicated on the plans, but is obviously or apparently required, contact the Engineer prior to submission of the bid.
- C. The piping indicated shall be installed complete and shall be of the size indicated. When a pipe size is not indicated, the Contractor shall request the pipe size from the Engineer. Where a section of piping is not indicated but is obviously required for completion of the system, the Contractor shall provide same at no additional cost to the project.
- D. Pay particular attention to conflict of piping with other work. Do not install until conflict is resolved. If in doubt, consult Engineer.

PART 2 - PRODUCTS

2.1 SITE NATURAL GAS PIPING:

- A. Exterior natural gas piping below grade shall be thermoplastic gas pressure pipe with fittings. All gas piping shall be per NFPA 54. Polyethylene pipe used for gas service lines must conform to specification ASTM D2513, "*Specifications for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*". The polyethylene pipe must be marked at intervals not exceeding two feet showing the manufacturer or trade name, size wall thickness or SDR number, PE type, batch identification, and ASTM D2513 compliance. The polyethylene pipe may be grade PE2406 or PE3408 with designation CD, CE, CDC, or CEC. PE2406 grade (medium density) must be yellow.

2.2 UNIONS, FLANGES AND WELDED TEES:

- A. Screwed unions, soldered unions or bolted flanges shall be provided as required to permit removal of equipment, valves, and piping accessories from the piping system. Keep adequate

clearances for coil removal, rodding, tube replacement, motor lubrication, filter replacement, etc. Flanged joints shall be assembled with appropriate flanges, gaskets, and bolting. The clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system.

- B. Dielectric insulating couplings or though ways shall be used wherever the adjoining materials being connected are of dissimilar metals such as connections between copper and steel pipe.
- C. Tee connections for welded pipe shall be assembled with welding fittings. Where the size of the side outlet is such that a different connection technique than on the run is required, a weldolet, sockolet, or threadolet type fitting may be used for the branch in place of reducing tees only where the branch is $\frac{2}{3}$ the run size or smaller. Weld-o-let and thread-o-let branch connections are acceptable.

2.3 NATURAL GAS PIPING – INTERIOR:

- A. Schedule 40 black steel pipe with malleable iron threaded fittings for pipe sizes 2" and smaller.
- B. Schedule 40 black steel pipe with wrought steel butt welded fittings for pipe sizes 2½" and larger.
- C. Where gas pressure is 2 psi or greater, piping shall be schedule 40 black steel pipe with wrought steel butt welded fittings.
- D. Paint all exterior piping as specified in Section IDENTIFICATIONS, TAGS, CHARTS, ETC.

PART 3 - EXECUTION

3.1 GENERAL:

- A. All piping shall be capped or plugged during erection as required to keep clean and debris and moisture free.
- B. All piping shall be installed straight and true, parallel, or perpendicular to the building construction. Piping shall be installed so as to allow for expansion without damage to the building finishes, structure, pipe, equipment, etc., use offsets, U-bends or expansion joints as required. No mitered joints or field fabricated pipe bends shall be accepted. Pipe shall clear all windows, doors, louvers, and other building openings.
- C. All pipes shall be supported in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on hangers. Vertical risers shall be supported at each floor line with approved steel pipe riser clamps. Spacing of pipe supports shall not exceed eight (8) foot intervals for pipes 3" and smaller and ten (10) foot intervals on all other piping. Small vertical pipes (1" and less) shall be bracketed to walls, structural members, etc. at four (4) foot intervals so as to prevent vibration or damage by occupants.
- D. The use of wire or perforated metal to support pipes will not be permitted. Hanging pipes from other pipes shall not be permitted.
- E. Support piping with standard pipe hangers with C-clamp connection to main structural members (not perlin's), use angle steel cross pieces between main structural members where required to

provide rigid support.

- F. Where piping rests directly on a hanger, clip, bracket or other means of support, the support element shall be of the same material as the pipe, (e.g., copper to copper, ferrous to ferrous, etc.) or shall be electrically isolated one from the other so as to prevent pipe damage by electrolysis. Pay particular attention and do not allow copper pipe to rest on ferrous structural members, equipment, etc. without electrolytic isolation. This includes temporary support required during Construction.
- G. In general, piping shall be installed concealed except in mechanical rooms, etc. unless otherwise indicated, and shall be installed underground or beneath concrete slabs only where indicated. All lines at ceilings shall be held as high as possible and shall run so as to avoid conflicts with other trades, and to facilitate the Owner's use and maintenance. Location of pipe in interior partitions shall be carefully coordinated with whoever will construct the partitions after the piping is in place. Where exposed risers occur, they shall be kept as close to walls as possible.
- H. Pipe shall be cut accurately to measurements established at the building by the Contractor and worked into place without springing or forcing. All pipes shall be reamed to full pipe diameter before joining and before assembling. All lengths of pipe shall be set vertically and tapped with a hammer to remove scale and dust and inspected to ensure that no foreign matter is lodged therein.
- I. Piping carrying water or other fluids subject to freezing shall not be installed in locations subject to freezing. If in doubt, consult Engineer.
- J. Piping materials in each system shall, to the extent practicable, be of the same material. Frequent changes of material (for example, from copper to steel) shall be avoided and in no case shall be accomplished without use of insulating unions and permission of the Engineers.
- K. Dielectric couplings or through ways shall be provided at all connections of dissimilar materials.
- L. Nipples shall be of the same material, composition, and weight classification as pipe with which installed.
- M. Apply approved pipe dope for service intended to all male threaded joints. The dope shall be listed for intended use.
- N. Installation of pipe shall be in such a manner as to provide complete drainage of the system, whether detailed or not on plans. Drain valves shall be provided at all drainage points on pipes. Drain valves shall be ½" size ball valves with ¾" hose thread end and vacuum breaker. Label each drain valve.
- O. When running any type of pipe below a footing, parallel to the footing, the area underneath the zone of influence shall be backfilled with 4" of crushed stone, sand bedding or concrete under the pipe. Each pipe section shall be anchored into unexcavated earth on both ends with deadman anchor system. The remainder of the trench in the zone of influence shall be backfilled with cementitious flowable fill. The zone of influence is the area within a 45 degree angle projecting down from the top edge of the footing on all sides of the footing.

3.2 PIPE TESTING:

- A. Piping shall be tested before being insulated or concealed in any manner. Where leaks or

defects develop, required corrections shall be made and tests repeated until systems are proven satisfactory.

- B. The Contractor shall perform all additional tests that may be required by the Department of Health or other governing agency.
- C. Any leaks or imperfections found shall be corrected and a new test run until satisfactory results are obtained. The cost of repair or restoration of surfaces damaged by leaks in any system shall be borne by the Contractor.

END OF SECTION 22 15 16

SECTION 22 20 00 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SCOPE OF WORK:

- A. Work Included: This section describes the requirements for excavating and backfilling pipe trenches. Obtain proper elevations from the Architect prior to the installation of underground piping, piping below slabs, and piping under foundations.
- B. All excavation shall be unclassified.

1.2 QUALITY ASSURANCE:

- A. Safety Codes and Standards: Perform trenching work, including shoring in compliance with the applicable requirements for governing authorities having jurisdiction.
- B. Existing Utilities and Trees: Offset piping to avoid existing utilities and trees. Existing utility lines shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the responsible Contractor, or at his expense. Where roots of live trees are uncovered in excavation, they shall be carefully protected during construction.

PART 2 - PRODUCTS

2.1 MATERIALS FOR BEDDING AND BACKFILL:

- A. Type 1: Clean granular material - crushed limestone, 100% retained on 1/2" screen and 100% passing 3/4" screen. Use for subsoil foundation drainage line backfill.
- B. Type 2: Crusher-run granular material - 2" max crusher-run crushed limestone with copious quantity of limestone dust; use for all fill and backfill except where clean granular material, earth material or sand is indicated or specified.
- C. Type 3: Earth material - clay soil free of vegetable matter and foreign matter, from source approved by Architect/Engineer. Site materials free of organic and foreign materials will be acceptable. Use of fill and backfill in exterior planted areas from initial backfill to below 6" below grade.
- D. Type 4: Topsoil - clean black topsoil from source approved by Architect/Engineer; use for 6" depth in planted area.
- E. Type 5: Sand - clean river sand; use for 4" around all underground piping or copper and for pipe having a protective coating or jacket.

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL - GENERAL:

- A. All excavation and backfill required for the installation of work shall be the complete responsibility of the contractor whose work requires excavation and backfill.
- B. Plumbing sub-contractors shall be responsible for the proper layout and the establishment of all lines and levels required for the execution of his work.
- C. When services are to be run side-by-side, a common trench may be used providing the required vertical and horizontal separation between the various services are maintained and methods of bedding and backfill meet the approval of the Architect/Engineer. Contractors involved shall make their own agreement as to the sharing of cost for the common trenching and backfill work.
- D. Excavation and trenching shall be in accordance with the North Carolina Department of Labor "Excavation & Trenching" 1926.651 and 1926.652 - latest edition.

3.2 TRENCHING:

- A. Unless otherwise noted on plans, all trenching for underground work shall be open cut from the surface. The sides of the trench shall be shored if vertical, or otherwise if soil conditions required. The width of the trench shall be limited to that necessary for proper installation of the work. The distance between the trench wall and the sides of pipe below a level 1' above the top of the pipe or duct shall not exceed 12".
- B. The width of trench 1' above top of pipe shall be only as wide as necessary for shoring, bracing and proper performance of the work.
- C. The depth of trench shall not exceed that required to achieve depth of cover indicated, with overdig permitted only for bedding material.
- D. If the width of trench exceeds that required, the space shall be filled with thoroughly compacted granular material or concrete.

3.3 SHORING AND PROTECTION:

- A. Plumbing sub-contractors responsible for excavation work shall be required to provide all necessary barricades, fencing, sheet piling, warning signs, pumping, etc., for the protection of workers, general public and properties. Excavation work shall comply with ASA Standard A10.2 "Safety Code for Building Construction" and ACC Standard "Manual of Accident Prevention in Construction."

3.4 EXCESS EARTH FROM EXCAVATION:

- A. All surplus earth shall be removed by the contractor from the building and disposed of at his own expense, where directed by the Architect.
- B. Debris, trash or rock not usable for fill shall be removed from the site by the respective contractor.

- C. Plumbing sub-contractors shall be responsible for immediate clean-up of streets, roadway and private property affected as a result of their work.

3.5 BACKFILL:

- A. Backfill shall not begin until after contractor's work has been properly installed and inspected by the authority having jurisdiction and approved by the Architect/Engineer.

3.6 PLACEMENT:

- A. In general, all initial backfill (to a point 6" above top of pipe) shall be of the same material as the bedding.
- B. Upper fill (above initial fill) shall be as follows:
 - 1. Within building - Type 3 material.
 - 2. Exterior of building under paved areas - Type 2 material.
 - 3. Exterior of building - Type 3 material. When beyond area of GC work, top with Type 4 material.
- C. Bedding and backfill requirements for specialty piping and ducts shall be as specified under separate heading in Division 22 of specifications.
- D. Before starting any backfill work, each contractor shall obtain Architect/Engineer approval of granular materials to be used, method of placing same and type of compacting equipment to be used. Do not place any backfill material until bottoms of excavations have been thoroughly cleaned of all water, debris and loose or soft soils.
- E. Placing of granular material shall be placed in lifts of 12" maximum. Compact each lift to 95% of maximum dry density as determined by the AASHA T-180 method of compaction.
- F. Place earth material in 6" maximum thickness layers and compact to dry density of at least 90% of maximum dry density as measured by AASHTO T-180.

3.7 ROCK EXCAVATION:

- A. The extent of excavation of rock is indicated by the test hole data indicated in these specifications. Plumbing contractors shall comply with the general conditions and shall determine a unit price for excavation of rock (if required).

3.8 RESTORATION OF EXISTING CONDITIONS:

- A. When the excavation is within the area of finished site work by the General Contractor, backfill to the height of rough grade. Final surfacing shall be by the General Contractor.
- B. When excavation is beyond the area of general construction work, final surface of the excavation and adjacent disturbed areas shall be restored to match the original condition by sodding, seeding asphalt paving, concrete, etc., as required. Work shall conform to applicable sections of the specifications.
- C. When the excavation is on public property, restoration of surface conditions shall meet the requirements of public authorities having jurisdiction.

January 15, 2026

University of North Carolina at Wilmington
Housing Village Phase 3
Complete Package - Construction Documents

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SCO 24-29053-02D

END OF SECTION 22 20 00

SECTION 22 40 00 - PLUMBING FIXTURES AND TRIM

PART 1 - 1

1.1 SCOPE OF WORK:

- A. This work shall consist of furnishing all labor, material, equipment, and services necessary for the installation of all equipment specified hereinafter.

1.2 SHOP DRAWINGS:

- A. Shop drawings shall be submitted on all equipment including the following:
 - 1. Cleanouts
 - 2. Trim
 - 3. Floor Drains
 - 4. Wall Hydrants
 - 5. Other items where shown on the drawings or as specified.
- B. All fixtures equipment and trim shall be made by company with not less than 5 years successful service in this country and in similar installments.

1.3 FIXTURES:

- A. All vitreous china fixtures shall be 2 fired, conforming in all respects to the standards adopted by the Vitreous China Fixtures Manufacturers Advisory Committee.
- B. Unless otherwise specified all vitreous china fixtures shall be white.

1.4 HANGING:

- A. Fixtures designed for wall mounting shall be provided with supports complete with all couplings, gaskets, anchors, etc. for compatible installation with fixtures provided.
- B. Wax gaskets shall not be used on fixtures receiving hot water.

1.5 PIPING AND TRIM:

- A. All exposed piping and trim, traps, valves, tail-pieces, faucets and fittings shall be chrome finished and shall be made of copper or copper alloy. P-traps shall be made of chrome-plated cast brass.

PART 2 - PRODUCTS

2.1 FIXTURES SCHEDULE:

- A. The following list and description of fixtures are from various manufacturers. Similar fixtures as manufactured by other manufacturers will be acceptable for approval.

2.2 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering plumbing fixtures and trim which may be incorporated in the work include, but are not limited to, the following:
- B. P7A Wall Hydrant: Nonfreeze
Type: 3/4" inlet, 3/4" outlet, integral vacuum breaker, bronze casing and stainless steel

- face, operating key and lockable cover
Mfg: Woodford model B65
- C. P-7B Roof Hydrant: Nonfreeze
Type: 3/4" inlet, 3/4" outlet nonremovable vacuum breaker, loose handle, floor mounted, brass construction, chrome plated
Mfg: Woodford model RHY2-MS
- D. FD-1 Floor Drain:
Type: 6" square type "S" strainer, polished nickel bronze strainer, cast iron body, diameter of outlet as shown on drawings
Mfg: Zurn No. ZN415S
- E. FD-2 Floor Drain:
Type: 9" diameter, 2" deep receptor, cast iron body, furnished with deep seal trap, secondary strainer, diameter of outlet as shown on drawings
Mfg: Zurn No. ZN-554
- F. FS-1 Floor Sink:
Type: 12"x12" square top, 8" deep receptor, stainless steel interior and top, stainless steel body, furnished with deep seal trap, secondary dome strainer, diameter of outlet as shown on drawings
Mfg: Zurn No. Z-1751

2.3 CLEANOUTS:

- A. Cleanouts shall have cast iron body and screw type cleanout plug with lead seal. Cleanouts shall be manufactured by Watts, J.R. Smith or Zurn, and shall be as follows:
- B. Outdoor Floor Finish: Watts model CO-300-MF. Six (6) inch cast iron cleanout with adjustable housing, ferrule with plug and round nickel brass scoriated top, vandalproof cover, spigot outlet.
- C. Conc. Floor Finish: Watts model CO-200. Four (4) inch cast iron cleanout with adjustable housing, ferrule with plug and round nickel brass scoriated top, vandalproof cover, spigot outlet.
- D. Cleanout in Concealed Vertical Piping: Wade Series 8400. Cast iron cleanout tee with brass plug and round stainless steel vandal proof access cover.

PART 3 - EXECUTION

3.1 INSTALLATION OF FIXTURES:

- A. Unless otherwise indicated, PC shall furnish and install all plumbing fixtures shown on drawings, including all necessary components and accessories.
- B. All fixtures shall be properly connected to waste, vent and supplies in an absolutely rigid and substantial manner.
- C. All fixtures shall be caulked to the wall or floor with a soft elastomeric caulking compound of color to match fixtures.
- D. All Wall Hydrants, and similar equipment normally held in place by the attached piping shall have the attached piping secured in the walls so that the item of equipment is held rigidly in place. At the time of final inspection or during the warranty period, if any item can be moved with normal hand pressure, that item shall be re-secured in the wall.
- E. All wall-hung fixtures shall be secured, rigidly in place. At the time of final inspection or during the warranty period, if fixtures can be moved by normal hand pressure, they shall be re-secured to the wall.
- F. If the preceding two paragraphs required cutting of the wall to secure the items in place, cutting and patching shall be done by the trade that originally installed the wall surface, but the work shall be paid for by the plumbing subcontractor.

3.2 INSTALLATION OF PIPING AND TRIM:

- A. All piping through wall shall be grouted to wall with cement or plaster to assure rigidity and to prevent noise transmission to other rooms.
- B. Provide chromium finished escutcheon plates on all piping passing through floor or wall. Escutcheon plates shall be held tight to wall with flush-head or socket type set screws.
- C. Exposed bolt heads shall be covered with china or chrome plated caps.

3.3 INSTALLATION OF STOP VALVES:

- A. Each water service connection to fixtures shall be individually valved.
- B. Integral stops of flush valves or fixture fittings as specified will be considered as a stop valve.

3.4 INSTALLATION OF INDIVIDUAL SERVICE CONNECTIONS:

- A. Individual service connection is defined as the short run of piping for water, waste and vent between the fixture and branch line or main.
- B. Individual service connection to fixtures shall be of one pipe larger than the outlets provided on the fixtures and associated trim, or as indicated on drawings.

3.5 INSTALLATION OF CLEANOUTS:

- A. Cleanouts in general must be screw plug which must be gas and watertight, provide quick and easy plug removal, located in such a manner to allow ample space for rodding tools.
- B. Cleanout openings shall not be used for any other purpose than the proper cleaning of the system, except where approved in writing by the administrative authority.
- C. Cleanout plugs shall not be covered with cement, plaster, or any other permanent finishing material. Where it is necessary to conceal a cleanout plug, a covering plate or access door shall be provided which will permit ready access to the plug.
- D. Accessible cleanouts shall be installed at each change of direction of the building drain, or of horizontal waste or soil lines, which is greater than forty-five (45) degrees.
- E. A cleanout shall be provided at or near the foot of each vertical waste or soil stack that serves more than one floor. Rain leaders and conductors connected to a building storm sewer shall have a cleanout installed at the base of each riser.
- F. Cleanouts, when installed on underground piping shall be extended vertically to or above the finished grade level.
- G. Cleanouts on concealed piping shall be extended through and terminate flush with the finished wall or floor, or pits or chases may be left in the wall or floor, provided they are of sufficient size to permit removal of the cleanout plug and proper cleaning of system.
- H. Where sanitary crosses are installed in the system and are the type that would allow a cable (or cleaning equipment) to pass over the vertical waste and vent stack and into the adjoining fixture waste pipe and fixture trap, the Plumbing Contractor shall provide a wall cleanout above the sanitary cross which extends to the surface of the wall and is equipped with the proper cleanout cover.
- I. Cleanouts shall be of the same nominal size as the pipes they serve up to four (4) inches and not less than four (4) inches for larger piping.
- J. Exterior cleanouts shall have an 18" x 18" x 4" thick concrete collar with chamfered edges.

END OF SECTION 22 40 00

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SECTION 22 90 00 - PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 RECORD DRAWINGS - BUILDING:

- A. Submit as-built drawings as required by General Conditions and obtain written receipt from engineer.

1.2 DEMONSTRATION OF COMPLETE PLUMBING SYSTEMS:

- A. The following systems shall be put into operation by the plumbing sub-contractor furnishing the equipment, and operated for the length of time required to prove proper operation and control.
 - 1. Cold water
 - 2. Hot water systems/recirculation systems
 - 3. Waste
 - 4. Storm
- B. Thoroughly demonstrate and instruct (3) three designated representatives of the Owner in the care and operation of all the plumbing systems and equipment furnished and installed in the contract.
- C. Manufacturers of certain equipment specified herein shall provide technically qualified factory representatives to train the Owner's representative in the care and maintenance and operation of their product. This instruction and service of the factory representative shall be furnished as specified elsewhere in the specifications. This time is in addition to what is specified above and will not be counted as part of this contractor's instructions.
- D. The time and place of all training shall be coordinated and scheduled by the contractor at the convenience of the Owner and as approved by the architect.
- E. Submit letters signed by the owner's representatives attesting to the satisfactory completion of all instructions.

1.3 OWNER'S RIGHT TO TEST SYSTEM:

- A. Should, in the opinion of the architect, and during the guarantee period, reasonable doubt exist as to the proper functioning of any equipment installed under this contract, the right is reserved for the owner and architect to perform any test deemed practical to determine whether such equipment is functioning properly and performing at required capacity. If such tests show proper functioning, the cost of the test will be paid by the owner. If the tests indicate a deficiency in equipment capacity or performance, the contractor shall pay the cost of the test and also make good any deficiencies shown by the test to the full satisfaction of the owner and the architect.

1.4 OPERATING AND MAINTENANCE MANUALS:

- A. The contractor shall carefully prepare an operating instructions and maintenance manual for each plumbing system, including all equipment furnished. The manual shall be submitted to the engineer for approval before final inspection and acceptance is made.
- B. The form in which the operating maintenance manual is to be presented shall be subject to approval by the architect. Three copies of the manual shall be provided.
- C. The following items together with any other necessary and pertinent data shall be included in the manual. This list is not necessarily complete and is only to be used as a guide.
 - 1. Suggested settings of all control and switches for normal operation with description of control and its location.
 - 2. A check list for periodic maintenance of all equipment.
 - 3. As-built wiring, interlock, and control diagrams for the equipment, with color coding shown on wiring and interlock diagrams.
 - 4. Part numbers of all replaceable items.
 - 5. Manufacturer's cuts and rating tables for all equipment.
 - 6. Oiling, lubricating and greasing data.
 - 7. Complete electrical load data from operation tests.
 - 8. Test data on all equipment
 - 9. Belt sizes, types, and lengths
 - 10. Serial number of all principal pieces of equipment
 - 11. Valve tag schedule
 - 12. Manufacturers', suppliers' and contractors' names, addresses and telephone numbers.

1.5 VALVE TAG SCHEDULE:

- A. Copies of the valve tag schedule and wiring diagrams shall be framed under glass and posted in the equipment room.

1.6 WARRANTIES:

- A. Deliver to Owner all warranties, etc., and obtain written receipts.

1.7 OBSERVATION REPORTS:

- A. During construction period the engineer will issue observation reports. These items shall be completed before engineer will approve next application for payment. Final punch list work shall be complete before acceptance.

1.8 FINAL INSPECTION AND ACCEPTANCE:

- A. The architect or his authorized representative will entertain the request for final inspection and acceptance only after the following items are done.
 - 1. Submit a list of uncompleted items, if any, and advise when the items will be done.
 - 2. Clean, test, and adjust all systems and equipment.
 - 3. Lubricate all motors.
 - 4. Complete all items on architect's or engineer's pre-final punch list.

5. Final inspection and tests of the completed construction shall be performed in the presence of the architect or his representative and shall be at such times as are convenient to the architect. Final tests shall show conclusively that all equipment performs its intended and specified function and that all work complies with the provisions of these specifications. All material, equipment, and instruments required for these tests shall be furnished by the contractor at his own expense.
6. Final Clean-up. During construction the contractor shall keep the site clear of debris and upon completion of construction he shall clean up the premises to remove all evidence of his work. In addition, upon completion of construction he shall clean, wash, and/or polish all fixtures, equipment, and exposed material and leave them bright and clean.

END OF SECTION 22 90 00

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SECTION 23 05 17
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Pipe sleeves.
- B. Pipe-sleeve seals.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Valve Stem Packings: Two for each type and size of valve.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified this section.
 - 1. Minimum three years experience.
 - 2. Approved by manufacturer.
- C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

1.05 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Final Acceptance.

PART 2 PRODUCTS**2.01 PIPE SLEEVES**

- A. Manufacturers:
 - 1. American Polywater Corporation; PZVR Watertight Wall Sleeves for Pipes: www.polywater-haufftechnik.com/#sle.
 - 2. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.

2.02 PIPE-SLEEVE SEALS

- A. Modular Mechanical Sleeve-Seal:
 - 1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.

2. Watertight seal between pipe and wall-sleeve, wall or casing opening, 20 psi.
 3. Size and select seal component materials in accordance with service requirements.
 4. Glass-reinforced plastic pressure end plates.
- B. Wall Sleeve: PVC material with waterstop collar, and nailer end-caps.
- C. Sleeve-Forming Disk: Non-conductive plastic-based material, 3 inch thick.
- D. Pipeline-Casing Seals:
1. End Seals: 1/8 inch, pull-on type, rubber or synthetic rubber based.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Provide sleeves when penetrating footings, floors, walls, partitions, and _____. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- E. Manufactured Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a water-tight seal.
 6. Install in accordance with manufacturer's recommendations.
- F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.02 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

**SECTION 23 05 19
METERS AND GAUGES FOR HVAC PIPING****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).
- C. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2024.
- D. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012, with Addendum (2018).
- E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- F. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS**2.01 POSITIVE DISPLACEMENT METERS (LIQUID)**

- A. AWWA C700, positive displacement disc type suitable for fluid with metal alloy main case and cast iron frost-proof, breakaway bottom cap, hermetically sealed register, remote reading.

2.02 HEAT CONSUMPTION METERS

- A. Manufacturers:
 - 1. Onicon System-10 BTU Meter, F-3500 Electromagnetic Flow Meter.

2.03 ELECTROMAGNETIC FLOW METERS

- A. Manufacturers:
 - 1. Badger Meter, Inc; _____: www.badgermeter.com/#sle.
 - 2. Foxboro; _____: www.schneider-electric.us/#sle.
 - 3. Onicon, Inc., F-3500: www.onicon.com/#sle.. (Preferred)
- B. Liquid Flow Capacity Range: As indicated on drawings.
- C. Construction: Stainless steel or aluminum sensor with integral NEMA EN 10250 Type 4 or 4X stainless steel or aluminum enclosure to hold thermal mass sensor and circuits with numeric display for consumption reading.
- D. Liquid Conductivity: 5 mS/cm, minimum.
- E. Accuracy: 0.02 percent of value applied to manufacturer-specified velocity range.
- F. Output: Two-wire, 0 to 10 VDC, non-loop powered.
- G. Service Pressure and Temperature: Up to 400 psi and 15 to 250 degrees F liquid side, 150 degrees F ambient.

2.04 PRESSURE GAUGES

- A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

2.05 PRESSURE GAUGE TAPPINGS**2.06 STEM TYPE THERMOMETERS**

- A. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

2.07 DIAL THERMOMETERS

- A. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
- B. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
- C. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.

2.08 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1 inch dial thermometers.

2.09 STATIC PRESSURE GAUGES

- A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- B. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
- C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- D. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.
- E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- F. Install thermometers in air duct systems on flanges.

- G. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- H. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- I. Coil and conceal excess capillary on remote element instruments.
- J. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- K. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- L. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- M. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION

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**SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASME B31.9 - Building Services Piping; 2020.
- B. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
- C. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- D. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- E. MSS SP-67 - Butterfly Valves; 2017, with Errata.
- F. MSS SP-68 - High Pressure Butterfly Valves with Offset Design; 2021.
- G. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; 2011.
- H. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

1.03 QUALITY ASSURANCE**PART 2 PRODUCTS****2.01 APPLICATIONS**

- A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- B. Provide the following valves for the applications if not indicated on drawings:
- C. Condenser Water Valves:
 - 1. Size 2 inch and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - 2. Size 2-1/2 inch and Larger, Iron Valves:
 - a. 2-1/2 inch to 4 inch: Threaded ends.
- D. Heating Hot Water Valves:
 - 1. Size 2 inch and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - 2. Size 2-1/2 inch and Larger, Iron Valves:
 - a. 2-1/2 inch to 4 inch: Threaded ends.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
- D. Valve-End Connections:
- E. General ASME Compliance:
 - 1. Building Services Piping Valves: ASME B31.9.

2.03 BRONZE, GLOBE VALVES

- A. CWP Rating: Class 125: 200 psi:
 - 1. Comply with MSS SP-80, Type 1.
 - 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.

3. Ends: Threaded or solder joint.
4. Stem and Disc: Bronze or PTFE.
5. Packing: Asbestos free.
6. Handwheel: Malleable iron.

2.04 BRONZE, BALL VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.

2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Wafer and Lug Style:
 1. Comply with MSS SP-67, Type I.
 2. Lug Style, CWP Ratings:
 - a. Sizes 2 to 12 inch: 150 psi.
 - b. Sizes 14 to 24 inch: 250 psi.
 3. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
 4. Stem: One or two-piece stainless steel.
 5. Seat: NBR.
 6. Disc: Aluminum-bronze.

2.06 HIGH-PERFORMANCE, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type; Bidirectional dead end service without downstream flange:
 1. Comply with MSS SP-68.
 2. Class 150: CWP Rating: 285 psi at 100 degrees F.
 3. Body: Provide carbon steel, cast iron, ductile Iron, or stainless steel.
 4. Seat: Metal or reinforced PTFE.
 5. Offset stem: Stainless steel.
 6. Disc: Carbon steel.

2.07 BRASS, INLINE CHECK VALVES

- A. Class 150: CWP Rating: 200 psi .
- B. Maximum Service Temperature: 250 degrees F.
- C. Body: Forged brass.
- D. Disc: Forged brass.
- E. Seal: PTFE, bubble tight.
- F. End-Connections: Press.

2.08 IRON, GATE VALVES

- A. NRS or OS&Y:
 1. Comply with MSS SP-70, Type I.
 2. Body Material: Gray iron with bolted bonnet.
 3. Ends: Flanged.
 4. Trim: Bronze.
 5. Disc: Solid wedge.
 6. Packing and Gasket: Asbestos free.

2.09 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Attachment: For connection to ball, butterfly, and plug valve stems.

3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

END OF SECTION

January 15, 2026

University of North Carolina at Wilmington
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SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

PART 2 PRODUCTS**2.01 SUPPORT AND ATTACHMENT COMPONENTS**

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Prefabricated Trapeze-Framed Metal Strut Systems:
 - 1. Strut Channel or Bracket Material:
 - 2. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.
- C. Hanger Rods:
 - 1. Threaded zinc-plated steel unless otherwise indicated.
- D. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

- F. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- G. Secure fasteners according to manufacturer's recommended torque settings.
- H. Remove temporary supports.

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC**PART 1 GENERAL****1.01 DEFINITIONS**

- A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., ductwork, piping).
- B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.02 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.
- C. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment; 2014.
- D. FEMA 413 - Installing Seismic Restraints for Electrical Equipment; 2004.
- E. FEMA 414 - Installing Seismic Restraints for Duct and Pipe; 2004.
- F. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2012.
- G. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2024.

PART 2 PRODUCTS**2.01 VIBRATION ISOLATION REQUIREMENTS**

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.

2.02 SEISMIC CONTROL REQUIREMENTS

- A. Design and provide HVAC component restraints, supports, and attachments suitable for seismic loads determined in accordance with applicable codes, as well as gravity and operating loads and other structural design considerations of the installed location. Consider wind loads for outdoor HVAC components.
- B. Seismic Design Criteria: ICC (IBC).
- C. Component Importance Factor (Ip): HVAC components to be assigned a component importance factor (Ip) of 1.5 unless otherwise indicated.
- D. Seismic Restraints:

1. Provide seismic restraints for HVAC components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
 2. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
 - a. ASHRAE (HVACA).
 - b. FEMA 412.
 - c. FEMA 413.
 - d. FEMA 414.
 - e. FEMA E-74.
 - f. SMACNA (SRM).
 3. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
 4. Ductwork Applications:
 - a. Provide independent support and seismic restraint for in-line components (e.g., fans, heat exchangers, humidifiers) having an operating weight greater than 75 pounds.
 - b. Positively attach appurtenances (e.g., dampers, louvers, diffusers) with mechanical fasteners.
- E. Seismic Attachments:
1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
 2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
 3. Do not use power-actuated fasteners.
 4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.
 5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.
 6. Concrete Housekeeping Pads:
 - a. Increase size of pad as required to comply with anchor requirements.
 - b. Provide pad reinforcement and doweling to ensure integrity of pad and connection and to provide adequate load path from pad to supporting structure.
- F. Seismic Interactions:
1. Include provisions to prevent seismic impact between HVAC components and other structural or nonstructural components.
 2. Include provisions such that failure of a component, either essential or nonessential, does not cause the failure of an essential component.
- G. Seismic Relative Displacement Provisions:
1. Use suitable fittings or flexible connections to accommodate:
 - a. Relative displacements at connections between components, including distributed systems (e.g., ductwork, piping); do not exceed load limits for equipment utility connections.
 - b. Relative displacements between component supports attached to dissimilar parts of structure that may move differently during an earthquake.
 - c. Design displacements at seismic separations.

- d. Anticipated drifts between floors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E. Vibration Isolation Systems:
 - 1. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 - 2. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 - 3. Adjust isolators to be free of isolation short circuits during normal operation.
 - 4. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.
- F. Seismic Controls:
 - 1. Provide specified snubbing element air gap; remove any factory-installed spacers, debris, or other obstructions.
 - 2. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
 - 3. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch, use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch or less.
 - 4. Equipment with Sheet Metal Housings:
 - a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
 - b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
 - c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.
 - 5. Concrete Housekeeping Pads:
 - a. Size in accordance with seismic design to meet anchor requirements.
 - b. Install pad reinforcement and doweling in accordance with seismic design to ensure integrity of pad and associated connection to slab.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect vibration isolation and/or seismic control components for damage and defects.
- C. Vibration Isolation Systems:
 - 1. Verify isolator static deflections.
 - 2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
- D. Seismic Controls:
 - 1. Verify snubbing element air gaps.

- E. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 PRODUCTS**2.01 IDENTIFICATION APPLICATIONS**

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Nameplates.
- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Tags.
- K. Pumps: Nameplates.
- L. Small-sized Equipment: Tags.
- M. Tanks: Nameplates.
- N. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

- A. Letter Color: White.
- B. Letter Height: 1/4 inch.
- C. Background Color: Black.
- D. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

B. Style: Individual Label.

C. Color: Yellow/Black.

2.05 PIPE COLOR STANDARDS

A. Following is the color standard for mechanical piping identification:

1. Chilled Water Supply and Return - Dark Blue
2. Condenser / Tower Water Supply and Return - Light Blue
3. Heating Hot Water Supply and Return – Orange
4. Natural Gas – Yellow

2.06 STENCILS

A. Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
2. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
3. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
4. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.

2.07 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:

1. HVAC Equipment: Yellow.
2. Fire Dampers and Smoke Dampers: Red.
3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 INSTALLATION

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 GENERAL REQUIREMENTS**

- A. Perform total system balance in accordance with one of the following:
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Final Acceptance of the project.
- C. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.

3.02 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.03 RECORDING AND ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

END OF SECTION

**SECTION 23 07 13
DUCT INSULATION****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- C. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- E. ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay; 2017 (Reapproved 2021).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
- G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
- B. Insulation: ASTM C553; flexible, noncombustible blanket.

2.03 GLASS FIBER, RIGID

- A. Insulation: ASTM C612; rigid, noncombustible.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- B. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.05 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

- A. Description: Custom cut and fabricated, removable and reusable blanket insulation system, consisting of inner liner, insulation layer, outer protective jacket, and fastening system.
- B. Provide insulation system based on surface temperature of piping, installed location of piping, and maximum safe-to-touch temperature of jacketing.
- C. Performance Criteria:
 - 1. Safe-to-Touch Temperature of Jacketing: 140 degrees F.

2.06 WEATHER BARRIER COATINGS

- A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based mastic for use over closed cell polyethylene and polyurethane foam insulation; applied with glass fiber or synthetic reinforcing mesh.
 - 1. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
 - 2. Water Vapor Permeance: Greater than 1.0 perm in accordance with ASTM E96/E96M.
 - 3. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.
 - 4. Color: As selected by Architect.

2.07 JACKETING AND ACCESSORIES

- A. Aluminum Jacket:
 - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
- B. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.

2.08 DUCT LINER

- A. Note: Choose the liner type - Elastomeric Foam, Glass Fiber, or Phenolic Foam.
- B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 23 07 16
HVAC EQUIPMENT INSULATION**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019.
- B. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).
- C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.
- D. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).
- E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- G. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- H. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
- I. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible.

2.03 GLASS FIBER, RIGID

- A. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.

2.04 CELLULAR GLASS

- A. Block Insulation: ASTM C552, Type I, Grade 6.

2.05 HYDROUS CALCIUM SILICATE

- A. Insulation: ASTM C533; rigid molded, asbestos free, gold color.
 - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1,200 degrees F.
 - 3. Density: 15 pcf.

- B. Tie Wire: 0.048 inches stainless steel with twisted ends on maximum 12 inch centers.
- C. Insulating Cement: ASTM C449.

2.06 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

END OF SECTION

**SECTION 23 07 19
HVAC PIPING INSULATION**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
- C. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

END OF SECTION

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**SECTION 23 08 00
COMMISSIONING OF HVAC****PART 1 GENERAL****1.01 SUMMARY**

- A. See Section 01 91 13 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 91 13.
- B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Provider (CxP) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
 - 1. Control system.
 - 2. Major and minor equipment items.
 - 3. Terminal units.
 - 4. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 REFERENCE STANDARDS

- A. ASHRAE Guideline 1.1 - Application of the Commissioning Process to New HVAC&R Systems; 2025.

1.03 SUBMITTALS

- A. Updated Submittals: Keep Commissioning Provider (CxP) informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Provider.
- C. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
 - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
 - 2. Full as-built set of control drawings.
 - 3. Full as-built sequence of operations for each piece of equipment.
 - 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
 - a. Floor.
 - b. Room number.
 - c. Room name.
 - d. Air handler unit ID.
 - e. Reference drawing number.
 - f. Air terminal unit tag ID.
 - g. Heating and/or cooling valve tag ID.

- h. Minimum air flow rate.
 - i. Maximum air flow rate.
 - 5. Full print out of all schedules and set points after testing and acceptance of the system.
 - 6. Full as-built print out of software program.
 - 7. Electronic copy on disk of the entire program for this facility.
 - 8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
 - 9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - 10. Control equipment component submittals, parts lists, etc.
 - 11. Warranty requirements.
 - 12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
 - 13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation.
 - b. Control drawings.
 - c. Points lists.
 - d. Controller and/or module data.
 - e. Thermostats and timers.
 - f. Sensors and DP switches.
 - g. Valves and valve actuators.
 - h. Dampers and damper actuators.
 - i. Program setups (software program printouts).
- D. Project Record Documents: See Section 01 78 00 for additional requirements.
 - 1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 - 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- E. Draft Training Plan: In addition to requirements specified in Section 01 79 00, include:
 - 1. Follow the recommendations of ASHRAE Guideline 1.1.
 - 2. Control system manufacturer's recommended training.
 - 3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- F. Training Manuals: See Section 01 79 00 for additional requirements.
 - 1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION**3.01 PREPARATION**

- A. Cooperate with CxP in development of the Prefunctional Checklists and Functional Test Procedures.
- B. Furnish additional information requested by CxP.
- C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by CxP; update the schedule as appropriate.
- D. Notify CxP when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction, notify ahead of time and be proactive in seeing that CxP has the scheduling information needed to efficiently execute the commissioning process.
- E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with Contract Documents.

3.02 INSPECTING AND TESTING - GENERAL

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform the Functional Tests directed by CxP for each item of equipment or other assembly to be commissioned.
- C. Provide two-way radios for use during the testing.
- D. Valve/Damper Stroke Setup and Check:
 - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 - 2. Set pump/fan to normal operating mode.
 - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
 - 4. Command valve/damper open; verify position is full open and adjust output signal as required.
 - 5. Command valve/damper to a few intermediate positions.
 - 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- E. Isolation Valve or System Valve Leak Check: For valves not by coils.
 - 1. With full pressure in the system, command valve closed.
 - 2. Use an ultra-sonic flow meter to detect flow or leakage.
- F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

- A. TAB: Testing, adjusting, and balancing of HVAC.
- B. Coordinate commissioning schedule with TAB schedule.
- C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

- D. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- E. Have all required Prefunctional Checklists, calibrations, startup, and component Functional Tests of the system completed and approved by CxP prior to starting TAB.
- F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

- A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by CxP.
- D. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
 - 1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
 - 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F. Demonstrate the following to CxP during testing of controlled equipment; coordinate with commissioning of equipment.
 - 1. Setpoint changing features and functions.
 - 2. Sensor calibrations.
- G. Demonstrate to CxP:
 - 1. That all specified functions and features are set up, debugged and fully operable.
 - 2. That scheduling features are fully functional and setup, including holidays.
 - 3. That all graphic screens and value readouts are completed.
 - 4. Correct date and time setting in central computer.
 - 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
 - 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
 - 7. Power failure and battery backup and power-up restart functions.
 - 8. Global commands features.
 - 9. Security and access codes.
 - 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
 - 11. O&M schedules and alarms.
 - 12. Occupancy sensors and controls.
 - 13. All control strategies and sequences not tested during controlled equipment testing.

- H. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

- A. See Section 01 78 00 for additional requirements.
- B. Add design intent documentation furnished by Engineer to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Provider for review; make changes recommended by Commissioning Provider.
- D. Commissioning Provider will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

- A. See Section 01 79 00 for additional requirements.
- B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to CxP during Functional Testing.
- D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E. TAB Review: Instruct Owner's personnel for minimum ____ hours, after completion of TAB, on the following:
 - 1. Review final TAB report, explaining the layout and meanings of each data type.
 - 2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
 - 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
 - 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - 5. Other salient information that may be useful for facility operations, relative to TAB.
- F. HVAC Control System Training: Perform training in at least three phases:
 - 1. Phase 1 - Basic Control System: Provide minimum of ____ hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - a. This training may be held on-site or at the manufacturer's facility.
 - b. If held off-site, the training may occur prior to final completion of the system installation.
 - c. For off-site training, Contractor shall pay expenses of up to two attendees.
 - 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of ____ hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
 - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.

- b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
- c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
- d. Every display screen, allowing time for questions.
- e. Point database entry and modifications.
- 3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of ____ hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G. Provide the services of manufacturer representatives to assist instructors where necessary.
- H. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

SECTION 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ANSI/FCI 70-2 - Control Valve Seat Leakage; 2021.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.04 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS**2.01 EQUIPMENT - GENERAL**

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL VALVES

- A. Ball Valves and Actuators:
1. Service: Use for brine (30 percent glycol), chilled water, hot water, or steam at 15 to 25 psig (104.4 to 172.4).
 2. Flow Characteristic: Include 2-way and 3-way diverting operation configured to fail normally closed (NC).
 3. Replacements in Kind: Provide pressure-independent type.
 4. Rangeability: 500 to 1.
 5. ANSI Rating: Class 150.
 6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
 7. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: NPT.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: Chrome-plated brass.
 - (d) Stem: Nickel-plated brass.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. 2-1/2 inches and Above:
 - 1) Connection Type: Flanged.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.

- (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - c. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F.
- 8. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 0 to 5 VDC configured for proportional control.
 - c. Accessories: Provide with valve position indicator and manual override.
- B. Butterfly Pattern:
 - 1. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.
 - 2. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Size for 1 psig maximum pressure drop at design flow rate.
- C. Electronic Operators:
 - 1. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 - 2. Select operator for full shut off at maximum pump differential pressure.

2.03 PRESSURE INDEPENDENT VALVES AND ACTUATORS

- A. Manufacturers:
 - 1. Flow Control Industries Inc model Delta P Valve. (Preferred valve).
 - 2. Belimo model PICCV.
 - 3. Honeywell VRN
- B. Size 2 inch and Smaller:
 - 1. Provide ball style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded connections.
 - 2. Metal construction materials consist of bronze or brass.
 - 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- C. Size 2.5 inch and Larger:
 - 1. Provide ball, globe, or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or _____.
- D. Actuator Requirements:
 - 1. Assembly: Factory-mounted.
 - 2. Input: 0 to 10 VDC configured for proportional control.
 - 3. Accessories: Provide with valve position indicator and manual override.

2.04 DAMPERS

- A. Manufacturers:
 - 1. TAMCO Series 9000 SW (Preferred).
 - 2. Ruskin CD40X2: www.ruskin.com.
 - 3. Greenheck ICD-45: www.greenheck.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats. See Section 26 27 26.
- C. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.02 MAINTENANCE

- A. Provide service and maintenance of control system for one year from Date of Final Acceptance .
- B. Provide complete service of controls systems, including call backs, and submit written report of each service call.
- C. In addition to normal service calls, make minimum of 4 complete normal inspections of approximately 8 hours duration to inspect, calibrate, and adjust controls.

3.03 SCHEDULES

- A. Control Valve Schedule
- B. Control Damper Schedule

END OF SECTION

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SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List connected data points, including connected control unit and input device.
 - 3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 - 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 5. Indicate description and sequence of operation of operating, user, and application software.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
- F. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.04 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.05 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

PART 2 PRODUCTS**2.01 SYSTEM DESCRIPTION**

- A. Campus energy management control system: Two tier architecture
 - 1. First Tier - Tridium Niagara N4 with Analytics software.
 - 2. Second Tier - Lon network with LonWorks certified controllers.
- B. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- C. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- D. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- E. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
- F. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- G. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.02 CONTROLLERS

- A. Building Controllers:
 - 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a LonWorks network using ANSI/CEA 709.1 (LonTalk) protocol.

- b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. Custom Application Controller:
 - 1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a LonWorks network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.

- b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- C. Application Specific Controllers:
 - 1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a LonWorks network using ANSI/CEA 709.1 (LonTalk) protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
- D. Input/Output Interface:
 - 1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 - 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.

- b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
- 4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
- 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
- 6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
- 7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
- 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
- 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.03 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 - 1. User access secured via user passwords and user names.
 - 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts are recorded.
 - 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 - 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.

- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
 - 1. Binary object is set to alarm based on the operator specified state.
 - 2. Analog object to have high/low alarm limits.
 - 3. All alarming is capable of being automatically and manually disabled.
 - 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
- F. Demand Limiting:
 - 1. Building power consumption monitored from signals generated by a pulse generator, mounted at the building power meter.
 - 2. Demand limit controlled via load shedding or load restoration in a predetermined and predictive manner.
 - 3. Demand Reduction Methods:
 - 4. Relevant variables that influence demand limiting control are based on the power company methodology for computing demand charges.
 - 5. Operator On-Line Changes Allowed:
 - 6. Information and Reports available Hourly, Daily, and Monthly:
- G. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- H. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.
- I. PID Control Characteristics:
 - 1. Direct or reverse action.
 - 2. Anti-windup.
 - 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 - 4. User selectable controlled variable, set-point, and PED gains.
- J. Staggered Start Application:
 - 1. Prevents all controlled equipment from simultaneously restarting after power outage.
 - 2. Order of equipment startup is user selectable.
- K. Energy Calculations:
 - 1. Accumulated instantaneous power or flow rates are converted to energy use data.
 - 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 - 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- L. Anti-Short Cycling:
 - 1. All binary output objects protected from short-cycling.
 - 2. Allows minimum on-time and off-time to be selected.
- M. On-Off Control with Differential:
 - 1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 - 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- N. Run-Time Totalization:
 - 1. Totalize run-times for all binary input objects.

2. Provides operator with capability to assign high run-time alarm.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.
- C. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.02 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide service and maintenance of energy management and control systems for one years from Date of Final Acceptance.
- C. Provide two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
- D. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 8 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

END OF SECTION

January 15, 2026

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SECTION 23 09 34
VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 2013 (Corrigendum 2019).
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- D. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.
- E. NEMA IS 10033 - Adjustable Speed Drives; 2020 (Reapproved 2025).
- F. NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).
- G. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems; 2021.
- H. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.
- I. NEMA MG 00001 - Motors and Generators; 2024.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- L. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. ABB: www.abb.com/#sle.
- B. Danfoss: www.danfoss.com/#sle.
- C. Honeywell: www.honeywell.com.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Controller Assemblies: Comply with NEMA IS 10033, NEMA IS 10034, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- D. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:

1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 3. Motor nameplate data.
 4. Requirements for speed control range, speed regulation, and braking.
 5. Motor suitability for bypass starting method, where applicable.
- E. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- F. Operating Requirements:
1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 3. Efficiency: Minimum of 96 percent at full speed and load.
 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
 5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- G. Power Conversion System: Microprocessor-based, pulse width modulation type.
- H. Control System:
1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
 - 2) Vector Control: Provide selectable autotuning function.
 - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
 - c. Selectable braking control; DC injection or flux braking.
 - d. Adjustable minimum/maximum speed limits.
 - e. Adjustable pulse width modulation switching carrier frequency.
 - f. Adjustable motor slip compensation.
 - g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
 4. Status Indications:
 - a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.
 - f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.

- i. Instantaneous power.
- 5. Protective Functions/Alarm Indications:
 - a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
- 6. Inputs:
 - a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
- 7. Outputs:
- 8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
- 9. Features:
 - a. Password-protected security access.
 - b. Event log.
- I. Power Conditioning/Filtering:
 - 1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
 - 2. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- J. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
 - 1. Disconnects: Circuit breaker or disconnect switch type.
 - a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
 - b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 - 2. Provide door-mounted remote operator interface.
 - 3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
 - a. Bypass Method: Manual, unless otherwise indicated.
 - b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
 - c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
 - d. Overload Relays: Solid state or bimetallic thermal type.
 - 4. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
 - b. Packaged Controllers with Bypass:
 - 1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
 - 2) Motor Control Selector Switch: HAND/OFF/AUTO.

- 3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
- K. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation under following service conditions without derating:
 - a. Altitude: Less than 3,300 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 - 2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- L. Short Circuit Current Rating:
 - 1. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
- M. Conductor Terminations: Suitable for use with conductors to be installed.
- N. Enclosures:
 - 1. Comply with NEMA IA 10030.
 - 2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
 - 4. Cooling: Forced air or natural convection as determined by manufacturer.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Overload Relays:
 - 1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 - 2. Comply with NEMA ICS 2.
 - 3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 - 4. Trip-free operation.
 - 5. Visible trip indication.
 - 6. Resettable:
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
 - 7. Bimetallic Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.
 - b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - c. Trip test function.
 - 8. Solid State Overload Relays:
 - a. Adjustable full load current.
 - b. Phase loss protection.
 - c. Phase imbalance protection.
 - d. Ambient temperature insensitive.
 - e. Thermal memory.
 - f. Trip test function.
 - g. Provide isolated alarm contact.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Install in accordance with NEMA IS 10034 and manufacturer's instructions.
- C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 23 05 29.
- F. Install controllers plumb and level.
- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Install field-installed devices, components, and accessories.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

END OF SECTION

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**SECTION 23 21 13
HYDRONIC PIPING****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- B. ASME B31.9 - Building Services Piping; 2020.
- C. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping; 2021a.
- D. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing; 2021.
- E. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).
- F. ASTM F2389 - Standard Specification for Pressure-Rated Polypropylene (PP) Piping Systems; 2023.
- G. AWWA C606 - Grooved and Shouldered Joints; 2015.
- H. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018 (Amendment 2019).

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

PART 2 PRODUCTS**2.01 HYDRONIC SYSTEM REQUIREMENTS**

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Engineer.
 - b. Use rigid joints unless otherwise indicated.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:

2.02 CONDENSER WATER PIPING, BURIED**2.03 HEAT PUMP & CONDENSER WATER PIPING, ABOVE GRADE**

- A. Pressure-Rated Polypropylene Pipe: ASTM D2774 or ASTM F2389, PP-RCT resin pipe with fiber layer, SDR 17.6 or SDR 11.
 - 1. Fittings: ASTM F2389, butt, socket, or saddle-weld heat fusion. Transitions to comply with ASTM F1960 or ASME B16.5.

2. Manufacturers:
 - a. Aquatherm Blue: www.aquatherm.com (Preferred).
 - b. Interplast: <https://www.interplast.gr>.
 - c. Nuoi Americas: <https://www.nupiamericas.com/>.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.05 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe of 2 Inches and Less:
- B. Flanges for Pipe 2 Inches and Greater:
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 1. Dimensions and Testing: In accordance with AWWA C606.
 2. Mechanical Couplings: Comply with ASTM F1476.
 3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

END OF SECTION

**SECTION 23 21 14
HYDRONIC SPECIALTIES****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

PART 2 PRODUCTS**2.01 EXPANSION TANKS**

- A. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.
- B. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

- A. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- B. Maximum Fluid Pressure: 150 psi.
- C. Maximum Fluid Temperature: 250 degrees F.

2.03 AIR SEPARATORS

- A. In-line Air Separators:
 - 1. Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure.
 - 2. Maximum Allowable Service Temperature: 450 degrees F.
- B. Centrifugal Air Separators/Strainers:
 - 1. Primed steel body, tested and stamped in accordance with ASME BPVC-VIII-1 with integral bronze strainer, tangential flanged inlet and outlet connections, and internal stainless steel air collector tube.
 - 2. Maximum Service Flow and Pressure: 16 gpm at 125 psi.

2.04 STRAINERS

- A. Size 2 inch and Under:
 - 1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.
- B. Size 2-1/2 inch to 4 inch:
 - 1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch or 3/64 inch stainless steel perforated screen.
- C. Size 5 inch and Larger:
 - 1. Provide flanged or grooved iron body for up to 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.
- D. Basket-Type, Size 1 to 30 inch for Liquid Service:

1. Flanged carbon steel body with 1/8 inch stainless steel perforated basket screen, bottom drain and capped air vent.
2. Fluid Service: Up to 285 psi at 100 degrees F.

2.05 MAGNETIC FILTERS

- A. Description: ASME BPVC-VIII-1 compliant, packaged oxide filtration assembly configured to remove dissolved ferrous metals from hydronic systems.
- B. In-line Filter Assembly:
 1. Magnetic belt surrounded by stainless steel vessel and nonferrous casing.
 2. Provide filter assembly with automatic air vent and EPDM flange gaskets.
 3. Flange Connections: 2 inches, ASME B16.5 Class 150.

2.06 SUCTION DIFFUSERS

- A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- B. Class 125:
 1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh screen and magnetic drain plugs for particle removal without disassembly.
 2. Maximum Operating Service: 175 psi and 300 degrees F.
 3. Sizes, Material, and Connection:

2.07 PUMP CONNECTORS

- A. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 1. Maximum Operating Service: 150 psi at 120 degrees F.
 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: _____ inch.
 - b. Lateral Movement: _____ inch.
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 3. End Connections: Same as specified for pipe jointing.
 4. Provide necessary accessories including, but not limited to, swivel joints.

2.08 PRESSURE-TEMPERATURE TEST PLUGS

- A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- B. Application: Use extended length plugs to clear insulated piping.

2.09 BALANCING VALVES

- A. Size 2 inch and Smaller:
 1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
 2. Metal construction materials consist of bronze, brass, or _____.
 3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or _____.
- B. Size 2-1/2 inch and Larger:
 1. Provide ball, globe, or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged, grooved, or weld-end connections.

2. Valve body construction materials consist of cast iron, carbon steel, ductile iron, or _____.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or _____.

2.10 AUTOMATIC FLOW CONTROL VALVES

- A. Construction:
 1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
 2. Built-in lug-type outlet butterfly valve with 2-position handle.
- B. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- C. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

2.11 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.12 PRESSURE REDUCING VALVES

- A. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 21 13.
- B. Materials of Construction:
 1. Valve Body: Constructed of bronze, cast iron, brass, iron, or _____.
 2. Internal Components: Construct of stainless steel, brass, or _____ and engineered plastics, composition material, or _____.
- C. Connections:
 1. NPT threaded: 1/2 inch or 3/4inch.
 2. Soldered: 1/2 inch.
- D. Provide integral check valve and strainer.
- E. Maximum Inlet Pressure: 400 psi.
- F. Maximum Fluid Temperature: 180 degrees F.
- G. Adjustable Pressure Range: From 10 to 45 psi, set to 25 psi.

2.13 AUTOMATIC FLOW LIMITING VALVES

- A. Size 1/2 inch to 14 inch:
 1. Provide ball, globe, or _____ style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or _____ connections.
 2. Metal construction materials consist of bronze, brass, or _____.
 3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or _____.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties and equipment in accordance with manufacturer's instructions.

END OF SECTION

January 15, 2026

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**SECTION 23 21 23
HYDRONIC PUMPS****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Armstrong Fluid Technology, Inc; _____: www.armstrongfluidtechnology.com/#sle.
- B. Bell & Gossett, a Xylem Inc. brand; _____: www.bellgossett.com/#sle.
- C. Taco: www.tacocomfort.com.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Electrical Requirements:
 - 1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
 - 2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 09 34, except for integral-VFDs.
 - 3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 IN-LINE PUMPS

- A. Casing: Cast iron with seal flush connection, threaded suction, and discharge ports with gauge port and drain plug.
- B. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- C. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- D. Electrical:
 - 1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 05 13.

2.04 END-SUCTION PUMPS

- A. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.
- B. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.
- C. Bearings: Oil lubricated roller or ball bearings.
- D. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- E. Drive: Flexible coupling with coupling guard.
- F. Baseplate: Cast iron or fabricated steel with integral drain rim.
- G. Electrical:
 - 1. Motor: 1,750 rpm, total-enclosed, fan-cooled (TEFC); see Section 23 05 13.

2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Controls Human-Machine Interface (HMI): HVAC operator terminal; see Section 25 35 00.

END OF SECTION

**SECTION 23 25 00
HVAC WATER TREATMENT****PART 1 GENERAL****1.01 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Closed System Treatment (Water):
1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 3. Conductivity enhancers; phosphates or phosphonates.
- B. Condenser Water System Treatment (Cooling Towers):
1. Sequestering agent to inhibit scaling; phosphonates, sodium polyphosphates, lignin derivatives, synthetic polymer polyelectrolytes, or organic phosphates.
 2. Acid to reduce alkalinity and pH; sulphuric acid.
 3. Corrosion inhibitor; zinc-phosphate, phosphonate-phosphate, phosphonate-molybdate and phosphonate-silicate, sodium tolyltriazole, or low molecular weight polymers.
 4. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite.

2.02 BY-PASS (POT) FEEDER**2.03 SIDE-STREAM FILTRATION SYSTEM**

- A. System: Flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valve.
- B. Performance: Design flow 60 gal/min with maximum pressure drop of ____ psi.
- C. Cartridges: 30 micron for start-up and 5 micron for system operation.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.

3.02 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

END OF SECTION

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**SECTION 23 31 00
HVAC DUCTS AND CASINGS****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- D. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated. Fibrous glass duct can be substituted at the Contractor's option.
- C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 33 19.
- D. Duct Shape and Material in accordance with Allowed Static Pressure Range:
- E. Duct Sealing and Leakage in accordance with Static Pressure Class:
- F. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
 - 4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
 - 5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - 6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
 - 7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

- A. Material Requirements:
 - 1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

2.03 FLEXIBLE DUCTS

- A. Flexible Ducts: UL 181, Class 1, polyethylene film, mechanically fastened and rolled using galvanized steel to form spiral helix.
 - 1. Pressure Rating: 10 in-wc positive and 5 in-wc negative.

2. Maximum Velocity: 5500 fpm.
3. Temperature Range: Minus 20 degrees F to 250 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION

**SECTION 23 33 00
AIR DUCT ACCESSORIES****PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- C. NFPA 92 - Standard for Smoke Control Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- I. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

PART 2 PRODUCTS**2.01 AIR TURNING DEVICES/EXTRACTORS**

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 COMBINATION FIRE AND SMOKE DAMPERS**2.03 DUCT ACCESS DOORS****2.04 FIRE DAMPERS**

- A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- B. Horizontal Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame, stainless steel closure spring, and lightweight, heat-retardant, non-asbestos fabric blanket.
- C. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch pressure-class ducts up to 12 inches in height.
- D. Multiple Blade Dampers: 16-gauge, 0.0598-inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- E. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.05 FLEXIBLE DUCT CONNECTORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.

2.06 SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

- B. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by pneumatic actuator.
- C. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.07 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

- A. Manufacturers:
 - 1. Ruskin Company; CD50: www.ruskin.com/#sle.
 - 2. Greenheck ICD-45: www.greenheck.com.
 - 3. TAMCO Series 9000 (Preferred).
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.

2.08 AIR MEASURING CONTROL DAMPERS

- A. Factory-Mounted Assembly Requirements:
 - 1. Damper Unit or Multi-Unit:
 - a. Construction: Flanged-to-duct frame made of extruded aluminum with V or 3V blades for low to medium pressure applications, zinc-plated steel hardware, frame-mounted shaft bearings, frame-assembly sleeve, and silicone seals at frame and blade ends.
 - b. Control: Opposed blade modulation by damper actuator(s) from air measuring sensor transmitter-controller unit.
 - 2. Air Measuring Sensor Transmitter-Controller:
 - a. Transmitter: Five percent accuracy, adjustable zero and span, 10 to 1 turndown, 0.1 percent of calibrated span linearity, 30 to 50 millisecond response time, minimum overpressure of 150 percent over highest range value, alphanumeric indicating display, wired or wireless connectivity for configuration, and terminal strip within enclosed electronic components.
 - b. Controller: Configure to control hardware-linked damper actuator(s) based on locally typed or software-defined setpoint. Access for user to do local or remote proportional, integrative, and derivative control-loop tuning.
 - c. Hardwired External Damper Actuator Output: Two-wire, 4 to 20 mA.
 - d. BTU Metering: Provide temperature sensor for field mounting upstream or downstream of heating or cooling source.
- B. Service Temperature Range: Minus 20 to 160 degrees F.
- C. Enclosure Rating for Transmitter-Controller and Damper Actuator(s):
 - 1. General: UL 50 or UL 50E listed for use in non-hazardous locations.

2.09 MISCELLANEOUS PRODUCTS

- A. Airflow Meters, Thermal-Dispersion Type:
 - 1. Configuration: Duct or plenum inserted assembly using up to eight water-resistant thermal dispersion sensors per metal probe wired into external access box holding self-diagnosing sensor interface electronics with respective field wire and cable landing terminals.
 - 2. Monitoring Range:
 - a. Air Velocity: 0 to 5,000 fpm converted to airflow using section area.
 - b. Temperature: Minus 20 to 120 degrees F.
 - 3. Accuracy: Plus or minus 2 percent with a plus or minus 0.25 percent repeatability over listed range. Includes means to zero, adjust, and calibrate outputs.
 - 4. Access Box: NEMA EN 10250, Type 4x with hinged cover housing and cable access ports.
 - 5. Outputs: Two-wire, 4 to 20 mA, for airflow and temperature signals, configurable.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.
- B. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- C. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- D. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION

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SECTION 23 34 16
CENTRIFUGAL HVAC FANS**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- C. AMCA 99 - Standards Handbook; 2025.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
- E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
- G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point plotted, power, rpm, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- D. Manufacturer's Instructions: Include complete installation instructions.
- E. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Extra Fan Belts: One set for each individual fan.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.04 FIELD CONDITIONS

- A. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS**2.01 PERFORMANCE REQUIREMENTS**

- A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. Fabrication: Comply with AMCA 99.
- D. Performance Base: Sea level conditions.

2.02 WHEEL AND INLET

- A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and backplate; cast iron hub riveted to back plate and keyed to shaft with set screws.

2.03 HOUSING

- A. Heavy gauge steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.

2.04 BEARINGS AND DRIVES

- A. Bearings: Heavy duty pillow block type, selfgreasing ball bearings, with ABMA STD 9 life at 50,000 hours.
- B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
- C. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
- D. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install fans with resilient mountings and flexible electrical leads, see Sections 23 05 48 and 26 05 83.
- C. Install flexible connections between fan inlet and discharge ductwork; see Section 23 33 00. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- D. Provide safety screen where inlet or outlet is exposed.

END OF SECTION

**SECTION 23 35 01
DRYER-VENT EXHAUST COLLECTION SYSTEMS**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ANSI Z223.1 - National Fuel Gas Code; 2024.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Regulatory Requirements:
 - 1. Comply with ANSI Z223.1.
 - 2. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.02 ACCESSORIES

- A. Inline Lint Collector:
 - 1. Construction: Stainless steel housing with access panel and replaceable filter.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

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**SECTION 23 37 00
AIR OUTLETS AND INLETS****PART 1 GENERAL****PART 2 PRODUCTS****2.01 RECTANGULAR CEILING DIFFUSERS**

- A. Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
- B. Connections: Round.
- C. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
- D. Fabrication: Steel with baked enamel finish.

2.02 CEILING SLOT DIFFUSERS

- A. Color: To be selected by Engineer from manufacturer's standard range.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket, mitered end border.
- C. Plenum: Integral, galvanized steel, insulated.

2.03 CEILING SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
- B. Color: As selected by Engineer from manufacturer's standard range.

2.04 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Color: To be selected by Engineer from manufacturer's standard range.

2.05 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, single deflection.
- B. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- C. Color: To be selected by Engineer from manufacturer's standard range.

2.06 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
- B. Frame: 1-1/4 inch margin with countersunk screw mounting.
- C. Fabrication: Steel frames and blades, with factory baked enamel finish.
- D. Color: To be selected by Engineer from manufacturer's standard range.

2.07 GRAVITY VENTILATORS

- A. Hood Intake and Relief Gravity Ventilator:
 - 1. General:
 - a. Low silhouette for intake applications with natural gravity or negative pressure system(s).
 - b. Performance ratings and factory testing in accordance with AMCA 511 and AMCA 550.

- c. Equipment to bear permanently affixed manufacturer's nameplate listing model and serial number.
- 2. Birdscreen:
 - a. Fabricate in accordance with ASTM B221 (ASTM B221M).
 - b. Construction: 1/2 inch Galvanized mesh.
 - c. Horizontally mounted across hood intake area.
- 3. Hood Support: Galvanized steel construction and fastened so hood can be removed completely from base or hinged open.
- 4. Options/Accessories:
 - a. Roof Curbs:
 - 1) Flat Roofs:
 - b. Curb Seal: Rubber seal between fan and roof curb.
 - c. Dampers:
 - 1) Type: Gravity.
 - 2) Factory designed to prevents outside air from entering back into building when fan is off.
 - 3) Balanced for minimal resistance to flow.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

END OF SECTION

**SECTION 23 40 00
HVAC AIR CLEANING DEVICES**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.
- B. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

2.02 DISPOSABLE PANEL FILTERS

- A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
- B. Performance Rating:
 - 1. Face Velocity: 500 fpm.
 - 2. Initial Resistance: 0.15 in-wc.
 - 3. Recommended Final Resistance: 0.50 in-wc.
- C. Casing: Cardboard frame.

2.03 EXTENDED SURFACE HIGH EFFICIENCY MEDIA FILTERS

- A. Media: Pleated, water-resistant glass fiber with aluminum separators; in 16 gauge, 0.0598 inch steel holding frame with corrosion resistant coating.
- B. Minimum Efficiency Reporting Value (MERV): 13, when tested in accordance with ASHRAE Std 52.2.
- C. Performance Rating, per ASHRAE Std 52.2:

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION

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SECTION 23 81 29
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS**PART 1 GENERAL****1.01 REFERENCE STANDARDS**

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008, Including All Addenda.
- B. ITS (DIR) - Directory of Listed Products; current edition.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.04 DELIVERY, STORAGE AND HANDLING**1.05 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS**2.01 HVAC SYSTEM DESIGN**

- A. System Operation: Heating and cooling, simultaneously.
 - 1. Zoning: Provide capability for temperature control for each individual indoor/evaporator unit independently of all other units.
 - 2. Zoning: Provide heating/cooling selection for each individual indoor/evaporator unit independently of all other units.
 - 3. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.
 - 4. Conditioned spaces are indicated on drawings.
 - 5. Branch selector unit locations are not indicated on drawings.
 - 6. Required equipment unit capacities are indicated on drawings.
 - 7. Refrigerant piping sizes are not indicated on drawings.
 - 8. Connect equipment to condensate piping provided by others; condensate piping is indicated on drawings.
- B. Cooling Mode Interior Performance:
 - 1. Daytime Setpoint: 68 degrees F, plus or minus 2 degrees F.
 - 2. Setpoint Range: 57 degrees F to 77 degrees F.
 - 3. Night Setback: 78 degrees F.
 - 4. Interior Relative Humidity: 20 percent, maximum.
- C. Heating Mode Interior Performance:
 - 1. Daytime Setpoint: 68 degrees F, plus or minus 2 degrees F.
 - 2. Setpoint Range: 59 degrees F to 80 degrees F.
 - 3. Night Setback: 60 degrees F.
 - 4. Interior Relative Humidity: 10 percent, minimum.
- D. Outside Air Design Conditions:

- E. Energy Design Wind Speed: 25 mph.
- F. Operating Temperature Ranges:
 - 1. Simultaneous Heating and Cooling Operating Range: minus 4 degrees F to 60 degrees F dry bulb.
 - 2. Cooling Mode Operating Range: minus 4 degrees F to 110 degrees F dry bulb.
 - 3. Heating Mode Operating Range: 0 degrees F to 77 degrees F dry bulb; minus 4 degrees F to 60 degrees F wet bulb; without low ambient controls or auxiliary heat source.
- G. Refrigerant Piping Lengths: Provide equipment capable of serving system with following piping lengths without any oil traps:
 - 1. Minimum Piping Length from Outdoor/Central Unit(s) to Furthest Terminal Unit: 540 feet, actual; 620 feet, equivalent.
 - 2. Total Combined Liquid Line Length: 3280 feet, minimum.
 - 3. Minimum Piping Length Between Indoor Units: 49 feet.
- H. Control Wiring Lengths:
 - 1. Between Outdoor/Condenser Unit and Indoor/Evaporator Unit: 6,665 feet, minimum.
 - 2. Between Outdoor/Condenser Unit and Central Controller: 3,330 feet, minimum.
 - 3. Between Indoor/Evaporator Unit and Remote Controller: 1,665 feet.
- I. Controls: Provide the following control interfaces:
 - 1. For Each Indoor/Evaporator Unit: One wall-mounted wired "local" controller, with temperature sensor; locate where indicated.
- J. Local Controllers: Wall-mounted, wired, containing temperature sensor.

2.02 EQUIPMENT

- A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.
 - 1. Performance Certification: AHRI Certified; www.ahrinet.org.
 - 2. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL, listed in ITS (DIR), and bearing the certification label.
 - 3. Provide outdoor/condensing units capable of serving indoor unit capacity up to 200 percent of the capacity of the outdoor/condensing unit.
 - 4. Provide units capable of serving the zones indicated.
 - 5. Thermal Performance: Provide heating and cooling capacity as indicated, based on the following nominal operating conditions:
 - 6. Energy Efficiency: Report EER and COP based on tests conducted at "full load" in accordance with AHRI 210/240 or alternate test method approved by U.S. Department of Energy.
- B. Electrical Characteristics:
 - 1. Power - Branch Selector Units: 208 to 230 Volts, single phase, 60 Hz.
 - 2. Power - Indoor Units: 208 to 230 Volts, single phase, 60 Hz.
 - 3. 208-230 Voltage Range: 187 to 253 volts.
- C. Refrigerant Piping:
 - 1. Insulate each refrigerant line individually between the condensing and indoor units.

2.03 OUTDOOR/CONDENSING UNITS

- A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.
 - 1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.

2. Refrigerant: Factory charged.
 3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
 4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
 5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted, due to potential reduction in space temperature.
 6. Sound Pressure Level: As specified, measured at 3 feet from front of unit; provide night setback sound control as a standard feature; three selectable sound level steps of 55 dB, 50 dB, and 45 dB, maximum.
 7. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.
 8. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 9. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
 10. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
 11. Controls: Provide contacts for electrical demand shedding.
- B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
1. Designed to allow side-by-side installation with minimum spacing.
- C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.
1. Provide minimum of 2 fans for each condensing unit.
 2. External Static Pressure: Factory set at 0.12 in WG, minimum.
 3. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG, minimum; provide for mounting of field-installed ducts.
 4. Fan Airflow: As indicated for specific equipment.
 5. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.
- D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance.
- E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
1. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.
 2. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
 3. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.

4. Provide oil separators and intelligent oil management system.
5. Provide spring mounted vibration isolators.

2.04 BRANCH SELECTOR UNITS

- A. Branch Selector Units: Concealed boxes designed specifically for this type of system to control heating/cooling mode selection of downstream units; consisting of electronic expansion valves, subcooling heat exchanger, refrigerant control piping and electronics to facilitate communications between unit and main processor and between branch unit and indoor/evaporator units.
 1. Control direction of refrigerant flow using electronic expansion valves; use of solenoid valves for changeover and pressure equalization is not permitted due to refrigerant noise; use of multi-port branch selector boxes is not permitted unless spare ports are provided for redundancy.
 2. Provide one electronic expansion valve for each downstream unit served, except multiple indoor/evaporator units may be connected, provided balancing joints are used in downstream piping and total capacity is within capacity range of the branch selector.
 3. When branch unit is simultaneously heating and cooling, energize subcooling heat exchanger.
 4. Casing: Galvanized steel sheet; with flame and heat resistant foamed polyethylene sound and thermal insulation.
 5. Refrigerant Connections: Braze type.
 6. Condensate Drainage: Provide unit that does not require condensate drainage.

2.05 INDOOR/EVAPORATOR UNITS

- A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.
 2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.
 3. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.
 - a. Provide thermistor on liquid and gas lines.
 4. Fans: Direct-drive, with statically and dynamically balanced impellers; high and low speeds unless otherwise indicated; motor thermally protected.
 5. Return Air Filter: Washable long-life net filter with mildew proof resin, unless otherwise indicated.
 6. Condensate Drainage: Built-in condensate drain pan with PVC drain connection.
 7. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.

3.02 SYSTEM STARTUP

- A. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.

- B. Adjust equipment for proper operation within manufacturer's published tolerances.

END OF SECTION

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SECTION 26 01 00 – GENERAL PROVISIONS - ELECTRICAL

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A The work covered by Division 26 of these specifications consists of furnishing all labor, equipment, supplies, and materials, and performing all operations, including trenching, backfilling, cutting, channeling, chasing and patching necessary for the installation of complete wiring systems in accordance with the contract documents. Work specified under the following sections is part of the electrical contract work:
- B In addition, the soil boring information included in the specifications or in the drawings is for information to all contractors.
- C In addition, the work specified under the following sections shall also be provided as part of Division 26 - Electrical. Division 26 Bidder is advised to verify scope of electrical work prior to bidding the project.
- D The Contract Drawings indicate the extent and general arrangement of the electrical work. The drawings and specifications shall be considered supplementary, one to the other, so that materials and workmanship indicated, called for or implied by the one and not by the other shall be supplied and installed as though specifically called for by both. All labor and material required to perform all work in conjunction therewith whether or not indicated or specified shall be furnished and installed as part of this work.
- E Instruction to Bidders and General Conditions of the Contract, Supplementary Instructions to Bidders, Guidelines for Recruitment and Selection of Minority Business, and Division 01 General Requirements are part of Division 26 - Electrical.
- F See section 260111 for general outline of electrical work.
- G The electrical subcontractor may also be referred to in this specification as electrical contractor. The electrical contractor may also be referred to in this specification as "this contractor", "contractor", "Contractor", "Division 26 contractor" or "electrical subcontractor".

1.2 DRAWINGS AND SPECIFICATIONS:

- A It is understood that while drawings shall be followed as closely as circumstances will permit, the Contractor is held responsible for the installation of the system according to the true intent and meaning of the drawings. Anything not entirely clear in the Contract Documents will be fully explained if application is made to the Architect in accordance with the General Conditions and Supplements thereto. However, should conditions arise where, in the judgment of the Contractor, certain changes will be advisable, the Contractor shall communicate with the Architect and secure his review of these changes before proceeding with the work, provided they are of a major nature.
- B The drawings are diagrammatic and are not intended to show each and every conductor, fitting, device, conduit, or a complete detail of all the work to be performed, but are for the purpose of illustrating the type system and special conditions necessary for the experienced electrician to take off his material and lay out his work. The Contractor shall be responsible for making such measurements as may be necessary at the Project and adapting his work to the project conditions.
- C Drawings shall not be scaled. Refer to architectural and structural drawings for building construction and dimensions and to room finish schedule or architectural drawings for material, finish and construction method of walls, floor and ceiling in order to insure proper rough-in and installation of work.

1.3 APPLICABLE SPECIFICATIONS AND STANDARDS:

- A The following specifications and standards, as applicable to the materials and methods specified, shall be considered part of these specifications:

- 1. AEIC American Association of Edison Illuminating Companies

2.	ANSI	American National Standards Institute
3.	ASHRAE/IES	90.1 Code - 2013
4.	ASTM	American Society for Testing and Materials
5.	BOCA	Building Officials Code Administrators
6.	BAS	Building Automation System
7.	DOE	Department of Energy
8.	EPA	Environmental Protection Agency
9.	EPAAct	Energy Polic Act of the US Department of Energy
10.	ETL	Electric Testing Laboratories
11.	NCSBC	The 2018 North Carolina State Building Code
12.	NCEC	North Carolina Energy Code
13.	ICC	International Code Council
14.	ICEA	Insulated Cable Engineers Association
15.	IEEE	Institute of Electrical and Electronic Engineers
16.	IES	Illuminating Engineering Society
17.	NCAC	North Carolina Administrative Code'
18.	NCCM	N.C. State Construction Manual
19.	NCBC	N.C. Building Code (also NCSBC (N.C. State Building Code)
20.	NCBCC	N.C. Building Code Council
21.	NEC	National Electrical Code – 2017(as amended by NCBCC)
22.	NECA	National Electrical Contractor Association
23.	NEIS	National Electrical Installation Standards
24.	NEMA	National Electrical Manufacturers Association
25.	NESC	National Electrical Safety Code
26.	NETA	International Electrical Testing Association
27.	NFPA	National Fire Protection Association
28.	OSHA	Occupational Safety and Health Standards
29.	TCLP	Toxicity Characteristic Leaching Procedure
30.	UL	Underwriters' Laboratories Inc.
31.	EIA/TIA 586 and Supplements	
32.	EIS/TIA 569 and Supplements	
33.	TIA/TSB-40 Levels (Categories) of electrical performance.	

- B All referenced manufacturer's requirements and specifications and nationally recognized and accepted standards and specifications shall be the latest edition unless specified otherwise and shall be used as they are applicable for products and craftsmanship incorporated in the Contract Drawings and this Section only. The references to these standards and specifications do not imply acceptance of any and all products described in the standards and specifications.

1.4 APPLICABLE REGULATIONS:

- A The installation shall comply with the 2020 edition of the National Electrical code and rules and regulations of the 2018 North Carolina State Building Code. In no case shall the materials and workmanship fail to meet the minimum requirements of the National Electrical Code.

1.5 SUBMITTALS:

- A All submittals shall be reviewed, corrected as necessary prior to submitting to Architect/Engineer and stamped "Approved" by the contractor, or the responsible subcontractor.

B Materials List:

1. As soon as practicable and in accordance with the General Conditions of the Contract, and before commencement of installation of any materials or equipment, submit six copies of a complete schedule of the materials and equipment proposed for installation and of names of specialty subcontractors for approval by the Architect/Engineer.
2. The schedule shall, as soon as possible, be supplemented by catalog cuts, diagrams, lighting fixture brochures, shop drawings, field working drawings and such descriptive data as may be required by the Architect/Engineer. In the event any items of materials or

equipment contained in the schedule fail to comply with the specification requirements, such items will be rejected.

3. Where shop drawings are called for in other sections of the specifications, the list shall name the manufacturer and item and state "Shop Drawings to Follow."
 4. The Architect/Engineer shall be notified immediately - in writing, of delivery scheduling of the material not ordered for immediate shipment. The first payment estimate will not be approved until the Architect/Engineer is satisfied that all material is ordered and delivery scheduled so that there will be no delay to the job because of getting material. The contractor may be required to remove and replace at his own expense any material installed before approval.
 5. All materials shall be new, with the required UL label, and manufacturer's label or nameplate giving complete electrical data. Where a manufacturer's catalog number is used, all parts shall be furnished to make it complete and fit the construction intended.
- C Shop Drawings: Shop drawings shall be submitted conforming to the requirements stated in Division 26, General Requirements, and in the supplementary general conditions, within 60 days of the issue of the notice to proceed for the following items:
1. Switchboards
 2. Panelboards
 3. Wiring Devices (catalog cuts)
 4. Disconnect Switches (catalog cuts)
 5. Special Electrical Systems, as specified in respective specification sections
 6. Transformers
 7. Lighting
 8. Additional items as specified in technical sections.
- D Factory Record Drawings: Submit factory final record drawings for panelboards, switchboards, transformers, and other specified power gear, as part of the operation and maintenance manual submittal.
- E Installation Instruction: Submit to the Architect/Engineer manufacturer's installation, operation and maintenance instructions for all electrical protective or operable equipment immediately after the completion of the job. Submit four copies of complete manufacturer's instructions for the following equipment.
1. Switchboards
 2. Panelboards
 3. Feeder Switches
 4. Circuit Breakers, including time current for all circuit breakers over 100 amperes.
- F Field Coordination Drawings:
1. Submit field coordination drawings in cooperation with mechanical contractor, as specified in Supplementary General Conditions. Include, as applicable, lighting fixtures, panelboards, switchboards, transformers, cable trays, conduit larger than 1 inch diameter, projection screens, in-ceiling projectors, receptacles, switches and outlets. The drawings shall be produced with a $\frac{1}{4}" = 1 \text{ ft.}$ scale, utilize a separate color for each trade, and be produced in the following order to help prevent space conflicts and subsequent drawing revisions. Of special importance is the final location of receptacles and outlets in special walls, like wood finished walls, if any, to arrive in a logical and visually location of these outlets in accordance to the type of wall panel being submitted. Also, refer to architectural drawings for location of electrical components. Also, verify at this time that the final location of pipes, ductwork and mechanical equipment does not encroach into the foot print of electrical equipment. The field coordination drawings shall include the proposed routing of the outdoor power and telecommunications ductbanks. Although these drawings are not required to be prepared at $\frac{1}{4}" = 1 \text{ ft.}$ scale.
 2. Submit $\frac{1}{4}$ inch – 1'-0" scaled plans of each electrical equipment room indicating locations of electrical gear, sleeves and conduit penetrations. Coordinate with structural system installer and provide steel framing or reinforcing steel as required to maintain integrity of structural systems.

3. Field coordination drawings are not shop drawings but are reviewed by the engineer but are not approved as typical for a shop drawing, until submitted to engineer and to a point in time when all engineer review comments are reconciled on these drawings by the contractor.
4. The field coordination drawings shall be submitted in packages as specified here. Hard copy documents will be reviewed by the A/E and returned with written comments.
5. Spacing of package submittals shall be at no less than 15 working day period.
6. Following up within 5 working days after the return of these documents to the office of the construction manager, all parties will meet to resolve conflicts.

G Operation and Maintenance Manuals:

1. See General Conditions and Supplements thereto. The contractor shall compile and bind 3 sets of all operation and maintenance manuals, equipment and parts lists, instructions, and descriptive literature furnished by the manufacturers of the furnished equipment to assist in the proper maintenance and operation of equipment. These instructions shall be turned over to the architect with application for final payment, and final payment will not be made until received. Each brochure shall include 1 copy of each of all approved shop drawings, catalog pages, instruction sheets, operating instructions, installation and maintenance instructions, and spare parts bulletins.
2. The contractor shall submit warranties and guarantees in one commercial quality, hardback binder sized to accommodate 8.5 by 11 inch pages, with a table of contents and two (2) copies of each warranty or guarantee. Marked tabs shall separate warranties and guarantees in sections following the order of the specs.
3. Submittal shall include, as required by ASHRAE Standard 90.1-2013, a complete narrative of how each system is intended to operate.

1.6 EQUIPMENT SIZES:

- A Listing of a manufacturer as a source of acceptable equipment does not relieve the contractor and the manufacturer of this equipment from the requirement of meeting all aspects of the contract documents including that of having to fit the equipment in the space allocated.

1.7 WARRANTY:

- A The electrical work shall be guaranteed for one-year against all deficiencies as specified in the General Conditions. In addition, the following special items shall carry an extended warranty, as indicated:
1. Any other item identified in the general conditions of the contract to have extended warrantee.

1.8 SITE INSPECTION:

- A Each electrical bidder shall visit the site of the work and familiarize himself with the character and conditions of the job site. The Contractor shall not be excused from doing required work because he did not visit the site.
- B The Contractor shall coordinate all necessary power outages with the University as required by giving a 30 day written notice to each agency. No power shall be reinstated to any facilities or equipment until an inspection and certificate is obtained from the NC State Construction Office of the Electrical Inspector.
- C The Contractor shall notify local gas and TV cable companies prior to digging. Contractor shall notify University for location of all other underground utilities prior to digging.

1.9 RECORD DRAWINGS:

- A The Contractor's competent supervisor shall maintain on the job site one complete set of contract documents of all trades, and shall coordinate with other trades so as to avoid conflicts. The A/E field representative will visit the contractor's office periodically and shall be allowed to inspect the record set of drawings to verify that they are being kept up to date.

- B The Contractor shall provide one set of marked plans to Architect/Engineer, as the Owner's representative, for his preparation of record drawings. The marked plans shall indicate all changes and deviations from the original contract documents. Each change shall be marked in a clear, legible manner, keying it to the appropriate change order, clarification note, or field authorization note, as applicable.
- C Contractor's electrical record drawings shall be submitted within 30 days after the date of building acceptance, as required by ASHRAE Standard 90.1 – 2013.

1.10 TEMPORARY FACILITIES:

- A Temporary facilities shall be provided as required, as specified in the Division I - GENERAL REQUIREMENTS.

1.11 CONSTRUCTION UTILITIES:

- A Refer to DIVISION I - GENERAL REQUIREMENTS

1.12 CONCRETE WORK:

- A Concrete work for electrical equipment, curbs, bases and pads shall be provided under Division 26 in conformance with Division 03 - Concrete.

1.13 METAL FABRICATIONS:

- A Steel frames, supports and metal assemblies necessary for the installation of electrical systems shall be provided under Division 26 in conformance with Division 05 - Metals.

1.14 PAINTING:

- A Provide prime and finish painting of all exposed electrical conduit, raceways, wireway, boxes and related supports in other than in mechanical, electrical and telecom equipment rooms. Painting of electrical conduit and items specified under Division 26 - Electrical shall conform to requirements of Division 09 - Painting. Finish color shall be as required to match adjacent surfaces.
- B Any electrical item factory painted that has a damaged or abraded area shall be touched-up to match surrounding finish unless it is rejected by the Architect/Engineer. Touch-up painting shall be done by Division 09 subcontractor at the expense of the electrical contractor.

1.15 EXCAVATION AND BACKFILL:

- A Excavation and backfilling shall comply with the requirements of Division 26.
- B Backfill shall not begin until after electrical contractor's work has been properly installed and inspected by the authority having jurisdiction and approved by the architect/engineer.
- C Required excavation for installation of all electrical work shall be provided by the Electrical Contractor and replacement and compaction shall be performed according to other specifications relating to the particular type of work. All excavations must comply with OSHA guidelines.
- D In unfinished areas, such as equipment rooms, etc., exposed equipment shall be furnished with suitable factory applied finishes, i.e. standard gray enamel finish for panelboards, etc. Equipment furnished in finishes such as stainless steel, brushed aluminum, etc. shall not be painted.

1.16 ABBREVIATIONS:

- A The following abbreviations may be found in this specification and in the drawings.

A	Ampere
AC	Alternating Current
A/E	Architect/Engineer

ADA	Americans with Disabilities Act
AEIC	Association of Edison Illuminating Companies
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institutes, Inc.
ASTM	American Society for Testing and Materials
ASYMM	Asymmetrical
AWG	American Wire Gauge
BAS	Building Automation System
C	Conduit
CAS	Campus Automation Systems
CBM	Certified Ballast Manufacturers
CFM	Cubic Feet per Minute
DB	Decibel
DC	Direct Current
ETL	Electric Testing Laboratories
F	Fuse or Fahrenheit, as applicable
GFI	Ground Fault Interrupter
HZ	Hertz
GRC or RMC	Galvanized Metal Conduit, Schedule 40
HV	High Voltage
IEEE	Institute of Electrical and Electronic Engineers
IMC	Intermediate Metal Conduit
KV	Kilovolt (1000-volt)
KVA	Kilovolt Ampere
MA	Milliampere
MCM	Thousand Circular Mil or KCMil
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOC	Normally Open Contact
NCC	Normally Closed Contact
NCDol	North Carolina Department of Insurance
NCSBC	2012 North Carolina State Building Code
PVC	Polyvinyl Chloride
RMC or GRC	Rigid Galvanized Metal Conduit, Schedule 40

RMS	Root Mean Square
RNMC	Rigid Galvanized Non-Metallic Conduit
RS	Rapid Start
SYMM	Symmetrical
SCO	State Construction Office
UL	Underwriters' Laboratories, Inc.
UPS	Uninterruptible Power Supply

PART 2 PRODUCTS

2.1 MATERIALS:

- A All materials used in this work shall be new unless otherwise noted. All materials used on this project shall be UL listed and labeled, where they have established a standard for the material to be installed. Any material installed that is not labeled shall be subject to a field evaluation by one by one of the third party agencies which have been approved by the North Carolina Building Code Council at the contractor's expense, if authorized by the authority having jurisdiction and the Architect/Engineer. Otherwise, any item not listed and labeled by UL shall be replaced by the contractor at his expense. It shall be the contractor's responsibility to verify that materials specified or used on the project are labeled. Materials are all items other than labor that are part of the electrical contract, including, but not limited to, devices, appliances and equipment.
- B Catalog numbers and trade names in these specifications and noted on the drawings are intended to describe the class of the material, devices or apparatus wanted and not to limit competition.
- C Where a manufacturer's catalog number is used, all parts shall be furnished that are required to make it complete and fit the construction intended.
- D The contractor may not install alternate equipment unless the substitution was requested within Bid period and approved under requirements of Division 01 – General Requirements. N.C. General Statue 133-3 (Specifications to Carry Competitive Items, Substitution of Materials, for strict adherence thereto (for all equipment where available).
- E The contractor shall be responsible for the security and storage of all materials and equipment.
- F Materials from listed manufacturers shall only be acceptable if they can properly fit in the allocated spaces without interference from building walls, ceilings, piping conduit, ducts or other equipment.
- G The contractor, through the manufacturer of the equipment specified here, shall review the use, details, and methods of installation of his product as indicated and shall disclose to the A/E any and all deviations from his recommended use and method of installation and shall also disclose to the A/E his recommendations for the use and method of installation of his product to achieve the intended purpose and result. Such disclosure shall be made within the time stipulated for submission of shop drawings.

PART 3 EXECUTION

3.1 PHASING AND SEQUENCING OF WORK:

- A Work under Division 26 - Electrical shall be staffed, phased and scheduled to satisfy general contractors work schedule.

3.2 FEES AND PERMITS:

- A Contractor shall secure and pay for all permits, fees, inspections and licenses required.

3.3 DIMENSIONS:

- A Unless specific dimensions are shown, locations of outlets, equipment connections, etc. are approximately and shall be verified by reference to related documents (i.e. architectural drawings and shop drawings, equipment shop drawings, lab equipment casework drawings, etc.)

3.4 WORK OBSERVATIONS:

- A Contractor shall cooperate with architect/engineer during the performing of project observations and project punch lists during the construction and post-construction (warranty) periods. Electrical work shall not be covered until reviewed by the A/E and the AHJ. Contractor shall open and close equipment doors and equipment cover, as required to gain access to equipment for observation by the architect/engineer as many times as requested. Provide qualified electricians to assist architect/engineer during observations and while performing punch listings.
- B The Contractor shall notify the State Electrical Inspector with Department of Administration; for state-owned projects and to notify the local inspector(s); for community college & county owned buildings, to schedule required inspections. The State Electrical Inspector at the State Construction Office to schedule required inspections, including rough-in, above ceiling and final inspections.

3.5 COORDINATION OF WORK:

- A Installation of electrical conduits, boxes and equipment shall not interfere with access to HVAC and plumbing equipment, its controls or its maintenance. Electrical contractor shall verify with HVAC, plumbing and fire protection contractors, during the preparation of the field coordination drawings, prior to installation of electrical equipment so that the electrical work will not interfere with any required access to these other contractors.
- B The Contractor shall coordinate the work under his contract as to avoid conflicts between his work and the work of other trades. Contractor shall carefully examine the drawings prior to running any conduit and shall be responsible for the proper fittings of materials and equipment into the space provided prior to installing any conduit or equipment in accordance with requirements of the National Electrical Code. If any departures from the contract drawings are deemed necessary by the Contractor, detail drawings of such departures and the reasons therefore shall be submitted as soon as practicable to the Architect/Engineer for his review. No such departures shall be made without this review and written change order.
- C Conduit shall be installed in a way that does not weaken, or interfere with, the structural system for the building.
- D Relocation of handholes, pullboxes, outlets, equipment, conduit, system connections or rough-in locations up to twenty feet, if necessary, in any direction shall be done at no additional cost to the Owner or its agents if identified as required, or communicated to the contractor, before roughing-in.
- E Electrical Contractor shall cooperate with other contractors and subcontractors to allow for the installation of their work as well as his own.
- F The Electrical Contractor shall be responsible for his work fitting in place without conflict with the other trades, where proper planning could avoid interference. Any work installed by this Contractor without regard for the work of others, or if a conflict results, must be changed as directed by the Architect/Engineer without additional cost to the Owner.
- G Coordinate with HVAC, plumbing, and fire protection contractors to prevent interference between cable tray and ductwork or piping. Whenever there is a conflict between sprinkler piping and cable tray, the electrical contractor shall, at no extra cost to the owner, relocate cable tray to avoid conflict with pipe or ductwork.
- H Coordinate with HVAC, Plumbing and Fire Protection Contractors to assure that no pipe or duct is run above panelboard or switchboard, prior to the installation of this equipment, except as otherwise noted. Piping that is unavoidable shall only be permitted if it allows for clear 6'-0"

space above the equipment after being protected with drip pan. Inform Architect/Engineer of any case where there is conflict.

- I The contractor shall verify that the electrical equipment to be installed fits in the assigned space prior to running any conduit or installing the equipment. Any potential conflict shall be brought to the attention of the A/E at once.
- J The Architect/Engineer reserves the right of observing all concealed work, before being covered. This Contractor shall notify the Architect/Engineer of the need of a job observation at least four working days prior to concealment of work.
- K Requests for information (RFI) answers provided by the A/E to contractor's RFI's do not constitute authorization to change the requirements of the contract documents. The contractor shall submit a change order request for consideration by A/E for any equipment, material, wiring method, or other work that as a result of the outcome of an RFI, may require changes from the original contract documents. No deviation from the original contract is authorized until the change order request is approved.

3.6 DEVICES AND EQUIPMENT MOUNTING HEIGHTS

- A Unless noted otherwise, the following requirements apply to this work. In case of conflict between these stringent mounting heights and other information expressed in the contract documents, request clarification from A/E prior to starting any work.
- B Specific Requirements:
 - 1. Set all recessed boxes with edges flush with finished surface.
 - 2. Immediately after installation, cover raceways and boxes to prevent entrance of foreign matter, paint, etc.
 - 3. Contractor shall coordinate with other trades, and shall study the architectural plan drawings, casework drawings, etc. to determine proper placement and mounting heights of all devices. The A/E representative shall be consulted concerning any possible location problems.
- C Where not shown or required otherwise, the following "standard" mounting heights and positions shall apply:
 - 1. Panelboard enclosures 6'-4" (plus or minus 4" in concrete block construction) from finished floor to top of can
 - 2. Install receptacle boxes in office areas 18" from finished floor to center of boxes.
- D In any case all devices shall be mounted in conformance with the Americans with Disabilities Act and the NCSBC. Any discrepancies with the ADA Guidelines and the drawings are to be discussed with the A/E representative prior to initiating work.

3.7 FIRE AND SOUND PROTECTION:

- A Do not install outlets back-to-back, regardless of what may appear to be shown on drawings. Outlets installed on opposite sides of same wall shall be installed not less than 12" apart as viewed on plan and 24" apart if wall is fire rated, unless suitable fireproofing protection is provided, as specified in Section 260541.
- B Provide additional fireproofing, either by spray-on fire proofing type method, by applying gypsum board layers, or by any other approved method, as required to maintain fire rating of overhead slabs where floor boxes are to be installed to satisfy requirements of the Authority Having Jurisdiction.

3.8 SUPERVISION:

- A The contractor shall have in charge of the work at all times during construction, a thoroughly competent foreman with extensive experience in the work to be performed under this contract. The foreman shall be a licensed electrician certified by the State of North Carolina. Anyone deemed not capable by the Architect/Engineer shall be replaced immediately upon request, and after a satisfactory foreman has been assigned, he shall not be withdrawn without the written consent of the Engineer.

3.9 CUTTING AND PATCHING:

- A This Contractor shall do all cutting and patching necessary for the proper installation of his work and shall repair any damage done by himself or his workmen.
- B Required excavation for installation of all electrical work shall be provided by the electrical contractor and replacement and compaction shall be performed according to other specifications relating to the particular type of work.

3.10 CONDUIT IN OVERHEAD SLAB:

- A Do not run conduit in slab on deck or in overhead slab except for the absolute minimum required to install an in-slab floor box, if any, in which case additional fireproofing insulation or material, like gypsum board, shall be provided to maintain fire rating of slab.

3.11 WASTE MATERIALS:

- A The Contractor shall at all times keep the premises free from accumulation of waste materials or rubbish caused by his employees or work and shall cleanup scraps and seep floors each day workers are at the job site. At the completion of the work he shall remove all leftover materials, equipment and debris resulting from the work done under this Division.
- B Waste that is classified by law, state or Federal agencies as hazardous or toxic, like fluorescent lamps, ballasts, or other equipment containing PCB's, shall be discarded through bonded hazardous waste disposal facilities utilizing methods prescribed by law.

3.12 ACCESS TO EQUIPMENT:

- A All equipment shall be installed in location and manner that will allow for convenient access for maintenance and inspection. Adjust location shown on drawings for placement of electrical equipment to assure that the required clearances are maintained.
- B Access doors and panels in walls and ceilings shall be provided as required for concealed equipment, controls and boxes, and all other items under Division 26 requiring accessibility for operation and maintenance. Doors and panels shall be provided conforming to Section 260541 under Division 26 -Electrical.

3.13 FIELD COORDINATION DRAWINGS

- A Submit field coordination drawings as specified in Section 260100, Part 1 prior to starting any work. Any variations in the location of equipment, light fixtures and outlets, or variations in the routing of feeders, branch circuits, cable tray, or conduits, required to accomplish the installation in accordance with the field coordination drawings shall be considered as part of the original contract, as long as they do not exceed 20 feet in any direction from the original location. These drawings are intended to reflect actual installation of mechanical and electrical systems showing actual dimensions of equipment and materials and their final location. Include plan view of each electrical equipment room showing electrical equipment. Electrical items interfering with work under other trades shall be relocated as required to avoid conflict, at no extra cost to the Owner or its agents. No rough-in shall be accomplished until these drawings have been approved by the A/E. These drawings shall not be used for record drawings submittal. As part of this submittal, coordinate with structural system installer prior to making any holes through floors or structural walls.

3.14 INTERRUPTION OF ELECTRICAL UTILITIES:

- A Shutdown of electrical or other utilities must be cleared with the Owner at least 60 days in advance. All modifications, connections and disconnections of high voltage circuits shall be done at night, over the weekend, or during school holidays to avoid interruption during regular working hours, as scheduled and directed by owner.

3.15 CONTINUATION OF ELECTRICAL SERVICES:

- A It is imperative that all utilities and services be maintained at all times except for scheduled interruptions. Should emergency repairs be required to systems that exist within construction

limits, the Contractor shall cooperate with the Owner to insure that these services are restored as soon as possible. Provide all necessary temporary services and connections required to provide uninterrupted continuance of building services except as otherwise permitted by Owner.

3.16 FIREPROOFING:

- A It is the responsibility of this contractor to provide all additional fireproofing required to maintain the fire resistance integrity and rating of floors, walls and ceilings that may be compromised by the installation of conduits, raceways, boxes and electrical cabinets.

END OF SECTION 26 01 00

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SECTION 26 01 11 – ELECTRICAL OUTLINE OF WORK

PART 1 GENERAL

1.1 SUMMARY:

A The work included in Division 26 electrical includes, but is not necessarily limited to the following items and systems:

1. Site Work:

- a. Power supply to the building shall be obtained from new pad-mounted transformer provided by Duke Energy. All work up to point of metering done by others.
- b. Service Equipment: Consisting of service rated switchboard and other service rated equipment, as indicated on drawings.
- c. Secondary deliveries from the pad mounted transformer to service equipment including connection to transformer.
- d. Conduits and feeders.

2. Interior Work: The interior work included in Division 26 electrical includes, but is not necessarily limited to the following items and systems:

- a. Feeder Circuits, Including Conduits, Conductors, Troughs and Fittings
- b. Compression lugs and terminals for all feeder cables feeding standby and emergency power equipment.
- c. Branch Circuits, Including Conduits, Conductors, Outlets, Boxes, Receptacles, Switches and Fittings
- d. Certified overcurrent protection coordination study and arc flash study and arc flash hazard labeling.
- e. Surge Protector Devices (SPDs)
- f. Panelboards
- g. Dry Type Transformers
- h. Equipment Tests
- i. Wiring Devices
- j. Grounding Systems, including supplementary grounding system
- k. Safety Switches
- l. Power Connection to all Equipment Requiring Power
- m. Power metering and monitoring system including required BAS interface gateway converter cards, if required for:
 - 1) Service switchboard feeder circuit breakers
 - 2) Monitoring and alarming via building management system (BAS)
- n. Lighting fixtures
- o. Lighting control Devices

B In addition, provide work and services required to comply with the project commissioner's requirements, including active participation in the Commissioning Program as required under Contract Documents, including, but not limited to Section 260800.

END OF SECTION 26 01 11

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SECTION 26 01 20 – DIVISION OF WORK (DIVISIONS 23 AND 26)

PART 1 GENERAL

1.1 SCOPE OF WORK:

- A This section delineates the DIVISION OF WORK between Division 23 and Division 26. The same rules described for Division of Work between Divisions 23 and 26 apply to Division of Work between Division 21 and Division 26 and between Division 22 and Division 26.
- B Refer to “Electrical Equipment Connections Diagram” on the drawings covering the items specified here. Specific work to be done under Division 26 is here in after listed or described. All other work necessary for the operation of Division 23 equipment shall be performed under Division 23.

1.2 DIVISION OF WORK:

- A All individual motor starters for mechanical equipment (fans, pumps, etc.), shall be furnished and installed under Division 23. Motor starters for mechanical equipment which are scheduled as part of motor control centers, if any, shall be provided under Division 26 - Electrical.
- B Under Division 26, generally, power wiring, including line power wiring to some Division 23 control panels, shall be provided up to a termination point consisting of junction box, trough, starter, VFD, or disconnect switch. Under Division 26, line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 23, as shown on the electrical drawings. However, whenever a direct connection to Division 23 equipment is shown, electrical contractor shall provide final connection.
- C Power and control wiring for equipment rated at less than 115 volts, and for all relays, actuators, including motorized dampers, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aquastats, freezestats, line and low voltage thermostats, thermals, remote selector switches, remote push-button stations, emergency break-glass stations, and interlocking devices, shall be provided by the contractor or subcontractor furnishing the equipment or control item. Power wiring of disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.
- D All wiring required for power, controls and instrumentation for Division 23 systems, not indicated on the electrical drawings, shall be furnished and installed by Division 23.
- E Additional power wiring required for HVAC equipment over and above what the electrical drawings show shall be provided by the HVAC contractor.
- F 120 Volts, 60 Hz power supply for Division 23 control functions, if not shown on electrical drawings being directly provided, or provided in adjacent junction box by Division 26, shall be provided under Division 23 utilizing spare circuit breakers in branch circuit panelboard with type of power compatible with the control function. Use standby emergency power panelboards for control of HVAC equipment on standby emergency power; use legal emergency power for HVAC smoke control functions; use normal power panelboards for control of HVAC equipment on normal power system.

END OF SECTION 26 01 20

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SECTION 26 01 34 – ELECTRICAL CONNECTIONS

PART 1 GENERAL

1.1 GENERAL

- A Refer to Section 260120 and electrical drawings for electrical connections to Divisions 21, 22, and 23 equipment.
- B Power connections to equipment that is not part of Divisions 21, 22 and 23 shall be provided under Division 26.
- C Equipment Connections.
- D Control Wiring: Control wiring for equipment not provided under Division 26 – Electrical, unless specifically called for on the electrical drawings will be provided by the respective equipment contractor. Refer to Section 260120 for HVAC contract control wiring.

PART 2 PRODUCTS

2.1 DISCONNECT SWITCHES

- A Disconnect switches for single phase motors through 1/2 horsepower shall be 20-ampere AC rated toggle switches. Disconnect switches for single phase motors larger than 1/2 horsepower shall be knife-type safety switches.
- B Disconnect switches for 3-phase motors and heating loads shall be fused knife type safety switches, as specified in Section 262816. Disconnect switches for motors shall be horsepower rated to match or exceed the rating of motor, whenever such rating is available - otherwise shall be as required by equipment.

PART 3 EXECUTION

3.1 RACEWAY CONNECTIONS

- A Equipment connections shall be made through raceway as previously specified except that connections to motor and appliances shall be through flexible metal conduit with grounding conductor, as applicable. Use liquid tight flexible metallic conduit for connections exposed to the weather. Flexible conduit connections shall be as specified in Sections 26 05 31 and 26 51 00. Do not use liquid tight flexible metallic conduit within air plenums.

3.2 COORDINATION

- A It shall be the responsibility of the Electrical Contractor to verify adequacy of supply wiring, overcurrent protection, proper voltage, phase rotation, maximum temperature rating of branch circuit conductor, and final location of the equipment provided by the Owner and under other sections of these specifications prior to the running of any conduit or wiring. Report to the Architect/Engineer any discrepancy or mismatch between equipment being connected and incoming branch circuit or feeder.

END OF SECTION 26 01 34

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SECTION 26 01 40 – NOISE AND VIBRATION CONTROL FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this section.

1.2 WORK INCLUDED:

- A Vibration Isolation
- B Sealing Around Penetrations through Walls and Slabs
- C Sealant
- D Installation of flexible conduit between non-isolated construction and isolated construction, including mechanical equipment, fans, pumps, and bridging between isolated room-within-a-room and non-isolated adjacent construction.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

- A Consult all other Sections to determine the extent of work specified elsewhere but related to this Section. This work shall be properly coordinated to produce an installation satisfactory to the Owner.
 - 1. Installation of Transformers
 - 2. Electric Service Distribution
 - 3. Concrete Housekeeping Pads

1.4 DEFINITIONS:

- A The term "or as approved" means the contractor may propose an alternate product, but the Architect's consultant, Acentech, Inc. shall be sole judge of acceptability of alternate products. The term "Contractor" as used in this Section refers to that contractor directly responsible for the supply and installation of the Electrical Systems, including noise and vibration control.

1.5 CONTRACTOR'S RESPONSIBILITY:

- A The Electrical Contractor shall be directly responsible for the supply and installation of noise and vibration control equipment and work for the Electrical Systems.
- B The Contractor shall be responsible for providing a complete and suitable installation of isolation equipment to meet the intent of this specification. The Contractor, even if not specifically mentioned herein or on the drawings, shall supply any additional equipment needed to meet the intent of this specification, without claim for additional payment.
- C Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.

1.6 MANUFACTURER'S RESPONSIBILITIES:

- A Manufacturer of vibration isolation equipment shall have the following responsibilities:
 - 1. Determine vibration isolation for all equipment and systems in accordance with all codes and authorities having jurisdiction on this project.
 - 2. Provide equipment isolation systems as scheduled or specified.
 - 3. Guarantee specified isolation system deflection.
 - 4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
 - 5. The vibration isolation systems shall be guaranteed to have deflection as specified. The mounting manufacturer shall determine mounting sizes, and the sizes shall be installed in accordance with the manufacturer's instructions.

6. The vibration isolator vendor shall ensure that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators. Where additional support structure is required, vibration isolator vendor shall provide this.

1.7 APPROVED MANUFACTURERS:

- A A single manufacturer who has supplied isolation equipment for at least five years shall furnish all noise and vibration control apparatus. The vendor shall design and provide all hangers, isolators, bases, pads, sleeves and other devices specified, required, or detailed for the vibration isolation of all electrical equipment and conduit. The vendor for vibration control equipment shall be one of the following, or as approved:

1. Mason Industries Inc.
2. Amber-Booth
3. Kinetics Noise Control

1.8 SHOP DRAWINGS:

- A The contractor shall submit fully coordinated shop drawings for all vibration and noise control equipment for review. These submittals shall state the performance of the noise and vibration control products to be provided, such as, but not limited to, the following: vibration isolator model or type, size and static deflection; isolator location shown on an outline of the isolated equipment; installation details; locations of isolated conduit hangers on conduit layout plans; materials and details for penetrations, including penetrations by groups of conduits, and locations of acoustically sealed pull boxes.

1.9 DESCRIPTION OF SYSTEMS:

A VIBRATION ISOLATION:

1. Vibration isolators shall be installed to attenuate the vibration transfer from equipment such as transformers to reduce vibration.
2. Flexible connections shall also be supplied for conduit and wiring serving electrical equipment on vibration isolators to ensure complete isolation of such equipment.

B TRANSFORMERS:

1. Transformers shall be located approximately where shown on the drawings.

PART 2 PRODUCTS

2.1 MATERIALS:

- A FOAM ROD: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

B NON-HARDENING SEALANT:

1. Sealant for electrical penetrations shall be non-hardening polysulphide type.
2. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise sensitive walls that are also fire rated.

C EQUIPMENT:

1. All equipment provided for vibration isolation shall be new and manufactured specifically for the purpose intended.

D VIBRATION ISOLATORS:

1. The static deflection of isolators shall be as given in the equipment schedule and specified below.
2. Vibration isolator sizes and layout shall be determined by the vibration isolator supplier to meet performance criteria below. Static deflections specified shall be met with equipment fully operational.

E ISOLATOR TYPE WP:

1. Type WP (Waffle Pads) shall be minimum 5/16 inch thick neoprene pads ribbed or waffled on both sides.

2. The pads shall be selected for 15% strain. Neoprene shall be bridge-bearing quality with a maximum durometer of 50. Where required to meet this strain criterion, steel load-spreading plates shall be incorporated between the equipment and the neoprene pad. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
 3. (Type WP: Mason Industries Type W, Super W, or as approved.)
- F ISOLATOR TYPE MWP:
1. Type MWP (Metal and Waffle Sandwich Pads) shall consist of two 5/16 inch thick ribbed or waffle neoprene pads sandwiching a 16 ga stainless steel plate. The pad shall be designed for 15% strain. Neoprene shall be bridge-bearing quality with a maximum durometer of 50. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.
 2. (Type MWP: Mason Industries Type WSW or as approved.)
- G ISOLATOR TYPE NIS:
1. Type NIS isolators shall be designed with a neoprene element to provide isolation in tension, shear or compression. Neoprene shall be bridge bearing quality with a maximum durometer of 30.
 2. (Type NIS: Mason Industries Type RBA or as approved.)
- H ISOLATOR TYPE DDNM:
1. Type DDNM (Double Deflection Neoprene Mounts) shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed, and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment. The strain on the neoprene shall not exceed 15%. Neoprene shall be bridge bearing quality with a maximum durometer of 50. DDNM mounts shall be selected for a static deflection of 0.25 inches unless otherwise specified.
 2. (Type DDNM: Mason Industries Type ND or as approved.)
- I ISOLATOR TYPE DDNH:
1. Type DDNH (Double Deflection Neoprene Hangers) shall consist of a molded neoprene element in a steel hanger box. A neoprene sleeve shall be located where the lower hanger rod passes through the steel box supporting the isolator, such that the hanger rod cannot contact the steel hanger body. The diameter of the clear hole in the mounting box shall be at least 3/4 inch larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed, the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.
 2. Unless otherwise specified, the static deflection of DDNH hangers shall be 0.25 inches with a strain not exceeding 15%. Neoprene shall be bridge-bearing quality with a maximum durometer of 50.
 3. (Type DDNH: Mason Industries Type HD or as approved.)
- J ISOLATOR TYPE SPNM:
1. Type SPNM (Spring and Neoprene Mounts) shall be free standing and laterally stable without any housing. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall be not less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.
 2. Unless otherwise specified, the minimum static deflection of SPNM isolators for equipment mounted on grade slabs shall be 1 inch, and the minimum static deflection for equipment mounted above grade level shall be 2 inches.
 3. Two Type WP isolation pads sandwiching a 16 ga stainless or galvanized steel separator plate shall be bonded to the isolator base plate.
 4. Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If the base plates are bolted to the structure, a neoprene vibration isolation

washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.

5. (Type SPNM: Mason Industries Type SLFSW or as approved.)

K ISOLATOR TYPE SPNH:

1. Type SPNH (Spring and Neoprene Hangers) shall consist of a steel spring in series with a neoprene element. The spring shall have a minimum additional travel to solid equal to 50% of the specified deflection. The neoprene element shall have a static deflection of not less than 0.3 inches with a strain not exceeding 15%. Neoprene shall be bridge-bearing quality with a maximum durometer of 50.
2. Unless otherwise specified, the static deflection of SPNH hangers shall be 2 inches.
3. Spring diameter and hanger box hole size shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be inserted in the steel hanger box where the lower hanger rod passes through it, such that the hanger rod cannot contact the steel hanger body. The diameter of the clear hole in the mounting box shall be at least 3/4 inch larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without compromising a minimum clearance of 1 inch.
4. (Type SPNH: Mason Industries Type 30N or as approved.)

L NEOPRENE MOUNTING SLEEVES:

1. Neoprene mounting sleeves for hold-down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.

PART 3 EXECUTION

3.1 GENERAL:

- A Ballasts, relays, dimmers, equipment controls and all transformers shall be located as shown on the drawings. If not shown, location is subject to review by architect and acoustical consultant prior to installation. Under no circumstances shall such devices be located within noise critical spaces or on walls, slabs or ceilings that are common to such spaces.

3.2 TRANSFORMERS:

- A All transformers shall be installed on Type DDNM or DDNH isolators. Wiring connections to a transformer supported on Type DDNM or Type DDNH isolators shall be made with a slack U-shaped flexible conduit or as otherwise approved.
- B Transformers shall not be hung from or supported on other equipment, pipes or ductwork installed on vibration isolators, but shall be supported on or suspended from building structure.

3.3 MOTORS AND ELECTRICAL EQUIPMENT:

- A All wiring connections to motors and electrical equipment supported on Type SPNM or Type SPNH isolators shall be made with a slack U-shaped section of flexible conduit. Wiring connections to motors and electrical equipment supported on Type DDNM and or Type DDNH isolators shall be made with a slack U-shaped flexible conduit. Flexible conduit and cable shall be capable of and recommended for such curvature.

3.4 ELECTRICAL EQUIPMENT ENCLOSURES:

- A Electrical equipment enclosures containing relays, contactors, small transformers or choke coils shall be mounted on Type NIS isolators. Wiring conduits to this equipment require no resilient connections or special isolation.

3.5 PENETRATIONS OF WALLS AND SLABS:

- A All conduit, cable tray and cable penetrations through electrical or mechanical room walls containing transformers shall be sleeved, packed and caulked airtight.

- B Where conduit crosses a building expansion joint or acoustic joint, an 18" length of flexible conduit shall be used to bridge between the two constructions. Rigid conduit shall not be acceptable.

3.6 FIELD QUALITY:

- A Contractor shall work in accord with best trade practices, shall fabricate and install all items in accordance with manufacturer's recommendations and Architect's directions, and shall consult and coordinate with trades doing adjoining work in order to provide an installation of first class quality.

3.7 TESTING AND ADJUSTMENT:

- A Contractor shall test and adjust noise and vibration control products and installations to achieve specified performance.

3.8 SITE ACCESS:

- A During installation of equipment, Contractor shall arrange for access as necessary for inspection of isolation and noise control equipment by Architect.

3.9 INSPECTION:

- A Upon completing installation and adjustment for suitable operation of all work specified under this section, the Contractor shall notify in writing the Architect, who will schedule for conformance. The letter shall certify that all work specified under this section is complete, operational and adjusted in every respect, and that all work is ready for the completion checkout. Defective equipment and installation shall be repaired at the cost of the Contractor, and another inspection shall be scheduled.
- B For each inspection, workmen shall be furnished to perform such functions as are necessary for inspection of the equipment.

3.10 COMMISSIONING:

- A This contractor, and the manufacturer of the equipment and materials specified in this section, shall provide the labor, materials, equipment, services and support required by the project commissioning agent to accomplish the successful commissioning of the equipment and systems specified here.

END OF SECTION 26 01 40

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SECTION 26 05 19 – BUILDING WIRE AND CABLE

PART 1 GENERAL

1.1 SCOPE OF WORK:

- A Requirements of Section 260100 shall apply.
- B This Section applies to secondary power and signaling conductors for systems rated 600 volts and below.
- C A complete system of conductors shall be installed in the raceway systems as specified here and shown on drawings.

1.2 APPLICABLE SPECIFICATIONS AND STANDARDS:

- A Compliance: The materials specified here shall meet the following specifications and standards in their current edition.
- B UL Standards:
 - 1. Insulation tape
 - 2. Wire Connectors and Soldering lugs
- C NEMA Standards:
 - 1. Thermoplastic - Insulated WC 5 (IPCEA S-61-402)
- D General:
 - 1. All wire and cable shall be listed by an "approved" third party testing agency.
 - 2. Prior to energizing; feeders, sub-feeders and service conductor cables shall be tested for electrical continuity and short circuits. A copy of these tests shall be sent to the A/E prior to energizing cables.
 - 3. All wire and cable shall be run in raceway, unless otherwise specifically noted.
 - 4. Minimum full size individual neutral wire shall be provided for each single phase, branch circuit requiring a neutral – no sharing of neutrals between branch circuits.

PART 2 PRODUCTS

2.1 CONDUCTORS:

- A All conductors shall be made of copper, except as otherwise noted. All wire shall be new, manufactured within 6 months of project award. If requested, contractor shall provide manufacturer's certification giving date of manufacture. Aluminum conductors shall not be installed. Each conductor shall bear easily readable markings along entire length, indicating size and insulation type.
- B Conductor insulation shall be as follows:
 - 1. Insulation on service and feeder conductor shall be 600 volt type XHHW or THHN/THWN.
 - 2. Branch circuit conductors shall be minimum #12 AWG, with 600 volt THHN/THWN insulation. Circuit wires carried through rows of fluorescent fixtures shall be at least Type RHHW or THHN.
 - 3. Conductors in any location subject to abnormal temperature shall be furnished with an insulation type suitable for temperature encountered as designated by the NEC.
- C Conductors, unless otherwise noted, shall be heat and moisture resistant grade, thermoplastic insulated. Conductors No. 8 AWG and larger shall be stranded Class B copper conductors, dual rated, Type THHN-THWN or XHHW. Conductors No. 10 and smaller shall be solid copper, Type THHN-THWN (dual rated), or XHHN, except otherwise required below. Branch circuit conductors for all other lighting fixtures shall have a temperature rating of not less than what is required by the UL listing of the fixture with a minimum rating of 90 degrees C.
- D Except as otherwise noted (and approved by the State Construction Office in advance) on technical specification sections, conductors for signal and control circuits above 50 volts AC shall be stranded type, THWN-THHN as permitted by NEC, No. 14 AWG. Conductors for signal and control circuits below 50 volts AC or DC may be 300-volt, PVC insulated, stranded

No. 14 AWG, except as otherwise noted on corresponding technical section of this specification.

- E Branch circuit conductors shall be not smaller than No. 12 AWG, except as noted here or on the drawings. Conductors for branch circuits whose length from panel to the first outlet in the circuit exceeds 50 feet for the 280/120 volt system shall not be smaller than No. 10 AWG, but not smaller than what is scheduled on panelboard schedule. Conductors for branch circuits whose length from the panel to the first outlet box in the circuit exceeds 125 feet for the 480/277 volt system shall not be smaller than No. 10 AWG, but not smaller than what is scheduled on panelboard schedule. Oversized conductors feeding multi-outlet assemblies may be reduced, at the outlet box used to feed the multi-outlet assembly, to a size conductor rated to match the circuit breaker ahead of the circuit, if the use of the larger conductors will exceed the wiring capacity of the assemblies. Where branch circuit conductor are increased to No.10, the grounding conductor shall also be increased to No.10 to comply with NEC 250.122.
- F Insulated grounding conductors exposed in spaces used for air return shall be listed for the application.
- G Conductors being connected to transformers and other equipment shall have a temperature rating as required by the transformer or equipment manufacturer.
- H Fire alarm and control wiring shall have stranded copper conductors.
- I Full size neutral conductor shall be provided for each service panel and sub-panel.
- J Maximum conductor size allowed shall be 500 KCMIL.
- K All wiring lugs including, but not limited to, breakers, panelboard / switchboard lugs, safety switch lugs, and transformers lugs, shall be rated for use with 75°C conductors.

2.2 METAL CLAD CABLE:

- A Metal clad cable Type MC is permitted.

2.3 COLOR CODING:

- A Conductors, feeders, and branch circuits shall be color coded by phases as follows:
 - 1. 480/277 volts systems: Phase A-Brown; Phase B-Orange; Phase C-Yellow; Neutral-Natural Gray; Grounding Wire-Green.
 - 2. 208/120 volts systems: Phase A-Black; Phase B-Red; Phase C-Blue; Neutral-White; Grounding Wire-Green.
 - 3. Insulating tape of proper color shall be used to identify the phase conductors No. 4 AWG and larger conductors. Conductors #6 AWG and smaller shall be factory color coded.
- B Provide color coding diagram on each piece of power distribution equipment as required by NEC.
- C Unless noted or accepted otherwise, busses in panels and switchgear shall be considered "A", "B", and "C" from left to right, top to bottom, or front to back when facing equipment.
- D Control wiring shall not use black, red, or blue; but shall use white for neutrals and green for grounding. Any other colors may be used but the coding shall provide same color between any two terminals being joined.
- E Switch legs, including "travelers" in 3-way and 4-way switching systems, shall be same color as phase leg.
- F Conductors shall be labeled within all junction boxes, etc. using plastic "punch" tape, identifying the conductors according to circuit numbers.
- G Wires within panel boards, terminal cabinets, and similar equipment shall be neatly squared and "bunched" together and held with plastic ties.

PART 3 EXECUTION

3.1 SPLICES:

- A Solid Conductor Splices:
 - 1. Solid conductors namely those sized #10, #12, and #14 AWG copper, shall be spliced by twisting securely and by means of Ideal 'wing nuts', 3M Company's 'Scotchlok' or twist on wire connectors in junction boxes and light fixtures.

2. "Sta-Kon" or other permanent type crimp connectors shall not be used.
- B. Stranded Conductor Splices:
 3. Namely #6 AWG and larger, shall be spliced by approved mechanical pressure type connectors or lugs plus gum rubber tape or friction tape. Solderless mechanical connectors, for splices and taps provided with U.L. approval insulating covers, may be used instead of mechanical connectors plus tape. Circuit joints shall not be made with terminal screws of wiring devices.

3.2 SPLICES IN WET LOCATIONS

- A Splices in wet locations like within manholes, handholes or outdoor junction boxes shall be made as specified above except that splice shall be insulated utilizing UL listed insulation kit suitable for wet locations. Submit proposed kit information along with manufacturer's installation requirements for approval by A/E.

3.3 INSTALLATION OF CONDUCTORS:

- A Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes, troughs and gutters. Pull boxes may be utilized where required. If other than long radius bends are required, pull boxes sized in accordance with the NEC shall be used. Location of feeder pull boxes shall be subject to approval by A/E and shall be included with installation drawing submittal specified under Section 260100 - General Provisions - Electrical.
- B Conductors in vertical runs shall be supported as required by NEC utilizing listed and approved support fittings.
- C Conductors shall be labeled within all junction boxes, etc. using plastic "punch" tape identifying the conductors according to circuit numbers.
- D Where connected under screw or bolt heads, stranded wire shall be fitted with a lug of proper size. Make solid conductor loops clockwise so as to be forced closed as screw is tightened. Only one solid wire loop may be held under a single screw.
- E Make all connections tight. Torque-tighten all connections to lugs per manufacturers' and UL requirements.
- F Wires within panel boards, terminal cabinets and similar equipment shall be neatly squared and "bunched" together and held with plastic ties.
- G Where "paralleling of conductors" is shown for feeders or service entrance, it is required they be exactly the same length between points of bonding together.
- H Provide a dedicated, separate neutral conductor for each circuit requiring a neutral. The neutral carrying all or any part of the current of any specific load or run shall be contained in the same raceway or enclosure with the phase wire or wires also carrying that current. No split neutrals permitted. For lighting, motor, appliance, circuits and receptacle circuits where two or more circuits are run in the same conduit, provide a separate neutral for each circuit.
- I The engineer shall evaluate the need for dedicated neutrals (one dedicated neutral per phase) in each project.
- J Do not run more than 3 single-phase, 277 or 120 volts, branch circuits, each with separate neutral, in the same conduit. All other circuit shall be run in separate conduits. Do not run more than one 3 single-phase 208, 240 or 480 volts branch circuits in same conduit. Do not run more than one 3-phase circuit in same conduit. Each feeder, regardless of configuration shall be run in its own, not shared, conduit. Provide grouping of circuits as required by NEC.
- K Circuit shall be connected to panels as shown on the drawings.
- L Under the above requirements and with required color coding system, no feeder or branch circuit raceway will contain more than one wire of the same color, except for switch legs and control circuits. The only exception is as otherwise noted for 208, 240 or 480 volts, single phase branch circuits.
- M Insulation on conductors #6 AWG and smaller shall be suitable colored in manufacturing.
- N Where no indication is made of wire size, the conductor shall be sized per NEC requirements to match its overcurrent protective device, but in no case smaller than #12 AWG.

- O Unless noted otherwise, or another arrangement is approved by the Engineer, busses in panels and switchgear shall be considered "A", "B", and "C" from left to right, top to bottom, or front to back when facing equipment.
- P Control and signal wiring shall not use the above named colors except green for grounding. Any other colors or striping may be used but the coding shall provide same color or striping between any two terminals being jointed.
- Q Travelers in switching circuits shall be of same color as phase conductors serving the circuits.
- R Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of 3" of concrete on all sides. Encased raceways shall have a minimum cover of 18", except for raceways containing circuits with voltages above 600 volts, which shall have a minimum cover of 30".
- S Although not prohibited by the NEC, conductors serving two separate power systems (i.e. 120/208 V and 277/480 V) shall not be mixed in the same raceway, pull box, or junction box. Exception is where control wiring is a different voltage than the power.
- T Outlets in the same general area shall be circuited together.
- U Conductors feeding lighting outlets shall not be combined in the same raceway with conduit serving convenience receptacles. Lighting outlets and convenience receptacles shall not be connected on the same circuit unless specifically intended.

3.4 CONDUCTOR SEQUENCE AND ROTATION:

- A All feeders, sub-feeds to panels, motors, etc., shall be completely phased out as to sequence and rotation. Phase sequence shall be A-B-C from front to rear, top to bottom, left to right when facing equipment.

3.5 CONNECTION OF OVERSIZED CONDUCTORS TO CIRCUIT BREAKERS AND SWITCHES:

- A When oversized branch circuit conductors are scheduled to be connected to circuit breakers, or switches, not having the capability to accept the larger conductor, provide splice in suitable junction box as close as possible to circuit breaker, but not further than 10 feet from circuit breaker, equipment or device being connected, as approved by the A/E, and connect to circuit breaker with the largest conductor that fit the circuit breaker.
- B For similar situations for feeder, or large branch circuits, (circuit breakers rated 125 amperes and larger) provide lugs as required by feeder conductors.

END OF SECTION 26 05 19

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 GENERAL

1.1 SUMMARY

- A Section Includes:
 - 1. Category 5e balanced twisted pair cable.
 - 2. Balanced twisted pair cabling hardware.
 - 3. Control cabling.
 - 4. Control-circuit conductors.

1.2 ACTION SUBMITTALS

- A Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A Source quality-control reports.
- B Field quality-control reports.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inch or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.2 CATEGORY 5E BALANCED TWISTED PAIR CABLE

- A Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.
- B Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.
- C Conductors: 100 ohm, No. 24 AWG solid copper.
- D Shielding/Screening: Shielded twisted pairs (FTP).
- E Cable Rating: Plenum.
- F Jacket: Orange thermoplastic.

2.3 BALANCED TWISTED PAIR CABLE HARDWARE

- A Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
- B General Requirements for Balanced Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 5e.
 - 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 same manufacturer as balanced twisted pair cable, from single source.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Jacks per Field: One for each four-pair cable indicated.
- D Patch Cords: Factory-made, four-pair cables in 36 inch lengths; terminated with an eight-position modular plug at each end.
 1. Patch cords must have color-coded boots for circuit identification.
- E 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.
 3. Marked to indicate transmission performance.
- F Jacks and Jack Assemblies:
 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.
 2. Designed to snap-in to a patch panel or faceplate.
 3. Standards.
 - a. Category 5e, shielded balanced twisted pair cable must comply with IEC 60603-7-3.
 4. Marked to indicate transmission performance.
 5. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
 6. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
- G Legend:
 1. Machine printed, in the field, using adhesive-tape label.
 2. Snap-in, clear-label covers and machine-printed paper inserts.

2.4 TWIN-AXIAL DATA HIGHWAY CABLE

- A Plenum-Rated Cable: NFPA 70, Type CMP.
 1. Paired, No. 20 AWG, stranded (7x28) tinned-copper conductors.
 2. Plastic insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. Plastic jacket.
 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
 6. Flame Resistance: Comply with NFPA 262.

2.5 CONTROL CABLE

- A Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 1. Twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
 2. PVC insulation.
 3. Unshielded.
 4. PVC jacket.
 5. Flame Resistance: Comply with NFPA 262.

2.6 CONTROL-CIRCUIT CONDUCTORS

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

PART 3 EXECUTION

3.1 EXAMINATION

A Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A Comply with requirements in Section 260537 "Sleeves and Penetrations" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes must be no smaller than 4 inch square by 2-1/8 inch deep with extension ring sized to bring edge of ring to within 1/8 inch 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.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A Comply with NECA 1.

B General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. 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.
6. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. 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.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lay on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. 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.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260537 "Sleeves and Penetrations."

3.4 CONTROL-CIRCUIT CONDUCTORS

A Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.

- 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
- 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.5 FIRESTOPPING

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

3.6 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 Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

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

3.8 FIELD QUALITY CONTROL

- A Tests and Inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- B End-to-end cabling will be considered defective if it does not pass tests and inspections.
- C Prepare test and inspection reports.

END OF SECTION 26 05 23

SECTION 26 05 26 – GROUNDING AND BONDING SYSTEM

PART 1 GENERAL

1.1 SCOPE:

- A Grounding and bonding of the electrical power system.

1.2 GENERAL:

- A The power distribution system shall be grounded at each voltage level. The conduit and neutral conductors of the wiring systems and all electrical equipment shall be grounded. The ground connection of the electrical system neutral and conduit system shall be made at the main service switchboard or main power device.
- B Each conductive, non-current carrying, part of the electrical system shall be bonded to an equipment grounding conductor sized in accordance with NEC.
- C The raceway system shall not be relied on as the sole grounding path for ground continuity. A green grounding conductor, properly sized per NEC Table 250-122, shall be run in all raceways (except telecommunications, data, and audio systems and low voltage raceways for fire alarm systems) to ground each conductive, non-current carrying part of the electrical power system. This conductor shall be bonded to each metallic conduit, box and cabinet that is part of the related power system raceway.
- D Secondary transformers shall be grounded to the main water pipe, effectively grounded structural steel or other suitable grounding electrode per NEC. See details on drawings.
- E The electrical service shall be grounded in accordance with Article 250 of NEC as follows:
 - 1. To the main metallic water main pipe, as per NEC Article 250-52
 - 2. To the steel frame of the building, if any.
 - 3. To the foundation re-bar system
 - 4. To the supplementary grounding electrode system specified in the "Early Site Package"
- F A copper ground conductor sized in accordance with the NEC shall be extended in appropriate raceway from the main service equipment and bonded to form the grounding electrode system required by Article 250-50 of the NEC. Connection to the water pipe shall be made by suitable ground clamp or by lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the supply side of the flange connection. Electrical bond shall be established around the water meter. A stamped metal tap with the inscription "Do not Disconnect" shall be provided at the connection to the water pipe.

1.3 GROUND RESISTANCE TESTS:

- A Resistance to ground of grounding system shall be determined through ground resistance tests. The tests shall provide a true overall measurement of the resistance to ground, and of the entire physical integrity of the system.
- B Ground resistance tests shall be made in dry weather and in no case less than 48 hours after rainfall. Tests shall be conducted using the ratio method which measures the ratio of the resistance to earth on an auxiliary electrode. All measurements shall be in accordance with the Institute of Electrical and Electronic Engineers, Inc., Publication No. 550, dated May 1949, "Master Test Code for Resistance Measurement", Paragraph 3.43 - ratio ohmmeter and as herein specified.
- C The indicating instrument shall be self-contained and shall include a direct current generator, synchronized current and potential reverse, cross current and potential coils, direct reading ohmmeter, series resistors, and range selector switch. The direct reading ohmmeter shall be calibrated for ranges of 0 to 20 and 0 to 200 OHMS on a scale logarithmic in character.
- D Associated Research, Inc. Vibroground instrument is acceptable.
- E Performance Criteria: Resistance to ground shall not exceed 25 OHMS at any point of the system as measured in accordance with the requirements of this specification and including connection to main water pipe and bonding to structural steel, if any, and to rebar system. Where tests show resistance to ground is over 25 ohms, appropriate action should be taken to

reduce the resistance to 25 ohms, or less, by driving additional ground rods. (The compliance should be demonstrated by retesting.)

F Record of Ground Resistance Tests:

1. A certified record of ground resistance tests on the entire system shall be prepared and submitted for compliance to the Architect/Engineer and to the Owner upon completion of the tests.
2. The record shall be prepared and submitted for compliance to the Architect/Engineer and to the Owner upon completion of the tests. The grounding resistance test shall be performed by an independent testing company, engaged by the contractor, with not less than five years of experience in this type of work. The name of the testing company, along with its credentials shall be submitted to the Owner's representative with the contract bid. The test shall include the system connected to the main water pipe, structural steel, the rebar system and bonded to the lightning protection system.
 - a. Determination for the need of a lightning risk assessment shall be evaluate in consultation together with the State Construction Office (SCO). The lightning risk assessment may be performed in accordance with the Simple or Detailed Risk Methods of NFPA 780 Standard for the Installation of Lightning Protection Systems or an alternative evaluation approved by the SCO.
 - b. Building surge protection system shall be Underwriter's Laboratories certified in accordance with UL-96A requirements. (See latest edition of NFPA 780 Lightning Protection Code). Lightning protection system UL Master Certification shall specifically state that building surge protection devices are include and not omitted from amongst the evaluated devices and components. The surge protection at the service entrance shall be rated for "Lightning Surges" based on the risk assessment.

PART 2 PRODUCTS

2.1 GENERAL:

- A All products shall be new and listed for the use intended.
- B Equipment grounding conductors, for other than supplementary grounding system or within spaces used as air plenums, shall have 600 volt insulation and shall be as specified in Section 260519. Use stranded bare copper cables for exposed grounding conductors within spaces used as air plenums.
- C Grounding conductors, where insulated, shall be colored solid green. Conductors intended as neutral shall be colored solid white on 120/208V circuits and natural gray on 277/480V circuits. Supplementary grounding field conductors shall be #1/0 AWG, bare stranded tinned copper conductors.
- D Clamps for attachment of grounding conductors to water pipes, etc. shall be of bronze or brass, with conduit hub with insulated bonding bushings and compression type lugs.
- E Ground rods shall be copper-clad steel rods not less than 3/4 inch in diameter and not less than 10 feet long. The rods shall be rolled to a commercially round shape from welded copper clad steel manufactured by the electro-forming process and shall have a hard, clean, and smooth continuous copper surface. Ground rods shall be sectional type with cone shape point and shall be die stamped near top with the name or trademark of the manufacturer and the length of the rod in feet.
- F All systems and equipment shall be grounded in accordance with NEC Article 250.
- G All grounding conductors shall be contained within a raceway, unless specifically noted otherwise.
- H The raceway system shall not be relied on for ground continuity. A green grounding conductor, properly sized per the NEC shall be run in ALL raceways less than 600 volts except for telecommunications, and data raceways.
- I All systems above 600 volts shall have grounding systems.
- J Where required by NEC Article 250, provide "made" grounding electrodes to supplement the above. Bond together all available and made electrodes.

- K Service ground clamps shall be attached to cold water mains at an accessible point and before its size is reduced. Clamp shall be accessible after construction is complete. Grounding conductor shall be without splice into the service enclosure where it shall be connected to main service ground buss, and interconnected with system neutral.

2.2 MASTER GROUND BUS:

- A Provide a master ground bus as indicated on drawings with all incoming and outgoing grounding conductors connected to the bar.

PART 3 EXECUTION

3.1 INSTALLATION AND WORKMANSHIP:

- A Installation of Grounding Rods: Grounding rods shall be installed with top of rod not less than 24 inches below grade, unless otherwise noted.
- B Installation exterior Grounding System Conductors: Rod connecting grounding conductors shall be installed underground and under slab 24 inches below grade. Cables shall be installed in a straight and neat manner. The contractor shall protect the installed conductors against physical damage by means of temporary conduit, or other suitable means, until the entire installation is accomplished.
- C Conductors inside building shall be installed above non-air plenum ceilings at accessible locations, preferably mounted on walls. Conductors penetrating walls or floors shall be provided with sleeves. Support conductors at intervals not exceeding 6 feet.
- D Installation of Connectors: Connectors shall be installed in strict accordance with manufacturer's instructions.
- E Any feeder raceway anywhere in the system which enters a box or cabinet through part of a concentric knock-out shall be fitted with a bonding bushing and jumper. The jumper shall be sized by NEC Table 250-94 and be lugged to the box.
- F Boxes with concentric, eccentric or oversized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC Table 250-66 and lugged to the box.
- G Ground Resistance Tests: Refer to Part 1 of this specification.
- H Bonding shall be done with insulated bonding bushings and lugs.

3.2 PAD MOUNT TRANSFORMERS, VAULTS, MANHOLES, MV SWITCHES

- A Pad mounted transformers and medium voltage switches shall be connected to ground rods with copper grounding conductors. Ground rod clamps shall be accessible after construction is complete. Grounding conductors shall be continuous without a splice.
- B Each manhole, hand hole and underground vault shall have a ground rod(s) installed in bottom. Ground rod and copper grounding conductor shall bond all metallic parts inside manhole, hand hole and vault. Ground rod clamps shall be accessible after construction is complete. Grounding conductors shall be continuous without a splice.
- C Upon completion of installation of the ground rods and bonding system for pad mounted transformers, medium voltage switches, manholes, hand holes and underground vaults, the ground resistance shall be tested with a ground resistance tester. Resistance to ground shall be less than 25 ohms. If test indicates a greater resistance, appropriate measures shall be taken, including driving additional ground rods, to reduce the resistance to less than 25 ohms. Contractor shall send a letter to the engineer and owner certifying that the ground resistance test has been performed and stating the resistance measured at each for pad mounted transformer, medium voltage switch, manhole, hand hole and underground vault.
- D Bushings shall be used wherever metallic conduits stub into transformer cabinets. The bonding jumper shall be sized by NEC Section 250 and lugged to the box.
- E Provide new grounding bushings and grounding conductors on the existing secondary conduits turning up into new pad mounted transformers

3.3 EQUIPMENT GROUNDING, ETC

- A Ground all fixed and portable appliances and equipment connected under the project with a green grounding conductor. This wire shall be carried inside the raceway and flex from equipment to nearest grounding portion of raceway system. Connect at both ends with suitable lugs.
- B Each grounding type receptacle shall be grounded. Grounding may not be through the grounding yoke.
- C Any feeder raceway anywhere in the system which enters a box or cabinet through part of a concentric knockout shall be fitted with a bonding bushing and jumper. The jumper shall be lugged to the box.

3.4 DRY TYPE TRANSFORMER SECONDARY GROUNDING

- A Equipment on the secondary side of transformers shall be considered "service" and be bonded and separately grounded directly to the main service ground bus or electrode. Grounding conductor may be run in feeder raceways back to main service enclosure.
- B In addition, transformer secondaries shall be provided with a local grounding electrode consisting of a clamp on a local 3/4" (minimum) copper cold water pipe or a grounded member. Grounding conductor shall be sized as shown on plans.
- C All grounding system tests shall be fully documented as to time of day, weather condition, ground moisture, "megger" readings, etc. Submit a report in writing to Owner and Engineer.

3.5 BONDING:

- A Bond cable tray system and lightning protection system to satisfy telecom standards and NEC.
- B Bond the above ground portion of the gas piping system that is likely to become energized to comply with NEC 250-104(B) requirements. Use #4 wire or larger.

3.6 BONDING JUMPER:

- A Bonding jumper at service equipment for both equipment and conduit shall be in accordance with NEC Article 250, which for parallel conductors shall be wire or a wire not smaller than 12½% of the cross sectional area of all parallel phase conductors added together.

3.7 COMMISSIONING:

- A This contractor, and the manufacturer of the equipment and materials specified in this section, shall provide the labor, materials, equipment, services and support required by the project commissioning agent to accomplish the successful commissioning of the equipment and systems specified here.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B Related Sections include the following:
 - 1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A EMT: Electrical metallic tubing.
- B IMC: Intermediate metal conduit.
- C RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.
- C Full and proper support shall be provided for all items of electrical equipment, raceways, etc. All materials, whether exposed or concealed, shall be firmly and adequately held in place. Fastening and support shall afford safety factor of three or higher.
- D All fixtures, raceways, and equipment shall be supported from the structure. Nothing may be supported from suspended ceilings or HVAC ducts.
- E Recessed fixtures shall be supported with 10 gauge steel wire or with the same type of wire used to support the lay-in ceiling track if heavier/stronger than 10 gauge steel wire adjusted as necessary to level fixture. Fixture shall be supported at the two opposite ends of the fixture to the building structural frame. Attach one end of the support wire to one corner of the luminaires and the other end to the building's structural system. The lay-in luminaire shall be screwed to the main runners of the lay-in ceiling track at all four corners using sheet metal screws.
- F Recessed ceiling speakers, where specified with an enclosure, shall have the enclosure - supported directly from the structure with a minimum of two 10 gauge wires run perpendicular to the ceiling and not pulling to one side. If recessed ceiling speaker is specified without an enclosure and is mounted in a suspended ceiling, the speaker shall be supported using T-Bar bridges such as Soundolier No. 81-8, or other device specifically designed for such support. In addition, each of the four corners of the ceiling grid block enclosing the speaker shall be supported from the structure using 10 gauge steel wire run perpendicular to the ceiling plane.
- G Other devices using octagonal or 4" square ceiling boxes, such as smoke detectors, dome lights, exit signs, etc., where installed in suspended ceilings shall be attached to the ceiling system using Caddy, or other, hangers specifically designed for such support. In addition, each of the four corners of the grid block enclosing the box shall be supported from the structure using 10 gauge steel wires run perpendicular to the ceiling plane.

1.5 ACTION SUBMITTALS

- A Product Data: For the following:
 - 1. Steel slotted support systems.

- 2. Nonmetallic slotted support systems.
- B Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Equipment supports.
- 1.6 INFORMATIONAL SUBMITTALS
 - A Welding certificates.
- 1.7 QUALITY ASSURANCE
 - A Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - B Comply with NFPA 70.
- 1.8 COORDINATION
 - A Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
 - B Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07.

PART 2 PRODUCTS

- 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
 - A Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - b. Allied Tube & Conduit.
 - c. Cooper B-Line, Inc.
 - d. ERICO International Corporation.
 - e. GS Metals Corp.
 - f. Thomas & Betts Corporation.
 - g. Unistrut; Atkore International.
 - h. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 4. Channel Dimensions: Selected for applicable load criteria.
 - B Raceway and Cable Supports: As described in NECA 1 and NECA 101.
 - C Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
 - D Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical 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 malleable iron.
 - E Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - F Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - d. MKT Fastening, LLC.
 - e. Simpson Strong-Tie Co., Inc.

- G Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - b. Cooper B-Line, Inc.
 - c. Empire Tool and Manufacturing Co., Inc.
 - d. Hilti, Inc.
 - e. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - f. MKT Fastening, LLC.
- 2.
- H Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
- I Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
- J Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
- K Toggle Bolts: All-steel springhead type.
- L Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 EXECUTION

3.1 APPLICATION

- A Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C 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.
- D Spring-steel clamps designed for supporting single conduits without bolts may be used for 1 1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C 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.0
- D 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. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps, as applicable.
 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 by means that meet seismic-restraint strength and anchorage requirements.
- E Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base, or as otherwise noted on drawings.
- B Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03, except that concrete case for engine generator set shall be formed with 4000 psi concrete.
- C Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A Touchup: 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.
- B Touchup: Comply with requirements in Division 09 or as applicable for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 31 - CONDUIT

PART 1 GENERAL

1.1 SCOPE OF WORK:

- A Requirements of Section 260100 shall apply.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

- A Section 260537 - Sleeves and Penetrations
- B Section 260539 - Fire Seals

1.3 UNDERGROUND RACEWAYS:

- A Feeder, power service raceways run under the building, or external to building foundation walls, and telecommunications service shall be encased with a minimum of three (3) inches of concrete on all sides. Branch circuit raceways run underground external to building do not need to be enclosed in concrete. Underground raceways shall comply with the following requirements:
 - 1. Raceways must have a minimum cover of twenty-four (24) inches, except for raceways containing circuits with voltages above 600 volts, which must have a minimum cover of thirty (30) inches and main telecom conduits which require 36" of burial
 - 2. Raceways shall be approved by the NEC as "suitable for concrete encasement" and suitable for direct burial and shall be PVC Schedule 40 or rigid galvanized steel conduit.
 - 3. Steel reinforcing shall be required under roadways and within 10 feet of all manholes and building entrances. The steel reinforcing of the duct bank shall be of a type approved by the NEC as "suitable for direct burial". Minimum raceway size shall be 3/4 inch.
- B Branch circuit raceways run underground external to building foundation walls shall be run in Schedule 40 raceways installed in accordance with the NEC, and shall be of a type approved by the NEC as "suitable for direct burial." Minimum power circuit conduit size shall be 3/4 inch except that for telecom circuits minimum conduit size shall be 1-inch.
- C Raceways run underground internal to building perimeter walls shall be Schedule 40 rigid conduit installed by a method approved by the NEC, except otherwise specifically noted on drawings, or on this section.
- D Where underground raceways are required to turn up into columns, walls, wall outlets, cabinets, equipment, at telecom backboards, or termination points, and into light poles, the elbow required and the stub-up out of the slab or earth shall be of schedule 40 rigid galvanized steel conduit.
- E The raceway system shall not be relied on as the only method for grounding continuity. See Section 260526, Grounding and Bonding, for clarification.

1.4 ABOVE GROUND CONDUIT:

- A Minimum size conduit for interior above-ground power circuit applications shall be 3/4 inch, except as otherwise noted. Minimum size conduit for telecom wiring is 1-inch.
- B Conduit shall be sized in accordance with the latest edition of the NEC unless larger conduit is indicated on drawings.
- C All conduit shall be in rigid metal conduit, 'RMC', except as otherwise noted. Rigid metal conduit shall be used for feeders leaving all freestanding switchboards, switchgears, and all panel feeders. Raceways used in service entrance concrete duct banks shall be PVC Schedule 40, except for the stub-ups which shall be RMC. RMC shall be used for feeder or branch circuits exposed to weather. RMC shall be used in all mechanical rooms. Use RMC anywhere conduit is exposed and subject to damage below 8 feet above finished floor.
- D All exposed conduits for interior to be dryfall painted. Coordinate with Architect for color information.
- E Intermediate metal conduit 'IMC' may be used as a substitute for 'RMC', except for stubups and stab-outs, transitioning from 'RNMC', which shall be 'RMC' only. Electrical metal tubing 'EMT'

may be used for concealed and exposed work in cinder (concrete block) walls, except as otherwise noted below

1. Exposed to the weather, or in damp location
 2. In earth or stone
 3. In concrete slabs
 4. In concrete slab on deck
 5. Where obviously subject to mechanical injury
 6. For exposed conduit in the area between floor and 6'-0" above floor in other than electrical and telecom rooms. Conduit stub-ups from underground shall be rigid steel conduit.
 7. Where specified otherwise
 8. As raceway carrying telephone or telecommunication service to demarcation point
- F Rigid non-metallic conduit (RNMCM) may be used in the following applications only: (All stub-ups and stub-outs shall be 'RMC')
1. Within CMU walls, when totally concealed by wall. In this case transition from RNMCM to above ceiling space, outside of the CMU wall cavity, may be accomplished with an EMT elbow.
 2. In slab on grade encased in 3-inches of concrete all around. In addition the installation must have the approval of the structural engineer.
 3. Encased in poured in place concrete walls and in other structural concrete elements if so allowed by the structural engineer.
- G Flexible metallic conduit shall not be used as a general wiring method, but for final connection to equipment, motors and lighting fixtures. Use flexible 6-foot long metallic conduit "whip" to connect to lighting fixtures.
- H Flexible non-metallic conduit shall not be permitted in this project.
- I The raceway system shall not be relied upon as the only method for grounding continuity. See Section 260526, GROUNDING AND BONDING for clarification.

1.5 APPLICABLE SPECIFICATIONS AND STANDARDS:

- A The materials specified here shall meet the following specifications and standards in their current edition.
1. UL Standards:
 - a. Flexible Metal Conduits-UL-1
 - b. Rigid Metal Conduit UL-6
 - c. Intermediate Metal Conduit UL-1242
 2. NEMA Standards:
 - a. Electric plastic conduit TC-2.
 3. ANSI Standards:
 - a. Specifications for Rigid Steel Conduit, Zinc Coated, ANSI C80.1.

1.6 SUBMITTALS:

- A Submit details, manufacturer's information, diagrams and product data for conduit specified here and associated fittings plus the following items:
1. Conduit expansion joint fittings suitable from the expected expansion and deflection at the joint.
 2. Waterproof conduit fittings for both interior and exterior of conduits.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A Metal raceway system components shall be as manufactured by GE, Kaiser, Republic or T&B. Non-metallic raceway system components, if shown on the drawings shall be manufactured by Carlon, Cantex or Queen City Plastics.

2.2 RIGID METAL CONDUIT:

- A Rigid metal conduit ('RMC') shall be schedule 40, of the best quality steel.
- B The interior and exterior surfaces of the conduit shall be protected with a metallic zinc coating. Rigid steel conduit shall be galvanized by the Hot-Dip process in accordance with ASTM A 123.
- C Fittings for 'RMC' shall be threaded type, UL listed.
- D Electrical Metallic Tubing:
 - 1. Electrical metallic tubing shall be rigid metal conduit of the thin-wall type in straight lengths, elbows or bends for use as raceways for wire or cables in an electrical system.
 - 2. Electrical metallic tubing shall utilize hexagonal steel type compression threadless fittings of plated steel. All compression fittings shall be UL listed for concrete-tight and rain-tight construction. All EMT connector fittings shall be provided with insulated throats. Pot metal, set screw or indented type fittings shall not be utilized. Electric metallic tubing (EMT) may be used for general branch circuits. EMT shall not be installed in any location where exposed and subject to severe physical damage, severe corrosive influence, outdoors, underground, in below slab-on-grade or in earth.
- E Flexible Metallic Conduit:
 - 1. Flexible metallic conduit shall conform to UL standard 'Flexible Steel Conduit'. All steel used in the fabrication of the conduit shall be zinc coated.
 - 2. Liquid-tight flexible steel conduit shall be provided with a protective jacket of polyvinyl chloride extruded over a flexible interlocked galvanized steel core to protect outdoor wiring against moisture, oil, chemicals and corrosive fumes.
- F Rigid Non-Metallic Conduit ("RNMC"):
 - 1. Schedule 40 (EPC-40), heavy wall polyvinyl chloride plastic conduit and fittings, UL listed, suitable for 90 degree C. conductors.
- G Intermediate Metal Conduit:
 - 1. Intermediate metal conduit 'IMC' shall be zinc coated steel, UL listed and labeled.
 - 2. Fittings shall be the same type as for 'RMC.'
- H Wireways and Troughs:
 - 1. Wireways or troughs shall be of the size noted on the drawings or as required by the NEC of code gauge galvanized steel. Sizes 6 inch x 6 inch and smaller wireways and all troughs shall be of the hinged cover type except as otherwise noted on the drawings. Larger sized wireways shall be of the flangeless screw cover lay-in type. All shall be without knockout, and shall be provided with fittings, supports, and appurtenances as required.

2.3 TERMINATIONS:

- A 'RMC' shall terminate with either a double locknut/bushing set, or in a threaded hub.
- B Where concentric, eccentric or oversized knockouts are encountered, a grounding-type insulating bushing shall be provided. These bushings shall also be used wherever conduits stub into switchboards or transformer cabinets. Grounding type insulated bushings shall always be used on both ends of conduits feeding panelboards.
- C Metallic conduit connectors shall be nylon-insulated.
- D Flexible conduit connectors shall have insulated throats and "anti-short" bushings.

2.4 CONDUIT COUPLINGS:

- A Split or "Erickson" coupling shall be OZ Gedney or approved equal.
- B Conduit couplings for GRC and PVC shall be in accordance with the NEC.
- C Flexible conduit couplings shall have UL listed insulated throats.
- D EMT couplings and connectors shall be compression-gland type of malleable steel, galvanized or sherardized. Connectors shall be insulated-throat type. Set screw, indenter, or cast type fittings are not acceptable.

PART 3 EXECUTION

3.1 INSTALLATION OF CONDUIT:

- A Do not run telecommunications station cable in conduit in slab on grade, or below slab on grade, except when there is no other choice, since it will require the use of gel filled cable.
- B See Section 260529 for additional support requirements. Refer to Section 260537 for additional requirements.
- C Metallic raceways shall not be stored exposed to the weather.
- D Conduit shall be securely fastened to all sheet metal enclosures with double galvanized locknuts and insulated bushings, care being observed to see that the full number of threads project through to permit the bushings to be drawn tight against the end of conduit, after which the locknuts shall be made sufficiently tight to ensure positive ground continuity between conduit and box.
- E Conduits shall be concealed within concrete slabs, walls, ceilings, and floors, where possible, under the conditions stated in Part I of this section, and shall be kept at least 6 inches from parallel runs of flues, steam pipes, or hot water pipes. Exposed runs of conduit and conduit run above suspended ceilings, shall have supports spaced not more than 8 feet apart and shall be installed with runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right-angle turns consisting of cast metal fittings or symmetrical bends. All raceways shall be run in a neat and orderly fashion. Conduits run in diagonal or disorganized way shall be removed from the premises if so instructed by the A/E. Bends and offsets shall be avoided where possible, but where necessary shall be made with an approved hickey or conduit bending machine. Conduit which has been crushed or deformed in any way shall not be installed.
- F Conduits installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of ¼ inch using "clamp-backs" or strut.
- G Conduit shall be supported on approved types of galvanized wall brackets, ceiling trapezes, strap hangers, or pipe straps, secured by means of toggle bolts on hollow masonry units, expansion bolts in concrete or brick, machine screws on metal surfaces, and wood screws on wood construction. Nails shall not be used as the means of fastening boxes on conduits. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure conduit supports.
- H Conduits shall be installed in such manner as to insure against trouble from the collection of trapped condensation, and all runs of conduit shall be arranged so as to be devoid of traps where feasible. The contractor shall exercise the necessary precautions to prevent the lodgment of dirt, plaster, or trash in conduit, fittings, and boxes during the course of installation. A run of conduit which has become clogged shall be entirely freed of these accumulations or shall be replaced.
- I The use of "LB's" shall be limited where possible. Where necessary to use "LB's" sized above 2-inch, mogul units shall be installed.
- J Contractor shall provide and properly install sleeves and advise other trades of required chases and openings so that they can be properly built-in. No supports shall be connected to the roof without prior approval of the designated representative.
- K Seal all incoming conduits into the building with sealing fitting as specified in this section.
- L Where conduit passes through a "below grade" wall from a conditioned interior building space, said conduit shall be sealed utilizing fittings similar and equal to OZ/GEDNEY type "FSK" thru-wall fitting with "FSKA" membrane clamp adapter if required, or any other similar UL listed fitting.
- M Use Link-Seal or approved equal method to seal core drilled penetrations through exterior walls, if any are required.
- N Insulated bushings of molded bakelite shall be used on all conduit entrances, one inch over in size, into junction boxes, panel boxes and motors starters having sheet metal enclosures.
- O 'GRC' directly installed underground shall be coated with two coats of bitumastic paint. Conduit installed underground or in concrete on ground shall be made watertight by wrapping the joints with 'Teflon' tape. Do not use Liquid-Tight flexible metallic conduit in air plenums.
- P All PVC conduits, except those installed for services, shall contain green grounding conductor. PVC conduit may be used under slab and underground. No exposed PVC allowed. Fittings for

PVC shall be U.L. listed for the use, and shall be installed per the manufacturer's instructions. Under slab PVC conduit runs shall utilize RMC elbows and RMC up through slab, and transition to EMT or RMC in masonry walls. PVC may be used for underground outdoor branch circuits and under slab branch circuits. Bends in PVC shall be made by methods approved by the manufacturer and the NEC.

- Q All runs exposed and all runs above accessible ceilings shall be neat and square with building structure such as walls and ceiling/roof structures. Multiple parallel runs shall use trapeze supports where possible.
- R Run concealed in finished areas.

3.2 EXPANSION FITTINGS:

- A Provide means to allow for building expansion and seismic building vibration without damage to conduit system where conduits of any type pass over a building expansion joint.

3.3 IDENTIFICATION OF UNDERGROUND SERVICE RACEWAYS:

- A All underground service raceways shall be identified by UNDERGROUND LINE MARKING TAPE located directly above the raceway at 6 to 8 inches below finished grade. Tape shall be permanent, bright-colored, continuous printed, plastic tape compounded for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.

3.4 PULL ROPE:

- A All runs of empty conduit only shall have a 100# nylon pull rope installed in the conduit.

3.5 CONDUIT SEALING:

- A Waterproof interior of each and all conduits, whether filled with cables, or empty, penetrating building from the outside to an interior lower elevation location utilizing O-Z/Gedney type CSB or CMS Series conduit sealing fittings, as applicable to the conduit installation, Tyco Electronics Rayflate water sealing system, or similar listed fitting from any other manufacturer. Submit catalog cuts as part of submittal process. Provide pull box and rigid steel conduit as required to accomplish seal.

3.6 CONDUIT PENETRATION SEALING

- A Seal all conduit penetrations through wall, floor or roof, regardless of whether the wall or floor is rated or not. Conduit penetrations through floor shall be water-tight. Conduit penetrations through wall shall be air-tight. Refer to Sections 260537-Sleeves and Penetrations and 260539-Fire Seals for additional requirements.

3.7 CONDUIT CAPS:

- A Provide threaded caps on any conduit sleeve, or empty conduit. In addition, provide watertight plugs or fittings if conduit or sleeve is exposed to weather or water runoff.

3.8 CONDUIT ON ROOF:

- A Conduit on roof is not allowed as a wiring method unless otherwise specifically noted on the drawings, and for the minimum required to accomplish connection to the HVAC roof mounted equipment. Do not run conduit on roof that will be visible from grade level. Do not run conduit on roof that will present a tripping hazard. Do not run conduit on roof that could have been run within building, or overhead on roof structures. Conduit that must be run on roof will be IMC or RMC supported on UV resistant, waterproof, rubber support blocks, suitable for membrane roof, with galvanized steel channel on top. Minimum installation height from bottom of conduit to roof surface shall be 5-inches. Branch circuit conductors within conduit installed on roof shall be increased in size from what is shown on drawings to comply with NEC Table 310.15(B)(2)(c) derating requirements. Do not use liquid tight flexible metallic conduit except for final connection to equipment.

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END OF SECTION 26 05 31

SECTION 26 05 37 – SLEEVES AND PENETRATIONS

PART 1 GENERAL

1.1 SCOPE:

- A Provide sleeves, seals and openings for raceway penetrating exterior walls, interior masonry walls and partitions, floors, and roofs as specified here.
- B All sleeves, seals and openings required shall be located and provided by this Contractor for his portion of the work prior to the pouring of the concrete slabs, and shall be done in a way that does not interfere with the structural system.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

- A Conduit - Section 260531
- B Fire Seals - Section 260539

1.3 SUBMITTALS:

- A Submit scaled shop drawings showing proposed location of sleeves coordinated with work by other trades.

PART 2 PRODUCTS

2.1 CONDUIT SLEEVES, SEALS AND ESCUTCHEONS:

- A Provide sleeves for each conduit passing through walls, partitions, floors and roofs.

A. Sleeve Material:

TYPE	DESIGNATION
1	18 gauge, adjustable or fixed length, galvanized steel, Pipe Shields Inc. or equal.
2	Standard weight galvanized steel pipe or conduit.
3	Standard weight galvanized steel pipe or conduit with a continuous welded stop of ¼" steel plate extending outside of sleeve a minimum all around, similar to R&S Manufacturing Corp. Fig. 204.
4	Cast iron pipe sleeve with center flange, similar to James B. Clow and Sons No. F-1430 and F-1435.
5	Thru-wall fitting type: Refer to Section 26 535.

B Sleeve Sizes:

- 1. Sleeves for conduit or cables shall be adequate size to accommodate a minimum of ½" clearance between inside of sleeve and outside of pipe.

B. Sleeve Lengths:

LOCATION	SLEEVE LENGTH
Floors	Equal to depth of floor construction including finish. In waterproof floor construction sleeves to extend minimum of 2" above finished floor level.
Walls and Partitions	Equal to thickness of construction and terminated with surfaces

C. Sleeve Caulking and Packing:

TYPE DESIGNATION	CAULKING AND PACKING REQUIREMENTS
A	Refer to Section 260531 for requirements.
B	Space between conduit or cable, and sleeve shall be caulked with a fire resistant foam sealant. This applies also to all telecommunication wiring sleeves and conduits penetrating fire rated walls or floors.
C	Space between conduit or cable, and sleeve shall be packed with mineral wool and sealed tight with acoustical caulking.

D. Sleeve Application:

SLEEVE TYPE	LOCATION	SLEEVE CAULKING & PACKING TYPE DESIGNATION
1	Interior fire rated walls, partitions and floors	B
	Interior non-fire rated stud walls and partitions	C
	Interior non-fire rated masonry walls and petitions	C
2	Membrane, waterproof floor and wall construction	B
3 or 4	Exterior walls	A
5	No membrane, waterproof, roof and wall construction where flashing is required	A or B

C Escutcheons:

1. Provide escutcheons on all exposed conduit passing through walls, floors, partitions and ceilings.
2. Escutcheons shall be held in place by internal spring tension or set screws.

D Application:

LOCATION	ESCUTCHEON MATERIAL
Finished spaces chrome-plated brass	Anodized aluminum
Unfinished spaces, excluding mechanical equipment rooms	Plain brass, cast iron or aluminum

2.2 PENETRATIONS THROUGH ROOF:

- A Penetrations through roof shall be accomplished by roof contractor at the expense of Division 26 electrical contractor.
- B Pipe curbs for raceway and piping passing through roof shall consist of a roof curb, curb covers, and resilient caps with stainless steel clamp sized for passing pipe. Curb covers shall be not less than 12 inches square and where multiple covers are required, galvanized steel troughs shall be provided between covers to provide a watertight assembly. Covers shall be fabricated of ABS plastic with pre-punched mounting holes and a laminated acrylic coating. Sealing caps shall be EPDM compression molded rubber, with openings sized for passing pipe or piping and with stainless steel clamps.

- C When feasible, penetrations through roof may be combined in a single pipe curb with piping provided under other trades.
- D Required penetrations through roof for connections to roof top equipment and exhaust fans shall be through the designated area within the roof top unit within roof curb provided with the equipment whenever feasible as directed by HVAC subcontractor.

PART 3 EXECUTION

3.1 PLACEMENT OF SLEEVES:

- A Sleeves shall be furnished and placed and openings located as construction proceeds and in ample time to avoid delay to the work. After construction of wall or floor has been accomplished remove the sleeve and proceed to install raceway or pipe, except that sleeves through floors with membrane waterproofing, fire rated gypsum or plaster drywalls and smoke partitions, shall remain in place properly secured to the slabs or wall.
- B Where sleeves or grouped raceway and pipe are to be installed in openings concurrent with or subsequent to construction, such items shall be securely fastened in place and the opening filled and patched with material approved for the particular construction.
- C Sleeves and openings shall be protected during all phases of construction. Care shall be taken to prevent concrete, plaster or other construction material from closing the sleeve.
- D Submit to the Architect/Engineer for approval plan of proposed sleeve locations and sites prior to performing any sleeve works.

END OF SECTION 26 05 37

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SECTION 26 05 39 – FIRE SEALS

PART 1 GENERAL

1.1 SCOPE OF WORK:

- A Work includes furnishing and installing fire and smoke barrier penetration seals for openings in floors, walls, and other elements of construction, whether the floors or walls are fire rated or not.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

- A Section 260537 - Sleeves and Penetrations

1.3 QUALITY ASSURANCE:

- A Applicator Qualifications: Two years experience installing UL Classified fire stopping materials.
- B Performance: Materials shall have been tested to provide fire rating equal to that of the construction.

1.4 SUBMITTALS:

- A Shop Drawings:

- 1. Submit shop drawings showing each condition requiring penetration seals indicating proposed UL systems materials, anchorage, methods of installation and actual adjacent construction.

- 2. Submit a copy of UL illustration of each proposed system indicating manufacturer approved modifications.

- B Manufacturer's Data: Submit copies of manufacturer's specifications, recommendations, installation instructions, and maintenance data for each type of material required. Include letter indicating that each material complies with the requirements and is recommended for the applications shown.

- C Applicators Qualifications Statement: List past projects indicating required experience.

1.5 DELIVERY, STORAGE AND HANDLING:

- A Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, grade and UL label where applicable. Coordinate delivery with scheduled installation date to allow minimum storage time at site. Store materials in clean, dry, ventilated location. Protect from soiling, abuse, and moisture. Follow manufacturer's instructions.

1.6 ENVIRONMENTAL REQUIREMENTS:

- A Furnish adequate ventilation if using solvent. Furnish forced air ventilation during installation if required by manufacturer. Keep flammable materials away from sparks or flame. Provide masking and drop cloths to prevent contamination of adjacent surfaces by fire stopping materials.

1.7 GUARANTEE:

- A Submit copies of written guarantee agreeing to repair or replace joint sealers which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be one year from date of Owner's acceptance.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A Manufacturer: Subject to compliance with requirements, provide products of one of the following manufacturers as further defined in the Systems and Applications Schedule in Part 3 of this Section.

1. 3M Company Barrier Caulk
2. US Gypsum - Thermafiber Insulation
3. Vimasco Corporation, Nitro-West Virginia
4. Nelson
5. Wrap/Strip moldable putty sheet forms
6. or approved equal.

2.2 MATERIALS:

A Provide materials classified by UL to provide fire stopping equal to time rating of construction being penetrated.

B Provide asbestos free materials that comply with applicable codes and have been tested under positive pressure in accordance with UL 1479 or ASTM E814.

PART 3 EXECUTION**3.1 INSTALLATION:**

A All holes or voids created to extend electrical systems through fire rated floors and walls shall be sealed by the electrical contractor with an intumescent material capable of expanding up to 10 times when exposed to temperatures beginning at 250 degrees F. It shall be UL classified and have ICBO BOCAI and SBCCI INER 243 approved ratings to 4 hours per ASTM E-814 (UL 1479).

B Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust or other substances that may affect proper fittings, adhesion, or the required fire resistance.

C Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction. Seal holes or voids made by penetrations to ensure an effective smoke barrier. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install fire stopping materials capable of supporting same loading as floor. Protect materials from damage on surfaces subject to traffic.

3.2 FIELD QUALITY CONTROL:

A Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas. Keep areas of work accessible until inspection by applicable code authorities. Perform under this section patching and repairing of fire stopping caused by cutting or penetration by other trades.

3.3 ADJUSTING AND CLEANING:

A Clean up spills of liquid components. Neatly cut and trim materials as required. Remove equipment, materials and debris leaving area in undamaged, clean condition.

3.4 SYSTEMS AND APPLICATION SCHEDULE:

A Construction conditions presented here are not necessarily encountered in this project and do not imply approval of any particular type of raceway listed here. Refer to Section 260531 - Conduit for type of raceways allowed in this project.

CONSTRUCTION CONDITION	UL DESIGNATION
Metal Conduit through Round Opening	CAJ1007, WJ1010, CAJ1027, JAJ1037 CAJ-1023, CAJ1044, CAJ7001, FB1002

CONSTRUCTION CONDITION	UL DESIGNATION
	WJ1001, WJ1042
Metal Conduit through Large Opening	CBJ1015, CAJ1002, CAJ1006
Blank Opening	CAJ0001, CAJ0002, CAJ0004, CBJ0007, CAJ0009, J900B, J900C, U900J, U900L
Metal Conduit through Gypsum Board Wall	WL1001
Cables through Gypsum Board Wall	WL3001

END OF SECTION 26 05 39

January 15, 2026

University of North Carolina at Wilmington
Housing Village Phase 3
Complete Package - Construction Documents

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SCO 24-29053-02D

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SECTION 26 05 41 – BOXES AND ENCLOSURES

PART 1 GENERAL

1.1 WORK INCLUDED:

- A Requirements of Section 260100 shall apply.
- B Work under this Section includes but is not necessarily limited to the following:
 - 1. Outlet Boxes, including floor outlets and poke-through devices
 - 2. Cabinets and Enclosures
 - 3. Access Doors

1.2 APPLICABLE SPECIFICATIONS AND STANDARDS:

- A Equipment specified in this Section shall meet the following specifications and standards.
 - 1. UL Standards
 - a. Electric Cabinet and Boxes
 - b. Outlet Boxes and Fittings
 - 2. NEMA Standards
 - a. Boxes, OS1

1.3 QUALITY ASSURANCE:

- A The contractor, through the manufacturer of the equipment specified here, shall review the use, details, and methods of installation of his product as indicated and shall disclose to the Architect any and all deviations from his recommended use and method of installation and shall also disclose to the Architect his recommendations for the use and method of installation of his product to achieve the intended purpose and result. Such disclosure shall be made within the time stipulated for submission of shop drawings.

1.4 SUBMITTALS:

- A Submit manufacturer's catalog data on all products specified here.

PART 2 PRODUCTS

2.1 OUTLET BOXES, PULL BOXES, CABINETS AND ENCLOSURES:

- A Boxes:
 - 1. Unless otherwise specifically noted, all boxes shall be of the metallic type.
 - 2. Boxes shall have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70, Article 314. Outer boxes that are exposed to the weather or that are in normally wet locations shall be of the cast-metal type having threaded hubs. Boxes shall be of suitable construction for installation in the environment of their location. Unless otherwise specifically stated all boxes shall be metallic boxes used.
 - 3. Fixture outlet boxes on ceiling shall be not less than 4 inch octagonal. Fixture outlet boxes in concrete ceiling shall be of the 4 inch octagonal concrete type, set flush with the finished surface. Fixture outlet boxes on plastered ceilings shall be fitted with open covers set to come flush with the finished surface.
 - 4. Except as otherwise noted, outlet, junction or pull boxes not larger than 5" x 5" in exposed work within 8'-0" from floor shall be of cast steel or alloy with threaded hubs and appropriate covers. Zinc-coated cadmium-plated sheet boxes may be used within electrical and telecom rooms, only.
 - 5. Outlet boxes in unplastered masonry walls shall be tile type.
 - 6. Outlet boxes for use with conduit and tubing for power systems shall be not less than 1½ inches deep unless otherwise noted.
 - 7. A device plate or cover shall be provided for each outlet to suit the outlet. Refer to Section 262726 for wiring device plates.

8. Boxes with concentric, eccentric, or oversized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC Table 250-122 and lugged to the box.
 9. Outlet boxes shall be sized in accord with NEC. All lighting outlet boxes shall have fixture studs. Device boxes shall be sectional type or 4" square equipped with plaster rings as required to mount the device. Set edge flush with finished surface. Boxes may be installed at top or bottom of a masonry course.
 10. Where installed in metal stud partitions, wall boxes shall be supported from two adjacent studs. Support on a single stud is not acceptable.
 11. Ensure all devices meet ADA requirements and specific project requirements regarding mounting heights and locations. Coordinate questions with Architect and Project Manager.
 12. The following are standard mounting heights:
 - a. Switch boxes 46" from finished floor to center. Boxes beside doors shall be mounted so edge of trim plate is 2" from edge of door trim on strike side.
 - b. Telephone boxes 18" from finished floor to center and vertical. Boxes for wall phones shall be 46" from finished floor and vertical.
 - c. Panel cans 6' - 4" ($\pm 4"$ in concrete block construction) from finished floor to top of can.
 - d. Fire alarm pulls stations 46" from finished floor to center.
 - e. Fire alarm chimes, horns, flashing lights, etc., 80" to bottom above finished floor or 6" below finished ceiling, whichever is lower, to comply with ADA requirements.
 13. Mount boxes for receptacles to receive device in a vertical position and locate:
 - a. Centered 18" above finished floor.
 - b. Centered 6" above counters, shelves, or cabinets where apparently intended to be so placed.
 - c. Centered 4" above high edge of backsplashes.
 - d. Where devices are to be ganged, provide boxes to receive devices trimmed with a gang plate.
 14. As soon as installed, all raceway openings shall be closed with plastic inserts to prevent entrance of foreign matter during construction. All enclosures shall be kept clean of any foreign matter.
 15. All outlet boxes, junction boxes and pull boxes shall have their covers and exterior visible surfaces painted with colors to match color scheme outlined in Section 260553. This includes covers on boxes above all type ceilings. In addition, the box cover shall be labeled using a permanent, black marking pen to identify circuits or systems in box.
- B Pull Boxes:**
1. Pull boxes shall be constructed of code-gauge galvanized sheet metal. Boxes shall be of not less than the minimum size required by the National Electrical Code and shall be furnished with screw fastened covers. When several feeders pass through a common pull box they shall be tagged to indicate clearly their electrical characteristics, circuit numbers and panel designations. Pull boxes coverplates larger than four square feet shall be provided with two handles.
 2. Pull boxes shall be furnished and installed where necessary, as approved by the A/E, in the raceway system to facilitate conductor installation. Except as otherwise noted for telephone and data raceways, conduit runs longer than 200 feet, or with more than four 90 degree angle bends, shall have a pull box installed at a convenient intermediate location. Normally, when feeder routing is shown on drawings, pull boxes are not indicated. It is the responsibility of the electrical contractor to provide pull boxes as necessary to meet the stated requirements.
- C Cabinets:**
1. Cabinet boxes shall be constructed of zinc-coated sheet steel and shall conform with the requirements of Underwriters' Laboratories "Standards for Cabinets and Cutout Boxes". Unless otherwise noted, cabinet trims shall have a corrosion inhibiting primer and a

lacquer finish. Cabinets shall be of suitable construction for installation in the environment of their locations.

2.2 QUALITY ASSURANCE:

- A It is the responsibility of Division 26 subcontractor to assure that the device brackets and plates intended for telecommunication devices are compatible and suitable for the telecommunication devices specified under Division 27.

2.3 FIRE RATED SLABS:

- A Provide sprayed on fire proofing, or gypsum board sheathing under slab, as acceptable to local Fire Marshall, to maintain rating of floor slabs at the location of floor boxes.
- B Wiremold Evolution Series or equal fire rated poke-through devices of equivalent capabilities, as specified floor boxes are acceptable if approved by A/E.

PART 3 EXECUTION

3.1 FIRE RATING:

- A Boxes shall not be permitted to be installed in walls, slabs, or in decks if installation violates or reduces fire rating of such wall, slab, or deck, unless additional fire proofing is provided to maintain fire rating.

3.2 INSTALLATION OF OUTLETS:

- A Location of outlets shown on drawings, other than those dimensioned, are only approximate, the Owner shall have the right to make slight changes in the position of outlets if the Contractor is notified before roughing-in is done. The Contractor shall study the general building plans in relation to the spaces surrounding each outlet in order that his work may fit the other work required by these specifications. When necessary, the Contractor shall relocate outlets of junction boxes so that, when fixtures or other fittings are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Do not install outlets back to back in dry walls.
- B Coordinate with telecommunications contractor for location of outlets provided under Division 26 for use by telecommunications contractor. Refer to Section 260100 for additional requirements.
- C Minimum length of conduit connecting to adjacent flush in wall outlets in sound rated walls shall be 18", or walls with sound attenuation materials.
- D Boxes shall be installed in a rigid and satisfactory manner, either by wood screws on wood, expansion shields on masonry, or machine screws on steel work.
- E Recessed boxes in dry wall type construction shall be supported from both adjacent studs, or by the use of metal stud brackets as manufactured by E-Z Mount Bracket Co., or equivalent.

3.3 INSTALLATION OF PULLBOXES:

- A Pull boxes shall be installed overhead or on walls at locations free of interference with equipment, ducts, piping and activities being carried out at the premises.

3.4 BOXES AND CABINETS IN FIRE RATED WALLS AND FLOORS:

- A Outlet boxes in one and two-hour fire rated walls shall be installed in conformance with approved UL methods. UL listed steel electrical outlets, switches, or junction boxes not exceeding 16 square inches in area and 2-3/16" in depth, in hollow walls or partition assemblies utilizing wood or metal studs or metal framing or channels are permitted, provided such outlet boxes do not exceed an average of 100 square inches per 100 square feet of wall and are staggered not less than 24 inches side-to-side horizontally when openings are provided on either side of the wall.
- B When location or dimension of outlet boxes does not meet the requirements listed above, protect each outlet utilizing gypsum board sheathing or fire proofing blankets in accordance

with UL approved methods if acceptable to the local code authority. One product approved to protect outlets is 3M Company moldable Putty Pads, Catalogue Number MPP-1. Fire proofing material must be independently supported of the box or cabinet being protected.

- C Provide gypsum board covering on all five sides of cabinets mounted in one or two hour fire rated walls to maintain rating of wall.
- D Provide additional fire proofing on underside of fire-rated slabs where floor boxes are installed. Use, as best suited to the project and as approved by the A/E and fire marshall, additional spray-on insulation of layers of gypsum board to maintain floor fire rating.
- E Do not install outlet boxes or cabinets in 4-hour rated walls.

3.5 OUTLET IDENTIFICATION:

- A All outlet boxes, junction boxes and pull boxes in equipment rooms and above accessible ceilings shall have their covers and exterior visible surfaces painted with colors to match the surface color scheme outlined above. This includes covers on boxes above lift-out and other type accessible ceilings.

END OF SECTION 26 05 41

SECTION 26 05 43 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A Specification Section 260100 – General Provisions – Electrical, Drawings, and General Provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
 - 2. Handholes and boxes.

1.3 DEFINITION

- A RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

- A Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for handholes, boxes, and other utility structures.
 - 4. Warning tape.
 - 5. Warning planks.
- B Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and handholes frame support rings.
 - 4. Ladder Step details, as applicable.
 - 5. Grounding details.
 - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.
- C Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858, and as applicable to the project.
- C Qualification Data: For professional engineer and testing agency.
- D Source quality-control test reports.

E Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B Comply with ANSI C2.
- C Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- 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 Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager's and Owner's written permission.

1.9 COORDINATION

- A Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B Coordinate elevations of ducts and duct-bank entrances into handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to handholes, and as approved by Architect.

1.10 EXTRA MATERIALS

- A Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 PRODUCTS

2.1 CONDUIT

- A Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.

4. CertainTeed Corp.; Pipe & Plastics Group.
 5. Condux International, Inc.
 6. ElecSys, Inc.
 7. Electri-Flex Company.
 8. IPEX Inc.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT; a division of Cable Design Technologies.
 11. Spiraduct/AFC Cable Systems, Inc.
 12. Or equivalent as approved by the A/E.
- C Underground Plastic Utilities Duct: NEMA TC 2, Type EPC-40-PVC, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 3.
- D Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 2. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."
 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- A Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carder Concrete Products.
 2. Christy Concrete Products.
 3. Elmhurst-Chicago Stone Co.
 4. Oldcastle Precast Group.
 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
- B Comply with ASTM C 858 for design and manufacturing processes.
- C Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 6. Cover Legend: Molded lettering, "ELECTRIC." "SIGNAL." As indicated for each service.
 7. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC," "SIGNAL," As indicated for each service.
6. 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.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

- 1.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.

C Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

- 1.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armorcast Products Company.

- b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
- D Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete, reinforced concrete, cast iron or fiberglass, as applicable and as indicated on drawings.
- 1.Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.
- E High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be polymer concrete.
- 1.Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. Carson Industries LLC.
 - b. Nordic Fiberglass, Inc.
 - c. PenCell Plastics.

2.5 UTILITY STRUCTURE ACCESSORIES

- A Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1.Bilco Company (The).
 - 2.Campbell Foundry Company.
 - 3.Carder Concrete Products.
 - 4.Christy Concrete Products.
 - 5.East Jordan Iron Works, Inc.
 - 6.Elmhurst-Chicago Stone Co.
 - 7.McKinley Iron Works, Inc.
 - 8.Neenah Foundry Company.
 - 9.NewBasis.
 - 10. Oldcastle Precast Group.
 - 11. Osburn Associates, Inc.
 - 12. Pennsylvania Insert Corporation.
 - 13. Riverton Concrete Products; a division of Cretex Companies, Inc..
 - 14. Strongwell Corporation; Lenoir City Division.
 - 15. Underground Devices, Inc.
 - 16. Utility Concrete Products, LLC.
 - 17. Utility Vault Co.
 - 18. Wausau Tile, Inc.
- B Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.
- 1.Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- C Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.
- D Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
- 1.Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- E Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
- 1.Tested Ultimate Pullout Strength: 12,000 lbf minimum.

- F Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- G Cable Rack Assembly: Steel, hot-rolled or hot-dip galvanized, except insulators.
1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- H Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
 2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- I Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- J Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Provide quantity as shown on drawings but not less than two.

2.6 SOURCE QUALITY CONTROL

- A Test and inspect precast concrete utility structures according to ASTM C 1037.
- B Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of 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 a independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated. Use 3-inch concrete encasement and red concrete.
- B Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated. Use 3-inch concrete encasement.
- C Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- D Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated. Use 3-inch concrete encasement.
- E Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

- F Underground Ducts Crossing Paved Paths, Walks and Driveways, Roadways and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
1. All Units: Precast concrete. AASHTO HB 17, H-20 structural load rating.

3.3 EARTHWORK

- A Excavation and Backfill: Comply with Division 31 but do not use heavy-duty, hydraulic-operated, compaction equipment.
B Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
C Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32.
D Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 32.

3.4 DUCT INSTALLATION

- A Slope: Pitch ducts a minimum slope of 1:300 down toward handholes and away from buildings and equipment.
B 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, both horizontally and vertically, at other locations, unless otherwise indicated.
C Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
D Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.
E Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet 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 duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 260537 "Sleeves and Penetrations."
F Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
G Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
H Concrete-Encased Ducts: Support ducts on duct separators.
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. 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.
2. Concreting Sequence: Pour each run of envelope between terminations in one continuous operation.
a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings

- installed according to manufacturer's written recommendations, 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 reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. 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.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 3 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated. Ducts used for high voltage cables shall not be less than 36-inches below grade.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
- a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE HANDHOLES AND BOXES

A Precast Concrete Handhole Installation:

- 1. Comply with ASTM C 891, unless otherwise indicated.
- 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts 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 sieve to No. 4 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 above finished grade.
- 2. Where indicated, cast handhole cover frame integrally with handhole structure.

C Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars.

D Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars.

- 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 Concrete Handholes: Do not drill deeper than inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 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 ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch 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 the enclosure.
- E Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- 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, 28-day strength, with-a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep, unless larger dimensions shown on drawings.

3.7 PROTECTION OF EXISTING FACILITIES:

- A Streets and Walks:
 - 1. Streets connecting to the project shall be protected from deposits of mud, sand, stone, litter or debris in any form, and this protection shall be the responsibility of the Contractor. All mud collected on vehicle wheels must be cleaned off before leaving the construction area. Should any mud or debris collect on the streets from the construction project, this shall be removed immediately before becoming a traffic hazard or being carried into the surrounding buildings.
- B Street Patching:
 - 1. Where street paving is cut for placing new utility lines, the asphalt shall be neatly cut and removed with an asphalt cutter. Breaking the asphalt out with a backhoe or other means will not be acceptable. Boards or other suitable material shall be placed under backhoe outrigging to prevent damage to the asphalt. The patching shall consist of a minimum of six inches of run-of-crusher stone and two inches of asphalt, regardless of the existing conditions. If the surrounding pavement is damaged by backhoe or by any other means, the damaged spot shall be cut out and patched as above. The asphalt that has been cut shall be replaced to match the original conditions within 48 hours of cutting it.
 - 2. Stone base and paving shall be placed immediately after opening in street is backfilled. Backfill shall be tamped thoroughly, and any minor settlement which occurs in the street during the twelve (12) month warranty period shall be repaired by resurfacing the patch with asphalt at no further cost to the Owner.
- C Walk Patching:
 - 1. Asphalt sidewalks shall be patched as specified for streets except use 2 inches of stone base and 1 ½ inches of asphalt. Brick and concrete sidewalk patching shall be of a quality equal

to the existing. Patches must be cut out neatly to all score mark boundaries or to squared up areas. Irregular or splotchy patching is not acceptable.

D Drainage Systems:

1. All catch basins and storm drain lines in the vicinity of the site shall be protected at all times from entry of mortar, concrete spoil, or other construction debris. The residue from the cleaning of ready-mix trucks, wheelbarrows, concrete buggies, etc. must be prevented from entering the drainage systems, and if cleaning is done, it must be contained from the residue removed from the campus with other refuse.

E Trees and Shrubs

1. Trees and shrubs to be retained within the limits of construction site shall be protected by a 48 inch chain link fence to be installed around the outer perimeter of the spread of the branches.
2. Care shall be taken to protect trees from damage by cranes, falling objects, etc. Trees and shrubs shall not be pruned or moved by the contractor. When pruning or moving is necessary, the A/E shall be notified and the work will, in turn, be performed by the Owner at no cost to the contractor.
3. Trees outside the construction limits shall be protected from:
 - a. Compaction of root areas by equipment, materials, or fill dirt.
 - b. Truck damage by moving equipment, material storage, mauling or bolting.
 - c. Poisoning by pouring solvents, gas, paint, etc. on or around roots.
 - d. Unnecessary cutting of roots.
 - e. Damage of branches by improper equipment activity.
 - f. Cutting of roots within the drop line of the tree.
4. Underground structures and utilities shall be designed in such a way that installation will not damage or destroy trees and shrubs which have been designate to remain. All such work shall be closely coordinated during construction to prevent damage or destruction to trees and shrubs.
5. Damaged shrubs or trees shall be repaired by a nurseryman or tree surgeon in a manner acceptable to the Owner, and the cost of repairs shall be paid for by the contractor.

F Site Maintenance

1. Pedestrian Traffic around the construction limits must be maintained in a clean and safe condition at all times. When excavation outside of the project limits is required, the contractors shall return the area to its original condition immediately following the excavation work. This is to provide a safe walking surface but prevents excessive dirt from being tracked into adjacent buildings.

3.8 GROUNDING

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

3.9 FIELD QUALITY CONTROL

- A Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

- B Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

- A Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B Clean internal surfaces of handholes, including sump. Remove foreign material.

END OF SECTION 26 05 43

January 15, 2026

University of North Carolina at Wilmington
Housing Village Phase 3
Complete Package - Construction Documents

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SECTION 26 08 00 – COMMISSIONING - ELECTRICAL

PART 1 GENERAL

1.1 GENERAL

- A Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, system calibration, testing adjusting and balancing, performance testing and training.
- B Electrical commissioning for this project shall be provided to fulfill the requirements of Section C408 of the North Carolina Energy Conservation Code and NC General Statute 143-135.35-.40 (SB 668). The process structure is based on ASHRAE Guideline 0-2013, ASHRAE Guideline 1.1-2007, ASHRAE Guideline 202-2013 and practices by the NEBB Commissioning Standard.
1. Review the Owner's Project Requirements (OPR) and design team's Basis of Design (BOD) for clarity and completeness.
 2. Develop commissioning requirements to be included in the construction documents.
 3. Perform a commissioning design review of the design documents and back-check the review comments prior to submission.
 4. Develop and implement the commissioning plan.
 5. Review contractor submittals applicable to systems being commissioned for compliance with the OPR, OBD and design documents.
 6. Verify applicable equipment and systems are installed properly and receive adequate operational checkout by installing contractors.
 7. Verify and document proper performance of electrical systems.
 8. Assist in review of O&M manuals and warranties.
 9. Coordinate and verify that the Owner's operating personnel are adequately trained.
 10. Provide a summary of the commissioning activities and submit a commissioning report.

1.2 ABBREVIATIONS

- A. The following are common abbreviations used in the Specifications.

Cx	Commissioning
CxA	Commissioning Authority
PM	Project Manager (Owner)
A/E	Architect and Design Engineers
GC / CM	General / Construction Manager (Prime Contractor)
EC	Electrical Contractor
PC	Plumbing Contractor
MC	Mechanical Contractor
CC	Controls Contractor
Subs	Subcontractors to Construction Manager
TAB	Test and Balance Contractor
PFC	Pre-functional Startup Checklist

FPT	Function Performance Test
Cx Plan	Commissioning Plan Document

1.3 RELATED SECTIONS

- A Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 and 26 Specification Sections, apply to this section.

1.4 COMMISSIONING TEAM

- A The members of the commissioning team consist of the Commissioning authority (CxA), the Owner Project Manager (PM), the General / prime contractor (GC), the Electrical Contractor (EC), the Controls Contractor (CC), any other installing Subcontractors or suppliers of equipment. Additionally, if desires, the facility plant operator/engineer is also a member of the commissioning team. Representative from the A/E team may also be invited to observe critical procedures.
- B The Contractor shall, through the GC provide skilled technicians to start-up and debug all systems within the division of work. These same technicians shall be made available to assist the Commissioning Agent in demonstrating prefunctional and functional tests as they relate to each system and their technical specialty.
- C The Commissioning Agent reserves the right to approve the technicians relative to each item of equipment, system, and/or sub-system. Qualifications of technicians include knowledge relative to the specific equipment involved, adequate documentation, tools to service/commission the equipment, and an attitude/willingness to work with the Commissioning Agent to get the job done.

1.5 MANAGEMENT

- A The CxA directs and coordinates the commissioning activities and the reports to the Owner. All members work together to fulfill their responsibilities and fulfill the objectives of the Contract Documents.

1.6 SCHEDULING

- A The CxA will work with the GC to project an initial commissioning schedule. The GC will integrate the tentative commissioning schedule into the master schedule. All parties shall address scheduling problems and make necessary notification in a timely manner to avoid delaying the commissioning process. The GC will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
- B Functional testing will not begin until the CxA is notified in writing, by the GC that all prefunctional checklists, including startup; and the subcontractors punch work is complete and the systems have been tested completely.
- C The CxA will have 7 business days to review prefunctional documentation for completeness. If it is determined that the prefunctional report has not been completed and it impacts the original schedule coordinated by the CxA and GC; the schedule will be revised to include the additional days taken for the contractor to properly complete their work and the CxA to review the document.
- D As construction progresses, more detailed schedules will be developed by the CxA and GC.
- E Commissioning is required to be scheduled and completed prior to Final Acceptance.

1.7 COMMISSIONING PROCESS DURING CONSTRUCTION

- A The following narrative provides a brief overview of the commissioning tasks during construction and the general order in which they occur:
1. Commissioning begins with a Cx kickoff meeting conducted by the CxA where the commissioning process, including Cx Plan is reviewed with the commissioning team members.

2. Additional meetings will be required throughout construction, scheduled by the PM, CxA & GC with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
3. Electrical equipment documentation is submitted to the CxA during the normal submittal process for review, after approval by the A/E, including start-up procedures.
4. The CxA works with the Subs to detail start-up procedures, including providing the Subs with prefunctional checklists (PFC's) to be completed during the startup process.
5. The CxA will review reports from independent testing agencies and A/E reports from on-site periodic construction observation to maintain cohesiveness with project activities.
6. The CxA will perform site visits and document the progress of the work. An Issues / Deficiency log will be developed to track installation and coordination issues which would affect commissioning and Owner maintenance.
7. The Subs, under their own direction, execute and document the prefunctional checklists (PFC's), including start-up and initial checkout. The CxA documents that the checklists and start-ups were completed by the Subs according to the approved plans. This will include the CxA witnessing start-up of selected (major) equipment.
8. The CxA develops specific equipment and system functional performance test (FPT) procedures. The procedures are developed using approved shop drawings and O&M documentation supplied by the contractors.
9. Under direction of the CxA, functional performance tests (FPT's) are executed by the appropriate sub-contractors. The results of the FPT's are documented by the CxA.
10. During prefunctional checkout and functional performance testing, items of non-compliance in material, installation or setup shall be corrected at the Sub's expense and the system retested.
11. The CxA reviews the O&M documentation for completeness.
12. The CxA coordinates and verifies training of Owner staff by vendors and sub-contractors.

1.8 SUBMITTALS

- A The GC will provide the CxA a copy of the following items, for the systems to be commissioned:
1. Construction Schedule (initial and all updates)
 2. Construction Progress Meeting Minutes (all meetings)
 3. Approved shop drawings, materials certifications and systems data for electrical related systems. Approval review comments by the A/E and any resubmittal required by the A/E shall be copied to the CxA.
 4. One set of approved coordination drawings either electronic media or hard copy which includes all commissioned systems e.g. electrical, controls.
 5. Subs shall submit start-up and initial checkout plan for each piece of equipment / system as recommended by the manufacturer.
 6. Prefunctional checklist (Engineering Point-to-Point Checklist) for controls and energy related equipment as required by this specification.
 7. Operational and maintenance documentation for FPT development.

1.9 SYSTEMS TO BE COMMISSIONED

- A Power distribution (utility – switchboard – distribution panels)
B Equipment power services (breakers – wiring)
C Power metering

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

- A All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division contractor for the equipment being tested.

- B All testing equipment used by the contractors shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications.

PART 3 EXECUTION

3.1 GENERAL

- A The following procedures apply to all equipment to be commissioned. This work is to be performed by the contractor or sub-contractor prior to Functional Performance Testing by the Commissioning Team.
- B Cooperate with the Commissioning Authority in the following manner:
 - 1. Allow sufficient time before final completion dates so that functional testing can be accomplished.
 - 2. Provide labor and material to make corrections when required without undue delay.

3.2 MEETINGS

- A Prior to the start of construction, the A/E, PM, CxA, and GC shall schedule, plan and conduct a commissioning kickoff meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CxA.
- B Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular subs.

3.3 START-UP AND INITIAL CHECKOUT

- A Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- B The CxA will develop prefunctional checklists with the Contractor which indicates the required procedures to be executed as part of startup and initial checkout of the systems. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form.
- C The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the CxA's prefunctional checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
- D The full start-up plan shall consist of:
 - 1. The CxA's prefunctional checklists.
 - 2. The manufacturer's standard written start-up procedures copied from the installation manuals with contractor sign-off.

3.4 CONTROL SYSTEM

- A Check each physical output control point by making a comparison between the control command at the main system and the status of the controlled device. Check each physical output control point by making a comparison of the actual state of the device and the operator workstation graphical representation of the point condition. Record the results for each device in the Prefunctional checklist.
- B Verify proper sequences by using the approved checklists to record results and submit the Prefunctional checklist. Verify proper sequence and operation of all specified functions.

3.5 EXECUTION OF PREFUNCTIONAL CHECKLISTS AND STARTUP

- A Thirty (30) days prior to startup, the Subs and vendors schedule startup and checkout with the PM, GC and CxA. The execution of prefunctional checklists, startup and checkout is by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
 - 1. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional tests and checklists.
 - 2. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off.

3.6 DEFICIENCIES, NON-CONFORMANCE AND APPROVAL IN CHECKLISTS AND STARTUP

- A The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the CxA within 1-week of test completion.
- B The CxA reviews the report and submits either a non-compliance report or an approval form to the PM. The CxA will work with the Subs and vendors to determine what is required to correct outstanding deficiencies and retest deficiencies of uncompleted items. The CxA will involve the PM and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected.
- C Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to render system performance will be permitted. If the Commissioning Agent deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Agent will notify the Architect/Engineer indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
- D If the deadline(s) passes without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.7 FUNCTIONAL PERFORMANCE TESTING

- A Objectives and Scope:
 - 1. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of Final Acceptance to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
 - 2. Demonstrate the operation of the hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority. Schedule the demonstration with the CxA one month in advance. Demonstration shall not be scheduled until submittals, control hardware and software, and the Prefunctional checklists are complete and approved. If the Work fails to be demonstrated to conform to Contract specifications, so as to require scheduling of the additional site visits by the Commissioning Authority for re-demonstration, the Contractor shall reimburse Owner for costs of subsequent CxA site visits.
 - 3. The contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, tools, instruments, ladders, lifts, computers, software, cables, etc. Contractor supplied personnel must be competent with and knowledgeable of all project-specific systems, and automation hardware and software. All documentation, including as-built drawings, O&Ms, and submittals shall be at the job site before functional testing commences.
- B Development of Test Procedures

1. The CxA will develop specific functional checklists test procedures and forms to verify and document proper operation of each piece of equipment and system. The CxA will provide a copy of the test procedures in advance to the Sub(s) who shall complete the tests.
 2. The Sub(s) shall review and point out to the CxA any specific problems related to the functional checklists because of feasibility, safety, equipment and warranty protection.
- C Coordination and Scheduling
1. The GC shall provide sufficient notice to the CxA regarding the Subs completion schedule for the prefunctional checklists and startup of all equipment and systems.
 2. Functional testing is conducted after prefunctional and startup testing has been satisfactorily completed and non-compliance form items have been closed out.
 3. The CxA will schedule functional tests after written notification from the GC and affected Subs. The CxA shall direct, witness and document the functional testing of equipment and systems with support from the Subs.
 4. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.
- D Documentation
1. The CxA shall witness and document the results of all functional performance tests using the specific functional checklist forms developed for that purpose. Prior to testing, these forms are provided to the GC & Subs for review.
- E Non-Conformance
1. The CxA will record the results of the functional test on a standard Test Form. All deficiencies or non-conformance issues will be noted and reported to the PM on a standard Issues Log.
 2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the Test Form.
 3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the PM.
 4. The CxA documents deficiencies and the Sub's response and intentions and they go on to another test or sequence. After the day's work, the CxA submits the Issues Log report to the Sub(s), GC and/or PM. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
 5. The CxA reschedules the test and the test is repeated.
 6. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - a. The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the PM, the GC and to the Sub representative assumed to be responsible.
 - b. Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.
 - c. The CxA documents the resolution process.
 - d. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA & GC reschedules the test and the test is repeated until satisfactory performance is achieved.
- F Cost of Retesting

1. The contractor and Subcontractors will notify the CxA that the systems are ready for testing. As such, for a given system it assumed that all specified prefunctional tasks are complete by the contractor or Sub.
2. If the CxA discovers that the systems are incomplete at the time of the first functional test, the entire system will be marked as deficient and the retesting procedure for deficient systems will be followed.
3. Deficiencies will be noted by the CxA and documented. Deficiencies are associated with completed systems. For deficiencies not related to any prefunctional checklist or start-up fault, the following shall apply:
 - a. The CxA will conduct retesting (back-check) of the equipment / system once at no charge to the GC for their time.
 - b. The time and expenses for the CxA and PM to direct, coordinate or perform any retesting beyond the initial retesting noted above will be chargeable to the GC.
 - c. The time and expenses for the CxA and PM to direct, coordinate or perform any retesting for items which are a repeated deficiency, previously reported via commissioning deficiency log will be chargeable to the GC.
 - d. The Contractor shall respond in writing to the CxA and PM at least as often as non-compliance reports (Cx Issues Log) are issued. The response shall report the status of each apparent outstanding discrepancy identified during commissioning. Responses shall cover explanations of any disagreements and proposals for their resolution.
 - e. The CxA retains the original non-conformance form (Cx Issues Log) until the end of the project.
 - f. The GC shall not consider any required retesting by any Contractor a justified reason for a claim of delay or for a time extension.

G Approval

1. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA, if necessary. The CxA recommends acceptance of each test to the PM using a standard form. The PM gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

3.8 OPERATION AND MAINTENANCE MANUALS (O&M'S)

- A The contractor shall provide one copy of the Operation and Maintenance Manuals to the CxA for the systems to be commissioned sixty (60) days in advance of functional testing.
- B Operation and Maintenance manuals shall conform to requirements detailed in Division 01.

3.9 OWNER TRAINING

- A The GC shall be responsible for training coordination, agendas, scheduling and ultimately for ensuring that training is complete per Division 01.
- B The CxA shall be responsible for overseeing and approving the adequacy of the training of Owner personnel for commissioned equipment.
- C In addition to these general requirements, the specific training requirements of Owner personnel by Subs and vendors are specified in Division 01 and 26.
- D Each Sub and vendor responsible for training shall submit a written training plan (agenda) to the CxA for review and approval prior to training. The plan shall include the following elements:
 1. Equipment (included in training)
 2. Intended audience
 3. Location of training
 4. Objectives
 5. Subjects covered (description, duration of discussion, special methods, etc.)
 6. Duration of training on each subject
 7. Instructor for each subject

8. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
- E The CxA will verify the training was satisfactorily completed and recommend approval of the training to the PM.

END OF SECTION 26 08 00

SECTION 26 09 13 - ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.1 SUMMARY

A Section includes equipment and systems used to monitor and control electrical consumption:

1. Multifunction meters.
2. Electrical power monitoring system software.
3. Electrical power monitoring and control software.
4. Network configuration software.
5. Monitoring and control of power distribution equipment.
6. System operator interfaces.
7. Raceways and boxes.
8. Wires and cables.
9. Identification.

1.2 ACTION SUBMITTALS

A Product Data: For each type of product.

B Shop Drawings: For power monitoring and control equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.
 - a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:
 - 1) Location of the meters and gateways, and routing of the connecting wiring.
 - 2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Include diagrams for power, signal, and control wiring.
5. Surge Suppressors: Data for each device used and where applied.

1.3 INFORMATIONAL SUBMITTALS

A Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
 - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

- g. Engineering, installation, and maintenance manuals that explain how to do the following:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
- h. Documentation of programs created using custom programming language including set points, tuning parameters, and object database.
- i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
- j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
- l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- m. Owner training materials.

1.4 COORDINATION

- A Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of specified functions.
- B Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- A Microprocessor-based monitoring of electrical power distribution system(s) that includes the following:
 - 1. Electrical meters that monitor and connect to the data transmission network.
 - 2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
 - 3. Owner will provide and install a PC-based workstation with its operating system and application software connected to data transmission network.
- B Electrical Components, Devices, and Accessories: Listed and labeled in accordance with UL 61010-1 and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

- A Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
 - 1. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines:
Comply with requirements as recommended by manufacturer for type of line being protected.
- B Addressable Devices: Transmitters and receivers must communicate unique device identification and status reports to monitoring and control clients.
- C Interface with Building Automation System: Provide factory-installed hardware and software to enable the DDC system for HVAC to monitor, display, and record data for use in processing reports.
 - 1. MODBUS IP communication interface with the DDC system for HVAC must enable the DDC system for HVAC operator to remotely monitor meter information from a DDC system for

HVAC operator workstation. Control features and monitoring points displayed locally at metering panel must be available through the DDC system for HVAC.

D Backup Power Source:

1. Electrical power distribution equipment served by a backup power source for controls must have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS

A Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

C Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power Factor: 1.0 percent.
4. Frequency: 0.1 percent.
5. THD: 1.0 percent.
6. Waveform Sampling: 64 per cycle.

E Data Link:

1. MODBUS IP.

F Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values:

- a. One screen to show user-selected values. Selections available to display must include the following:
 - 1) Meters.
 - 2) Measurements.
 - 3) THD.
 - 4) Energy.
 - 5) Demand.
 - 6) Minimum and maximum values.
 - 7) Power demand.

G Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on voltage and current channels of the meter.

H Meters:

1. Instantaneous, RMS:

- a. Current: Each phase, neutral and three-phase average.
- b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
- c. Active Power (kW): Each phase and three-phase total.
- d. Reactive Power (kVAR): Each phase and three-phase total.
- e. Apparent Power (kVA): Each phase and three-phase total.
- f. Power Factor: Each phase and three-phase total.
- g. Frequency (Hz)

2. Energy:

- a. Active Energy (kWh): Three-phase total.
- b. Reactive Energy (kVARh): Three-phase total.
- c. Apparent Energy (kVAh): Three-phase total.

- 3. Demand, Derived from Instantaneous RMS Meters (W, VAR, A, and VA):
 - a. Current: Present and maximum.
 - b. Active: Present and maximum.
 - c. Reactive: Present and maximum.
- 4. Power Quality Measurements:
 - a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.
- I I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics must be 150 mA at 200 V.
 - 1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:
 - a. User-defined pulse output, associated with kWh.
- J Capacities and Characteristics:
 - 1. Power Supply: 480 V(ac), 60 Hz
 - 2. Circuit Connections:
 - a. Voltage: Measurement autoranging, 60 to 400 V(ac) L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
 - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
 - c. Frequency: 45 to 65 Hz.
 - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 PC OPERATING SYSTEM SOFTWARE

- A Description: System software must monitor, analyze, display, control, and save the parameters and features available at the connected meters.
- B Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.
- C Minimum Requirements:
 - 1. Real-time multitasking and multiuser 64-bit operating system that allows execution of multiple real-time programs and custom program development.
 - 2. Operating system must be capable of operating Microsoft Windows applications.
 - 3. Scheduling software must schedule centrally based time and event, temporary, and exception day programs.

2.5 NETWORK CONFIGURATION SOFTWARE

- A Network Management Graphical Interface Features:
 - 1. View the building Electrical infrastructure One-Line Diagram.
 - 2. View the status of the Main Switchboard (MSB), its Main Circuit Breaker (MCB), and all its branch circuit breakers.
 - 3. Operate Open/Close the MSB's main circuit breaker and all its branch circuit breakers.
 - 4. View the status of the Automatic Transfer Switches (ATS).
 - 5. Add and remove devices in the power monitoring and control network.
 - 6. Application for naming devices based on a user-defined naming scheme.
 - 7. Add and remove I/O servers in the power monitoring and control network.
 - 8. Edit communication properties for devices including timeouts and delays.
 - 9. Display mandatory fields when adding a new device.
 - 10. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.

11. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
 12. Pool modem resources so that the software uses any available modem.
 13. Monitor the following diagnostics:
 - a. Communication request/response and error rates, and timeouts.
 - b. Log acquisition services.
- B Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.
- 1.Features:
 - a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
 - b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
 - c. Distribution of reports via email.
 - 2.Report on power and demand profiles.
 - 3.Power quality report with CBEMA evaluation.
 - 4.EN 50160 compliance report.
 - 5.100-ms PQ report.
 - 6.Energy over Period Report:
 - a. User-defined rollup interval by day, week, month, or year.
 - b. Compare daily energy to the following:
 - 1) Previous day.
 - 2) Same day, previous week.
 - 3) Same day, previous month.
 - 4) User-defined specific day.
 - c. Compare weekly energy to the following:
 - 1) Previous week.
 - 2) Same week from previous month.
 - 3) Same week from previous year.
 - 4) User-defined specific week.
 - d. Compare monthly energy to the following:
 - 1) Previous month.
 - 2) Same month from previous year.
 - 3) User-defined specific month.
 - e. Compare annual energy to the following:
 - 1) Previous year.
 - 2) User-defined specific year.
 - 7.Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
 - 8.Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
 - 9.System Configuration Report:
 - a. Device name.
 - b. Device type.
 - c. Device address.
 - d. Connection status.
 - e. Device protocol.
 - f. Device description.
 10. Each default report must include the following:
 - a. Summary aggregation of data from the selected devices.
 - b. Individual device information.
 - c. Raw data.
 11. The reporting tool must provide a graphical interface to create and manage multiple Time of Use schedules:

- a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
- b. Off-peak and on-peak times.

2.6 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C Ethernet Connectivity:

1. Serial communications network must be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network must be included within the power distribution equipment.

2. Serial communications devices within the equipment must be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D Ethernet Gateways:

1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.

2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (8PSJ) Ethernet port, that is accessible from the front of the equipment. Initial setup must be limited to basic Ethernet addressing parameters, as assigned by Owner.

3. Common Gateway Features:

a. User configurable, with secure password-protected login process.

b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.

c. Allow firmware upgrades through the communications port.

4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.

5. Implement a common user interface ("look and feel") across different styles of power equipment.

E Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.

2. Display Data:

a. Circuit summary page to display circuit name, three-phase average RMS current, real power (kW), power factor, and breaker status (if applicable).

b. Load current summary page to display circuit name, and phase a, b, and c RMS current values.

c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.

d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.

e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.

f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above must be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).

g. For motor-control centers, the circuit summary web page must be tailored specifically for this application, to display circuit name, three-phase average RMS current, ther-

mal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.7 SYSTEM OPERATOR INTERFACES

- A Operator means of system access must be through the following:
 - 1.Desktop workstation with hardwired connection through LAN port.

2.8 RACEWAYS AND BOXES

- A Comply with requirements in Sections 260531, 260537 & 260541 for electrical power wiring and NFPA 70 Class 1 & 2 remote-control and signaling circuits.

2.9 WIRES AND CABLES

- A Electrical Power Wiring: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1.Copper conductors are Type THHN/THWN-2.
- B Control Wiring:
 - 1.Copper: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- C Balanced Twisted-Pair Cable: 100 ohm, four-pair balanced twisted-pair cable, Category 5e.
- D Control-Voltage Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
 - 1.Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
 - 2.Ordinary Switching Circuits: Three conductors unless otherwise indicated.
 - 3.Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 EXECUTION

3.1 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

- A Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
- B 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.
- C Wiring and Cabling Installation:
 - 1.Comply with Section 260519 "Building Wire and Cable" for electrical power wiring.
 - 2.Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.
- D Raceways Installation:
 - 1.Comply with Sections 260531 "Conduit" and 260541 "Boxes and Enclosures" for electrical power wiring and NFPA 70 Class 1 and Class 2 remote-control and signaling circuits.
- E Identification Installation:
 - 1.Comply with Section 260519 "Building Wire and Cable" for electrical power wiring.

3.2 INSTALLATION OF WORKSTATION SOFTWARE

- A Graphics Application:
 - 1.Use system schematics indicated as starting point to create graphics.
 - 2.Develop Project-specific library of symbols for representing system equipment and products.
 - 3.Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
 - 4.Submit sketch of graphic layout with description of text for each graphic for Owner's review before creating graphic using graphics software.
 - 5.Seek Owner input in graphics development once using graphics software.
 - 6.Final editing must be done on-site with Owner's review and feedback.
 - 7.Refine graphics as necessary for Owner acceptance.

8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the system operation and maintenance manual.

3.3 NETWORK NAMING AND NUMBERING

- A Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.4 GROUNDING

- A For data communication wiring, comply with BICSI N1.
B For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A Field tests and inspections must be witnessed by Owner.
B Tests and Inspections:
1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 2. Visually inspect balanced twisted-pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of components.
 4. Power Monitoring and Control System Tests.
 - a. Test Analog Signals:
 - 1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 - 2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 - 3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
 - b. Test Digital Signals:
 - 1) Check digital signals using a jumper wire.
 - 2) Check digital signals using an ohmmeter to test for contact making or breaking.
 - c. I/O Control Loop Tests:
 - 1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
 - 2) Test every I/O point throughout its full operating range.
 - 3) Test every control loop to verify that operation is stable and accurate.
 - 4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
 - 5) Test and adjust every control loop for proper operation according to sequence of operation.
 - 6) Test software and hardware interlocks for proper operation.
 - 7) Operate each analog point at the following:
 - (a) Upper quarter of range.
 - (b) Lower quarter of range.
 - (c) At midpoint of range.
 - 8) Exercise each binary point.
 - 9) For every I/O point in the system, read and record each value at operator workstation, at controller, and at field instrument simultaneously. Value displayed at operator workstation and at field instrument must match.

- 10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

C Nonconforming Work:

1. Wiring and cabling will be considered defective if they do not pass tests and inspections.

D Prepare test and inspection reports.

3.6 FINAL REVIEW

- A Submit written request to Engineer when the power monitoring and control system is ready for final review. Written request must state the following:
1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
 2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
 3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
 4. The system is complete and ready for final review.
- B Review by Engineer will be made after receipt of written request. A field report must be issued to document observations and deficiencies.
- C Take prompt action to remedy deficiencies indicated in field report and submit a second written request when deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D Final review must include a demonstration to parties participating in final review.
- E Beginning at Final Acceptance, maintenance service must include three months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

3.7 SOFTWARE SERVICE AGREEMENT

- A Technical Support: Beginning at Final Acceptance, service agreement must include software support for two years.
- B Upgrade Service: At Final Acceptance, update software to latest version. Install and program software upgrades that become available within two years from date of Final Acceptance. Upgrading software must include operating system and new or revised licenses for using software.
1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 TRAINING

- A On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
 2. Instructor must provide training materials, projector, and other audiovisual equipment used in training.
 3. Provide as much of training located on-site as deemed feasible and practical by Owner.
 4. On-site training must include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
 5. The operator workstation provided with the system must be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

END OF SECTION 26 09 13

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

3.9 SECTION INCLUDES

A Piping materials and installation instructions common to most piping systems.

3.10 PIPE, TUBE, AND FITTINGS

A Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

3.11 JOINING MATERIALS

A Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

END OF SECTION 22 05 00

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260100 "General Provisions - Electrical" apply to this Section.

1.2 SUMMARY

- A Description:
 - 1. Section includes requirements for the provision of Lighting Controls including manufacturing, fabrication, configuration, and installation as required for the complete performance of the Work, as shown on the Drawings, as specified herein.
 - 2. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all lighting controls.
 - 3. Specifications and drawings are intended to convey all salient features, functions, and characteristics of the lighting control devices only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper execution and completion of the lighting controls shall be included, the same as if they were herein specified or indicated on the drawings.
- B Section Includes:
 - 1. General lighting control devices
 - 2. Lighting control relay panels
 - 3. Electronic digital time switches
 - 4. Emergency lighting control devices
- C Related Requirements:
 - 1. Refer to Section 262726, "Wiring Devices" for requirements related to lighting snap switches and wall plates.

1.3 REFERENCES

- A Abbreviations and Acronyms
 - 1. BAS: Building Automation System.
 - 2. DDC: Direct Digital Controller/Direct Digital Control.
 - 3. IP: Internet protocol.
 - 4. NRTL: Nationally Recognized Testing Laboratory
 - 5. SPD: Surge Protection Device
- B Definitions
 - 1. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100 and ANSI/IES LS-1.
 - 2. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
 - 3. Zone: A light fixture or group of light fixtures controlled simultaneously as a single dimmer/relay/entity.
 - 4. Occupancy Sensor: Motion sensing device programmed as automatic on and automatic off.
 - 5. Vacancy Sensor: Motion sensing device programmed as manual on and automatic off.
- C Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
 - 1. National Electrical Contractors Association (NECA):

- a. NECA NEIS 130, "Standard for Installing and Maintaining Wiring Devices"
- 2. Underwriters Laboratories, Inc. (UL):
 - a. UL 508, "Standard for Industrial Control Equipment."
 - b. UL 773, "Plug-in, Locking Photocontrols for Use with Area Lighting."
 - c. UL 773A, "Nonindustrial Photoelectric Switches for Lighting Control."
 - d. UL 916, "Standard for Energy Management Equipment Systems."
 - e. UL 917, "Clock Operated Switches."
 - f. UL 924, "Emergency Lighting and Power Equipment."
 - g. UL 1008, "Transfer Switch Equipment."
 - h. UL 1449, "Transient Voltage Surge Suppressors."
 - i. UL 2108, "Low-Voltage Lighting Systems."

1.4 SUBMITTALS

- A Product Data: For each type of product indicated including physical data and electrical performance. Include data on features, accessories, finishes, and the following:
 - 1. Physical description, including dimensions.
 - 2. All available finishes and colors for each device and wall/cover plate shall be submitted to the Architect for selection during review.
 - 3. Control type: 0-10V, DMX, bi-level, etc.
 - 4. Sample Warranty.
- B Shop Drawings: Show installation details for occupancy, vacancy, light-level sensors, and digital control devices.
 - 1. Lighting floor plan showing location, orientation, and coverage area of each wall and ceiling mounted sensor.
 - 2. Interconnection diagrams showing field-installed wiring.
 - 3. Riser diagrams indicating device network and cabling types.
 - 4. Include systems descriptions, set points, and controls settings and adjustment.
- C Manufacturer's Installation Instructions: Include for manufactured components.
- D Qualification Data: For Start-Up Field Technician
- E Closeout Submittals
 - 1. Operation and Maintenance Data: For each type of product to include in operation and maintenance manuals. In addition to items specified in Division 01 and Section 260100 "General Provisions - Electrical", include the following:
 - a. Description of operation and servicing procedures.
 - b. Technical support contact
 - c. List of components.
 - d. Recommended spare parts.
 - e. Programming instructions and system operation procedures.
 - f. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.
 - g. Include operation and maintenance manuals for equipment and devices, including sensors, power supplies, and other equipment furnished.
 - h. Provide detailed set-up information for furnished equipment, indicating required initial configuration switch settings, jumper positions, to facilitate equipment replacement.
 - i. Include device calibration settings after system programming and start-up with manufacturer's representative.

1.5 MAINTENANCE MATERIAL

- A Extra Stock Material: Provide one (1) of each type of sensor, switch, dimmer, power pack, and emergency lighting control device installed. Package with protective covering for storage and identified with labels describing contents.
- B Keys and Special Tools: Provide one extra set for access to locked or tamperproof enclosures.

1.6 QUALITY ASSURANCE

- A Manufacturer Qualifications:
 - 1. Manufacturer must maintain an authorized service organization within 100 miles of the project location that stocks a full complement of parts for all equipment specified in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
 - 2. Provide toll free technical telephone support.
- B Installer Qualifications:
 - 1. An employer of workers qualified and trained in electrical safety as required by NFPA 70E.
- C Start-Up Field Technician Qualifications:
 - 1. Minimum experience of 2 years training in the electrical/electronic field.
 - 2. Certified by the manufacturer on the system installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A Comply with manufacturer instructions for storage of equipment and devices to prevent damage from dirt, moisture, or other environmental concerns.

1.8 COORDINATION

- A Preinstallation Conference: Arrange a pre-installation conference between all applicable sub-contractors and architect/engineer prior to the installation of rough ins for the lighting controls.
- B Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, speakers, fire alarm, HVAC equipment, fire-suppression system, and partition assemblies.
- C Coordinate protocol and interface points of lighting control devices with temperature controls (BAS/DDC) specified in Division 23.
- D Product procurement and coordination:
 - 1. Order products according to application.
 - 2. Confirm the proper and complete catalog number with distributor and agent.
 - 3. Provide additional parts and pieces required to complete the installation in the location and manner intended by the design.
 - 4. Confirm voltages.
- E Contractor shall coordinate with Vendors and other trades, in advance of installation work, to define all infrastructure and installation requirements. Contractor shall coordinate all infrastructure requirements with all approved lighting control devices prior to infrastructure installation. This includes, but not limited to, appropriately sized, positioned, and located junction boxes, structural supports, feeds, power conduits, control conduits, and remote code-compliant power-supply enclosures.

1.9 WARRANTY

- A Manufacturer's Warranty: Manufacturer agrees to repair or replace lighting controls, finishes, wiring, cabling, and all of its components that fail in materials or workmanship within 5 years from date of Final Acceptance.

PART 2 PRODUCTS

2.1 GENERAL 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 NFPA 70, as well as applicable ANSI, IEC standards, and FCC regulations.
- C Comply with CFR Title 47, Part 15, Subparts A and B, for Class A digital devices.
- D Devices shall be in accordance with NFPA 70, NEMA, and UL listed and labeled.
- E RoHS compliant.
- F Devices located in above ceilings shall be plenum rated.

- G Power failure: Incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost and should restore system to its last operating state without requiring user input.
- H Failsafe operation: If automatic switching device loses power, device will latch to closed "ON" position.
- I Components shall be designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
- J Products tested in identical manner, complaint to NEMA WD 7 -2011 Occupancy Motion Sensors Standards.
- K Voltage: 120/277VAC unless noted otherwise
- L Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449 and with ANSI C62.41 for Category A locations.
- M Refer to Section 262726 "Wiring Devices" for device and faceplate colors.
- N Standard Operating Range: 32 to 120 deg F, up to 90 percent relative humidity, non-condensing, unless noted otherwise.
- O Minimum load rating: 800W at 120VAC and 1200W at 277VAC.
- P Provide all control devices with LED status indicator.
- Q Minimum Occupancy and Vacancy Sensor Coverage Radius:
 - 1. Wall Switch: 35 ft for large motion, 20 ft for small motion.
 - 2. Ceiling, 360 deg, Standard Range: 12 ft radius for small motion.
 - 3. Ceiling, 360 deg, Extended Range: 28 ft radius for large motion.
 - 4. Corner, 120 deg: 40 ft for large motion.
 - 5. Hallway: 100 ft for large motion.
 - 6. High Bay, 360 deg: 20 ft radius at 15 ft mounting height for large motion

2.2 GENERAL LIGHTING CONTROL DEVICES

- A Basis of Design: Subject to compliance with requirements, provide products indicated on Drawings or equivalent by one of the following:
 - 1. Wattstopper
 - 2. Lutron
 - 3. Acuity Sensorswitch
 - 4. Hubbell
 - 5. Leviton
- B General Requirements:
- C Wall Switch Occupancy and Vacancy Sensors: Decora style sensor with on/off switch(es) for mounting in a single gang switchbox.
 - 1. Programmable Automatic On and Manual On Operating Modes.
 - 2. Time Delay for Automatic Off: 30 minutes.
 - 3. Programmable sensitivity settings.
 - 4. Sensing Technology: Dual technology, PIR and Ultrasonic or Microphonics unless noted otherwise.
 - 5. Noise filtering to eliminate false triggers.
 - 6. Vandal resistant lens
 - 7. Multi-Way: Multi-way: Capable of operation in 3-way application where indicated.
 - 8. Dimming: Provide 0-10V dimming output where indicated.
 - 9. Dual Relay: Where independent control of two loads is required, provide unit with two isolated relays and override switches, capable of independent operating modes and time delays.
- D Line Voltage Occupancy Sensors: Self-contained occupancy sensor with integral power supply and relay suitable for mounting to a standard outlet box in ceiling and wall mounted applications
 - 1. Automatic On operation.
 - 2. Time delay for Automatic Off: 30 minutes .
 - 3. Sensing Technology: Dual technology, PIR and Ultrasonic or Microphonics unless noted otherwise.

4. Dual Relay: Where independent control of two loads is required, provide unit with two isolated relays and override switches, capable of independent operating modes and time delays.
- E Low Voltage Occupancy, Vacancy Sensors, Daylight Sensors, Power Packs, and Low Voltage Wall Stations
 1. Programmable Automatic On and Manual On Operating Modes.
 2. Time Delay for Automatic Off: 30 minutes .
 3. Sensing Technology: Dual technology, PIR and Ultrasonic, unless noted otherwise.
 4. Noise filtering to eliminate false triggers.
 5. Isolated Relay: Low voltage relay with N.O. and N.C. outputs to indicate occupancy status for HVAC interface with BAS/DDC system.
 6. Power Packs/Load Controllers: Self-contained power supply with relay module capable of switching 20-amp load.
 - a. Class 2, 24VDC output for powering low voltage sensors.
 - b. UL 2043 Plenum Rated.
 - c. Threaded 1/2-inch nipple, suitable for mounting inside or outside a junction box.
 7. Wall stations: Low voltage, decorator style, with single or multiple pushbuttons for interface with power packs and sensors.
 - a. Multi-way: Capable of operation in 3-way application.
 - b. Manual Dimming: Provide 0-10V dimming output where indicated.
- F Interval Timer Light Switch: Combination countdown timer and conventional switch lighting control unit, switchbox mounted, decorator style.
 1. On/Off Switch with Status LED.
 2. Adjustable preset intervals.
 3. Warning: Audible and/or flash timeout warning.
- G Wallbox Dimmer Switches
 1. Single gang decorator style, suitable for full range continuous variable control of luminaire light intensity.
 2. Comply with UL 1472.
 3. Preset slide style dimming control with a mechanical air-gap switch to totally disconnect power from the load when in the off position.
 4. Compatible with luminaire ballast or driver.
- H Wired Digital Load Controllers (Room, Plug Load And Fixture)
 1. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control requirements. Controllers are simple to install, and do not have dip switches/potentiometers or require special configuration for standard Plug n' Go applications. Control units include the following features:
 - a. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room (Plug n Go)
 - b. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
 - c. Multiple wired load controllers connected in a local wired IRB network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device serial number from highest to lowest.
 - d. Device Status LEDs to Indicate:
 - 1) Data transmission
 - 2) Device has power
 - 3) Status for each load
 - 4) Configuration status
 - e. Quick Installation Features Including:
 - 1) Standard junction box mounting

- 2) Quick low voltage connections using standard RJ-45 patch cable
- f. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - 1) Turn on to 100 percent
 - 2) Turn off
 - 3) Turn on to last level
- g. Each load to be configurable to operate in the following sequences based on occupancy:
 - 1) Auto-on/Auto-off (Follow on and off).
 - 2) Manual-on/Auto-off (Follow off only).
- h. Polarity of each load output shall be reversible, via digital configuration, so that an on command turns load off and an off command turns a load on.
- i. BACnet object information shall be available for the following objects:
 - 1) Load status
 - 2) Schedule state, normal or after-hours
 - 3) Demand Response enable/disable
 - 4) Room occupancy status
 - 5) Total room lighting and plug loads watts
 - 6) ** NOTE TO SPECIFIER ** When metering is present in the Load Controllers, these additional objects shall also be available.
 - 7) Electrical current
 - 8) Total watts per controller
 - 9) Total room watts/sqft.
- j. UL 2043 plenum rated
- k. LED On/Off status indication for each load
- l. Zero cross circuitry for each load
- m. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- n. Dimming Room Controllers shall share the following features:
 - 1) Each load shall have an independently configurable preset on level for Normal Hours and After Hours to allow different dimmed levels to be established.
 - 2) Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - 3) The following dimming attributes may be changed or selected using a wireless configuration tool:
 - (a) Establish preset level for each load from 0-100 percent.
 - (b) Set high and low trim for each load.
 - (c) Initiate lamp burn in for each load of either 0, 12 or 100 hours.
 - 4) Override button for each load provides the following functions:
 - (a) Tap for on/off control.
 - (b) Press and hold for dimming control (lighting only).
 - 5) Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - 6) Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 - 7) Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.

- o. All configurations shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dipswitches are not acceptable.

2.3 LIGHTING CONTROL RELAY PANELS

A Manufacturers:

1. Wattstopper
2. Lutron
3. Leviton
4. Lighting Controls & Design (LC&D)
5. Lyntec

B Description: Lighting control panel using mechanically latched relays to control lighting and appliances based on inputs from sensors, switches, or other sources along with zone based timed overrides and blink warnings. Capable of operation in a standalone application or interconnected with digital communications to operate multiple panels as a single system.

1. Pre-assembled steel enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit. Comply with UL 508.
2. A vertical barrier separating branch circuits from control wiring.
3. Suitable for surface or flush mounting with a hinged locking door assembly.
4. Relay capacity and configuration as required to accommodate switched zones shown on drawings plus 20 percent spare capacity.
5. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

C Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.

1. Native Ethernet Communications: Comply with TCP/IP protocol. Provide for programming of all control functions of lighting control panels including timing, sequencing, and overriding.
2. Integral keypad, USB port, and LCD digital-display for local programming
3. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation, including accurate time of day and date.
4. Web Server: Display control, setup, and diagnostic information over a standard Web-enabled server for displaying information over a standard browser.
5. Timing Unit
 - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
 - b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
 - c. Four independent schedules, each having 24 time periods.
 - d. Schedule periods settable to the minute.
 - e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
 - f. 10 special date periods.
6. Sequence Control and Override:
 - a. Automatic sequenced on and off switching of individual or groups of relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control must allow any relay connected to it to be switched on or off by a manual switch or by an automatic switch, such as a sensor. Provide 2-hour override unless otherwise noted.
 - d. Override control "blink warning" must warn occupants approximately five minutes before actuating the off sequence. Does not apply to exterior lighting.
 - e. Activity log, storing previous relay operation, including the time and cause of the change of status.

D Relays

1. Electrically operated, mechanically held, minimum 20 A rating at 120/277 VAC for single pole switches and 208/240/480VAC for double pole switches.
 2. Integral manual ON/OFF switch with visual display of switch state.
 3. Suitable for control of incandescent, fluorescent, LED, and HID loads.
 4. Short-circuit current rating must not be less than available fault current as indicated in power system study.
- E Integral Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, control-voltage inputs, and any field-installed sensors.
- F Push-Button and Key Operated Wall Station Switches: Modular, momentary contact or digital, for operating one or more relays and to override automatic controls.
- G Sensors and photocells: Powered from the lighting control relay panel, and signal compatible with the relay panel control unit. Comply with General Requirements section specified herein.

2.4 ELECTRONIC DIGITAL TIME SWITCHES

- A Basis of Design: Subject to compliance with requirements, provide product indicated or equivalent product by one of the following:
1. Intermatic
 2. Tork
- B Description: Electronic, solid-state programmable units with alphanumeric display complying with UL 916 and UL 917.
1. Contact capacity and configuration as required to accommodate switched zones and loads shown on drawings.
 2. Contact Rating: 30-A, 120/277-VAC.
 3. Operating Temperature: -40 to 155 deg F.
 4. Enclosure: Steel, NEMA 3R outdoor, lockable.
 5. Schedule: Astronomic 7-day/365-day dusk to dawn scheduling with up to 48 on and 48 off events per week and an annual holiday schedule that overrides the weekly operation on holidays.
 6. Automatic daylight savings time changeover.
 7. Adjustable switching configurations for simultaneous, independent, or pulse control of contacts.
 8. 2-hour override buttons.
 9. Backup power: Minimum 100-hour time and date retention.
 10. Nonvolatile memory, to maintain programming after power loss.
 11. USB connection for uploading, downloading, and transferring of programs

2.5 EMERGENCY LIGHTING CONTROL DEVICES

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bodine
 2. Wattstopper
 3. Dual-Lite
 4. LVS
- B Automatic Load Control Relays (ALCR)
1. Operation: Automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
 2. UL 924 listed device with relay switching circuitry, test switch, normal power indicator light, and an alternate power indicator light in a single enclosure.
 3. Universal Input Voltage: 120-277V, 60Hz
 4. Load Rating: 20A

5. Suitable for indoor or damp locations.
- C Branch Circuit Emergency Lighting Transfer Switches (BCELTTS)
 1. Operation: Automatically switch a lighting load from a normal source to a designated emergency source when normal power is lost.
 2. UL 1008 listed device with relay switching circuitry, test switch, normal power indicator light, and an alternate power indicator light in a single enclosure.
 3. Universal Input Voltage: 120-277V, 60Hz
 4. Load Rating: 20A
 5. Suitable for indoor or damp locations.

2.6 CONDUCTORS AND CABLES

- A Wiring to supply side of remote-control power sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519, Low-Voltage Electrical Power Conductors and Cables
- B Low-voltage control cable for 0-10VDC dimming: Manufacturer's standard multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG, plenum rated unless otherwise recommended by the manufacturer.
- C Class 1 and 2 Control Cables: Multi-conductor cable with copper conductors not smaller than No. 14 AWG, plenum rated unless otherwise recommended by the manufacturer.
- D UTP cabling: Unshielded, plenum rated, Cat5e twisted-pair cable. Comply with lighting control system manufacturer's recommendations.

2.7 SOURCE QUALITY CONTROL

- A Factory Tests and Inspections: Perform full-function testing on 100 percent of all system components and panel assemblies at the factory prior to delivery.
- B System control components shall be certified by the manufacturer to have been designed, manufactured, and tested for interoperability.

PART 3 EXECUTION

3.1 EXAMINATION

- A Examine lighting control devices and equipment before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B Examine walls, ceilings, and other mounting surfaces for suitable conditions where lighting control devices and equipment will be installed.
- C Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A Install lighting controls and equipment in accordance with manufacturer's written instructions, applicable requirements of NEC, and NECA 500 and 501.
- B Electrical installations shall conform to and meet IEEE C2, NFPA 70, and to the requirements specified herein.
- C Devices and Equipment shall be installed and programmed to meet the control intent.
- D Device Installation:
 1. Comply with Section 262726 "Wiring Devices" for wall mounted device and faceplate installation requirements.
 2. Install in a single box and provide a single cover plate where two or more devices are shown adjacent on plans. Provide voltage barrier where required.
 3. Verify door swings with door frame installed prior to rough-in for switches and sensors. Locate switches on latch side of door.
 4. Device Orientation: Install switches and dimmers with the "OFF" position down.
- E Panels and Cabinets:
 1. Install panels and cabinets in accordance with NECA 407.
 2. Mount top of trim no greater than 90-inches above finished floor unless otherwise indicated.

3. Mount panel cabinet plumb and rigid without distortion of box.
4. Install filler plates in unused spaces.
- F Conductors/Wiring:
 1. Wiring Methods: Comply with Section 260519, Low-Voltage Electrical Power Conductors and Cables.
 2. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
 3. Voltage Drop: Adjust conductors and conduit sizes accordingly based on actual field installed conditions.
 4. Where the total conductor length for 0-10VDC dimming applications exceeds the values below, adjust conductor size as noted.
 - a. Conductor lengths up to 300 feet: #18 AWG minimum.
 - b. Conductor lengths between 300 feet and 430 feet: #16 AWG minimum.
 - c. Conductor lengths between 430 feet and 690 feet: #14 AWG minimum.
 - d. Conductor lengths between 690 feet and 1100 feet: #12 AWG minimum.
 - e. Conductor lengths between 1100 feet and 1750 feet: #10 AWG minimum.
 5. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
 6. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
 7. Provide plenum-rated cable, where installed exposed or in open cable tray, within environmental airspaces, including plenum ceilings.
- G Lighting Controllers/Power Packs:
 1. Room controllers shall be surface mounted in accessible ceiling space above entry door. Install no higher than 6" above accessible ceiling.
 2. Install controllers/power packs on the unswitched line side of local switches to keep sensors powered at all times.
 3. Provide controllers/power packs(s) for each room/area/control zone for a working system.
 4. Note all power pack locations and branch circuiting on as-built record drawings.
- A. Lighting Contactors
 5. Install lighting contactors as indicated on plan. Install at accessible locations.
 6. Mount contactors in a manner to eliminate structure-borne vibration
- B. Occupancy and Vacancy Sensors
 7. Provide quantity of sensors indicated as a minimum. Provide additional units to give full coverage over controlled area. Provide full coverage for hand and arm motion detection in office, classroom, and administration type areas and walking motion for storage rooms and hallways.
 8. Install wallbox sensors at switch height indicated on drawings.
 9. Install wall sensors without manual switches at 8 ft above finished floor unless otherwise noted on drawings.
 10. Install ceiling mounted sensors at locations indicated on manufacturer's shop drawings. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.
 11. Locate sensors such that motion through open doors will not falsely activate sensors.
 12. Do not locate ultrasonic sensors within six feet of supply air diffusers.
 13. Locate infrared sensors to avoid obstructions.

3.3 IDENTIFICATION

- C. Comply with Section 260553 "Identification for Electrical Systems."
 1. Identify all components and power and control wiring.

2. Label time switches and contactors with a unique designation.
3. Provide directories inside relay panels and contactor cabinets that identify each relay and the associated control zone.

3.4 FIELD QUALITY CONTROL

- A Visual and Mechanical Inspections:
1. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted.
 2. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.
- B System Start-up:
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Confirm layout and location of sensors with manufacturer's recommendations to achieve proper coverage of indicated areas. Provide additional sensors and control units as required to achieve complete minor motion coverage of the space indicated. Provide customizable sensor masks to block off unwanted viewing areas.
 3. Confirm control schedules with owner including operating hours for each day of the week and holiday schedules. Submit to design team for approval.
- D. System Functional Tests: After installing all control devices, automatic time switches, and sensors, and after electrical circuitry has been energized, test systems for compliance with approved sequences in accordance with energy code requirements.
4. Adjust time delays, trim settings, dead bands, and scene settings.
 5. Owner and architect/engineer shall be present during adjustment of scene settings. Exterior scenes shall be adjusted during non-daylit hours.
 6. Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 7. Include testing of devices under conditions that simulate actual operational conditions including occupied and unoccupied states.
 8. Verify all emergency lighting functions upon loss of power.
 9. Record all control settings, operations, cues, and functional observations.
- E. Nonconforming Work:
10. Lighting control devices and equipment will be considered defective if it does not pass tests and inspections.
 11. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace defective units and retest.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C Prepare test and inspection reports.

3.5 ADJUSTING

- A Occupancy Adjustments: When requested within 12 months of date of Final Acceptance, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.
- B The lighting and lighting controls systems shall be synchronized and fully operable to address the lighting operation in a complete and code-compliant manner.
- C All ladders, scaffolds, lifts, gloves, cleaning cloths, access/adjustment tools, etc. required for aiming and adjusting lighting controls shall be furnished by the Contractor.

3.6 PROTECTION

- A Install lighting control devices after all wall preparation, including painting, is complete.
- B Replace all devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

- C Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
- D Do not remove surface protection, such as plastic film and smudge covers, until final cleaning has been completed.

3.7 DEMONSTRATION

- A Engage a factory-authorized service representative to train Owner's facility management and maintenance personnel, and selected Owner representatives. as specified below:
 - 1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of four (4) hours training.
 - 2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
 - 3. Training shall include, but not be limited to, overview, adjustment, operation, use, maintenance, and demonstration of the lighting control system.

END OF SECTION 26 09 23

SECTION 26 27 26 – WIRING DEVICES

PART 1 GENERAL

1.1 WORK INCLUDED:

- A Requirements of Section 260100 shall apply.
- B Wiring devices shall be as indicated and as specified below. All devices shall be UL listed and comply with NEMA WD-1.
- C Related Work Specified Elsewhere:
 - 1. Section 260541 – Boxes and Enclosures

1.2 PART NUMBERS:

- A Manufacturer's numbers listed are to establish a type and standard of quality. Any prefix and/or suffix, whether to be added or deleted to complete the number, shall be the Contractor's responsibility. This applies specifically but not exclusively to color identification, grade, and compliance with standards and specifications.
- B Standard duplex receptacles shall be federal specification, or heavy duty grade. All other wiring devices of any one general type (i.e. all duplex receptacles, all wall switches, etc.) shall be of the same manufacturer, color and shall match throughout.

1.3 GRADE:

- A Only the highest quality device in a category (single pole toggle, conventional duplex, etc.) will be acceptable. The addition or deletion of a prefix or suffix to change the device to a lower grade will not be acceptable.

1.4 COLOR:

- A. Unless indicated otherwise, color of 20 ampere devices shall be gray for all normal power circuits, and red for emergency and standby circuits. Illuminated switches shall be clear. Colors shall be that of the molding compound. Painting will not be acceptable.

1.5 WIRING:

- A Unless noted SWO (side wired only), devices shall be back and side wired screw type terminals. Pigtails will not be acceptable unless noted otherwise.

1.6 GROUNDING:

- A All devices shall be equipped with a "hex-head" green grounding screw for grounding the device to the grounding conductor run with the circuit conductors.

1.7 WIRING TEMPERATURE RATING:

- A Each wiring device shall be UL listed for use with 75 degree C rated wire or higher.

1.8 MANUFACTURER:

- A All devices shall be by a single manufacturer unless noted otherwise or not commercially available.
- B Furnish manufacturer's data and literature for each item provided under this Section.

PART 2 PRODUCTS

2.1 RECEPTACLES:

- A All standard duplex receptacles shall be federal specification grade type. All other wiring devices of any one general type (i.e. all duplex receptacles, all wall switches, etc.) shall be of the same manufacturer, color and shall match throughout.
- B Standard duplex receptacles shall be grounding type with nylon body arranged for back and side wiring, with separate single or double grounding terminals. Standard duplex receptacles shall

be straight blade, NEMA configuration 5-20R, rated 20A., 125-volt and the face configuration shall conform to the NEMA Standard No. WDI, NEMA WD-6, DSCCW-C596G and UL-498, and shall be "approved" third-party listed. Self-grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a direct, green insulated conductor connection to the equipment grounding system. Standard duplex receptacles shall be federal specification, or heavy duty grade, mounted vertically. Standard duplex receptacles shall have a solid brass mounting strap with non-riveted integral one piece grounding system. Receptacles mounted over counters, back-splashes, etc. shall be of horizontal configuration. In addition, receptacles used in wet locations shall be listed for use in such locations. Receptacles with USB charging ports shall be provided with two 5-20R receptacles as well as two USB charging ports with 2.1 amperes capacity.

2.2 MANUFACTURERS:

- A Manufacturers are subject to meeting this specification. Standard duplex receptacle manufacturers shall be Hubbell, Bryant or P&S.

DEVICE	MANUFACTURER		
	P&S	Hubbell	Bryant
Duplex, NEMA 5-20R, 20A, 125V	5362-A	HBL5362	5362
GFI duplex, 3-wire feed through 20A, 125V NEMA 5-20R	2094	GFR5352	GF53

- B Special Devices: Provide NEMA 5-20R duplex GFI receptacle for any application where the receptacle is within 6 feet of a sink and as otherwise noted on drawings, unless the circuit is protected with GFI type circuit breakers.

NEMA CONFIGURATION	P&S	HUBBELL	ARROW-HART
5-30R	3802	9308	5716
5-50R	3803	9360	5711
6-20R	5862	5462	5862-S
6-30R	3801	9330	5700
6-50R	3804	9367	5709
10-30R	3860	9350	9333
10-50R	3890	7512	7987
14-20R	3820	8410	5759
14-30R	3864	9430	5744
14-50R	3894	9450	5754
14-60R	3871	9460	9460
15-20R	3821	8420	5781
15-30R	5740	8430	8430
15-50R	5750	8450	8450
15-60R	5760	8460	8460
18-20R	3822	7250	7250

NEMA CONFIGURATION	P&S	HUBBELL	ARROW-HART
18-60R	3870	7301	5515
L5-20R	L520-R	2310	6200
L5-30R	L530-R	2610	6330
L6-20R	L620-R	2320	6210
L6-30R	L630-R	2620	6340
L14-20R	L1420-R	2410	6400
L14-30R	L1430-R	2710	6510
L15-20R	L1520-R	2420	6420
L15-30R	L1530-R	2720	6520
L21-20R	L2120-R	2510	6470
L21-30R	L2130-R	2810	6610

C Interior Weatherproof Receptacles: shall be duplex NEMA 5-20R with gasketed weatherproof cast aluminum plate UL listed for wet and damp locations with cover closed, vertical mounting except as:

1. Exterior Receptacles: Receptacles not protected from rain by building features shall be duplex NEMA 5-20R, with built-in GFI, with enclosure listed as weatherproof when receptacle is being used. Receptacles mounted on exterior of building, but protected from rain by building features, shall be as specified for interior weatherproof receptacles, but with built-in ground fault protection. Exterior receptacles shall be listed as weather-resistant in accordance with NEC 2020 requirements. Exterior receptacles shall have corrosion resistant gasketed metallic covers with baked aluminum finish with NEMA 3R rating while in use. Plastic covers are not acceptable.

2.3 OUTLET BOXES:

- A Refer to Section 260541 for outlet boxes, floor boxes and poke-through devices. Outlet boxes for devices with weatherproof cover shall be as required by specified cover. In mechanical rooms specified with weatherproof covers, outlet boxes shall be surface mounted if required by cover plate.

2.4 DEVICE PLATES:

- A Cover plates for flush mounted wiring devices and telephone outlets shall be Type 302 stainless steel or nylon type, standard size, single or ganged as shown on the drawings. Cover plate mounting screws shall be slotted head oval screws and shall match the finish and material of the plate and shall be furnished with the plate manufacturer. Quantity of 2% spare cover plates of each type shall be provided to the owner.
- B Switch and receptacle cover plates on exposed work shall be galvanized cast ferrous metal, standard size, and shall be single or ganged as indicated on the drawings.
- C Exterior mounted receptacle plates, and those notes to be weatherproof, shall be extra duty rated, standard size, single or ganged as indicated on the drawings.

PART 3 EXECUTION

3.1 GENERAL:

- A Devices shall be mounted tightly to boxes and be adjusted plumb and level.

- B Where two or more devices are indicated for gang installation they shall be trimmed with gang type plates.
- C Ground each receptacle by means of a separate code size ground wire (#12 minimum) connecting the receptacle ground terminal to the grounded conduit system.

3.2 GFI RECEPTACLES:

- A GFI receptacles shall be installed as required by NEC, as part of original contract documents, whether shown on plans or not.

3.3 ORIENTATION OF RECEPTACLES:

- A Generally, receptacles shall be mounted vertically. Receptacles mounted over counters, back-splashes, etc., shall be mounted horizontally.
- B All vertically mounted receptacles shall be mounted with the grounding blade up.
- C All horizontally mounted receptacles shall be mounted with the neutral blade up.
- D Receptacles shall not be mounted back-to-back.

3.4 RECEPTACLE LABELING:

- A Each receptacle, whether mounted in wall or in multi-outlet assembly, shall have a permanent label indicating circuit and panel number. Refer to Section 260553 for requirements. The contractor is responsible for taking the necessary steps to make sure that each receptacle ends up with the correct plate/circuit number and it is not all messed up when the walls are painted. The A/E will spot check receptacle circuit numeration for correctness during final inspection.

END OF SECTION 26 27 26

SECTION 26 28 16 – ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SCOPE OF WORK:

- A Requirements of Sections 26 01 00, 260574 and 260553 shall apply.
- B Work included shall include but not necessarily be limited to the following:
 - 1. Fusible safety and disconnect switches
 - 2. Non-fusible safety and disconnect switches

1.2 APPLICABLE STANDARDS

- A NEMA KS-1 Enclosed and miscellaneous distribution equipment switches (600 volts maximum)
- B UL 98 Enclosed and dead-front switches

1.3 SUBMITTALS:

- A Provide manufacturers' catalog data for all products specified here.

PART 2 PRODUCTS

2.1 WIRING TEMPERATURE RATING:

- A Products specified here shall be UL listed for connection to 75-degree C conductors, or higher, and third party listed.
- B Safety Disconnect Switches: Provide fusible and/or non-fusible heavy duty safety and disconnect switches with ratings and fuse types and sizes as shown on the drawings. General duty switches are unacceptable for use. Provide horsepower rated switches for use as motor circuit disconnecting means, in accordance with the individual manufacturer's published ratings. For applications in excess of switch ratings provide non-automatic molded cast circuit breakers rated not less than 125% of motor full load current. Provide each fused switch with the following:
 - 1. Line terminal shields
 - 2. Visible copper blades
 - 3. ATC chute for each pole
 - 4. Non-fusible, positive, quick-make, quick-break interrupter operating mechanism.
 - 5. Rejection fuse clips sized for specified fuses. Contractor shall provide fuse reducer if so required.
 - 6. Handle whose position is easily recognizable in the 'on' or 'off' position and can be multiple padlocked in the "OFF" position.
 - 7. Defeatable door interlocks that prevent the door from opening when the operating handle is in the "ON" position.
 - 8. Factory installed ground lug.
 - 9. 'R' type fuse holders – furnish switches completely fused
 - 10. Provide padlocks on switches located in public areas.
- C Non-fusible disconnect switches shall be as specified above, except without provisions for fuses.
- D Fusible disconnect switches with short-circuit withstand ratings of 100kA and up require Class R or Class J rejection fuse block feature.
- E Enclosure: Provide these in accordance with the following schedule:
 - 1. NEMA 1 enclosure for dry, indoor areas.
 - 2. NEMA 3R for outdoor locations.
 - 3. NEMA 12 within air plenums
- F Manufacturer: Provide safety/disconnect switches as manufactured by one of the following:
 - 1. Eaton Corporation
 - 2. General Electric Company
 - 3. Square D Company

4. Siemens

PART 3 EXECUTION

3.1 INSTALLATION OF WORKMANSHIP:

- A Enclosure: Mount switch enclosure rigidly and with proper alignment on the building structure one (1) inch off the wall and with top of enclosure 6'-6" above finished floor. Use steel supports fabricated from standard rolled structural steel shapes. Install supports in such a manner as to no block the vertical flow of air between enclosure and wall.
- B Switches shall be securely fastened to the supporting structuring or wall utilizing four 1/4 inch minimum size, bolts. Switches shall not be mounted in an inaccessible location or where passageway to the switch may become obstructed. Provide suitable angle galvanized steel supporting structure for switches when wall space is not available for support. Supporting structure shall be attached to floor slab or overslab with 3/8 inch expansion shields.
- C Wiring: Install all incoming and outgoing power circuits.
- D Fuses: Install fuses, where required, of the proper type and ratings as shown on the drawings.
- E Locate disconnect switches as close as possible to the equipment being protected, at accessible location.
- F Provide nameplate identifying equipment served and circuit serving equipment. Refer to Section 260553.

3.2 FLASH PROTECTION BOUNDARY:

- A The flash protection boundary and the incident energy for the electrical equipment shall be determined in accordance with IEEE 1584 NFPA 70E and NEC 110-16 requirements. Refer to Section 260574.

END OF SECTION 26 28 16

SECTION 26 41 00 - FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, and Section 260100 "General Provisions - Electrical" apply to this Section.

1.2 SUMMARY

- A Section includes requirements for providing a complete UL master labeled traditional lightning protection system for ordinary structures.
- B Related Requirements:
 - 1.Refer to Section 260526, "Grounding and Bonding for Electrical Systems" for additional requirements related to grounding electrodes and connections.
 - 2.Refer to Section 264300, "Surge Protection Devices" for additional requirements related to surge suppression.

1.3 REFERENCES

- A Abbreviations
 - 1.LPI: Lightning Protection Institute
 - 2.LPS: Lightning Protection System
- B Definitions
 - 1.Grounding: Establishing a direct or indirect connection to Earth or some conducting body that serves in place of Earth.
 - 2.Bonding: Method by which all non-energized conductive materials are effectively interconnected to create a low impedance path.
- C Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
 - 1.National Fire Protection Association (NFPA)
 - a. NFPA 780, Standard for the Installation of Lightning Protection Systems
 - 2.Underwriters' Laboratories (UL)
 - b. UL 96, Standard for Lightning Protection Components

1.4 COORDINATION

- A Coordinate system scope and layout requirements, attachment methods, and envelope penetrations with architectural roof plans, elevations, and sections.

1.5 PREINSTALLATION MEETINGS

- A Schedule preconstruction conference with Architect, Owner, and all affected trades. Agenda topics should include, but are not limited to, the following:
 - 1.System Installation Schedule.
 - 2.Planned down conductor routing.
 - 3.Planned building enclosure penetrations.
 - 4.Building material compatibility.
 - 5.Cutting and patching requirements.
 - 6.Surge protection requirements.

1.6 SUBMITTALS

- A Product Data: For each type of product.
- B Shop Drawings: Indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional responsible for their preparation.

2. Include layouts of the lightning protection system, with details of the components to be used in the installation.
 1. Include raceway locations needed for the installation of conductors.
 2. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
 3. Include roof attachment and penetration details, coordinated with roof installation warranty.
 4. Calculations required by NFPA 780 for bonding of metal bodies.
- C Delegated Design: For system layout, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional responsible for their preparation.
- D Qualification Data: For Installer.
- E Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.
- F Sample Warranty.
- G Closeout Submittals
 1. Operation and Maintenance Data: For lightning protection system to include in maintenance manuals.
 2. In addition to items specified in Division 01 and Section 260100 "General Provisions - Electrical" include the following:
 - a. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.
 3. As-Built Data: Dimensioned site plan showing dimensioned route of the grounding electrodes.
- H Completion Certificate:
 1. UL Master Label Certificate suitable for fastening to building for display.

1.7 QUALITY ASSURANCE

- A Manufacturer Qualifications: Regularly engaged in manufacturer of lightning protection equipment, of types, sizes and ratings required, whose products have been satisfactorily used in similar service for not less than 5 years. The firm shall be a member of and certified by the Lightning Protection Institute.
- B Installer Qualifications: A firm with at least 3 years of successful installation experience on projects with lightning protection work similar to that required for project
 1. The System Design shall be completed, and the shop drawing stamped by an LPI Certified Master Installer – Designer of Lightning Protection Systems.
 2. The installing contractor shall be listed with the Lightning Protection Institute, and Underwriters' Laboratories, Inc.
 3. The installation contractor shall have personnel on staff Certified by the LPI as a Master Installer – Designer of lightning protection systems.
 4. LPI qualified staff, Journeyman or higher, shall provide on-site supervision of the installation.

1.8 WARRANTY

- A Furnish a 10-year adhesion warranty for all adhesives.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- B. Subject to compliance with requirements, provide products from one of the following:
 1. East Coast Lightning Protection
 2. Harger
 3. nVent Erico
 4. Thompson Lightning Protection
 5. VFC/Lyncole
- B Source Limitations: Obtain components through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I materials on structures not exceeding 75ft and Class II materials on structures or portions of structures exceeding 75ft.
- B Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency suitable to the Authority Having Jurisdiction as complying with UL 96 and marked for intended location and application.
- C Surge Suppression products for the electrical service entrance and communication services shall comply with NFPA 780 and UL 1449

2.3 MATERIALS

- A Comply with minimum Class I and Class II material requirements as listed in NFPA 780.
- B Air Terminals:
 - 1.Aluminum unless otherwise required due to adjacent materials or existing conditions.
 - 2.Safety tip.
 - 3.Threaded base support: Adhesive type for membrane roof, non-penetrating clamp for standing seam metal roof.
- C Main and Secondary Conductors:
 - 1.Aluminum unless otherwise required due to adjacent materials or existing conditions.
 - 2.Smooth weave cable for Class I materials and Concentric or Ropelay for Class II materials
 - 3.Cable Fastener: Adhesive type for membrane roof, non-penetrating clamp for standing seam metal roof.
- D Underground Conductors: Tinned copper.
- E Ground Rods:
 - 1.Material: Copper-clad steel.
 - 2.Diameter: 3/4 inch.
 - 3.Rods: not less than 120 inches long.
- F Conductor Splices and Connectors for aboveground applications:
 - 1.Suitable configuration and class type for the intended application and of the same material as the conductors or of electrolytically compatible materials
- G Adhesives: High performance, solvent free, UV resistant, for durable bond with substrate. All adhesives must be compatible with the roofing material and approved by the roofing system manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

- A Install lightning protection components and systems according to NFPA 780.
- B Install conductors with direct paths from air terminals to ground connections without excessive splices. Maintain a horizontal or downward route along the entire path to ground. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.
- C Rigidly fasten exposed conductors at intervals not exceeding 3 feet.
- D Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed systems in NFPA 780.
 - 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 bars 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.Structural elements and design features shall be used whenever possible to minimize the visual impact of exposed conductors.
 - 4.Coordinate sequence of installation with other trades to avoid coring, cutting, and patching.

5. Do not install conductors in gutters, downspouts, or on surfaces where water is retained.
- E Where conductors are exposed to potential damage or environmental hazards at grade level, provide guards to protect the conductors to a point 10 feet above grade. Bond down conductors to guards or conduit at both ends.
- F Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.
- G Provide Ground Ring Electrode for structures exceeding 60 feet. The conductor shall not be less than the main-size lightning conductor.
- H Where local conditions such as soil material, earth resistivity, or limited project boundary require the use of other grounding electrode configurations, refer to grounding electrode requirements in Section 260526, "Grounding and Bonding for Electrical Systems".
- I Provide bonding between the LPS grounding electrode system and the Building grounding electrode system in accordance with NEC and NFPA 780 requirements.
- J Install surge suppression at all power service entrances and at all entrances of conductive communications systems.

3.2 CONNECTIONS

- A All connections to down conductors and connections in earth or concrete: Exothermic weld.
- B Aboveground concealed connections: Exothermic welds or high-compression fittings listed for the purpose.
- C Aboveground exposed connections shall be done using the following types of connectors, listed, and labeled for the purpose: bolted connectors, exothermic weld, high compression, or crimp type.
- D 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.
- E Follow manufacturer's temperature and substrate requirements for installation of adhesives.

3.3 CORROSION PROTECTION

- A Coordinate lightning protection materials with building materials to assure compatibility.
- B 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.
- C Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.
- D Provide bimetallic connectors and fittings for splicing or bonding dissimilar metals.
- E Do not install aluminum materials in the following locations:
1. Embedded in or in direct contact with concrete, masonry, limestone, plaster, or mortar.
2. On copper surfaces or in locations exposed to direct water run-off from copper surfaces.
3. On a building surface coated with alkaline based paint.
4. In direct contact with earth or within 18-inches of the point where a conductor comes into contact with the earth.
- F Do not install copper materials in the following locations:
1. On aluminum surfaces or on exterior sheet metal surfaces.

3.4 FIELD QUALITY CONTROL

- A Testing: Upon completion of installation of lightning protection system, test resistance-to-ground with resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by driving additional ground rods.
- B Engage a third-party inspector to perform inspections required to obtain a UL Master Label for system.
- C Prepare detailed test and inspection reports with corresponding test results and photos.

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SECTION 26 43 00 – SURGE SUPPRESSION

PART 1 GENERAL

1.1 SCOPE OF WORK:

- A General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 01 Specification sections apply to this section.

1.2 DESCRIPTION:

- A Provide a transient surge suppression system comprising of surge protection devices (SPD) for the protection of AC electrical circuits and electronic equipment from the effects of lightning induced voltages, external switching transients and internally generated switching transients.

1.3 REFERENCE STANDARDS AND PUBLICATIONS:

- A General: The latest edition of the following standards and publications shall comply to the work of this section:
 1. ANSI/IEEE C84.1, American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hertz)
 2. ANSI/IEEE C62.34, Test Methods and Performance of Low-Voltage (1000 V rms or Less) Surge Protective Devices Used on Secondary Distribution Systems (Between the Transformer Low-Voltage Terminals and the Line Side of the Service Equipment)
 3. ANSI/IEEE C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
 4. ANSI/IEEE C62.45, IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
 5. Underwriters Laboratories UL 1449 (latest edition), Standard for Safety - Transient Voltage Surge Suppressors
 6. Underwriters Laboratories, UL 1283, Standard for Safety - Electromagnetic Interference Filters
 7. National Fire Protection Association, NFPA 20, 70, 75 and 780
 8. IEEE Standard 142, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book)
 9. ANSI/IEEE Standard 141, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (IEEE Red Book)
 10. IEEE Standard 1100, IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book)
 11. FIPS Pub 94, Federal Information Processing Standards Publication - Guideline on Electrical Power for ADP Installations
 12. National Electrical Manufacturer's Association LS-1, (NEMA LS-1)
 13. MIL Standard 220A Method of Insertion-loss Measurement
 14. ISO 9001:1994, Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing.
 15. NEC Article 280 or 285 as applicable.
 16. In addition, the surge suppression system shall be rated for "Lightning" surges in accordance with UL master label requirements for lightning protection systems.

1.4 MANUFACTURER QUALIFICATIONS:

- A Products from Innovative Technology, Inc., Liebert, Current Technology, EFI, APT, Datek, Eaton, Square D or GE are acceptable if they meet this specification.
- B The manufacturer shall submit a written statement indicating that a factory authorized representative inspected the installation. The installing contractor shall submit a checkout memorandum to the manufacturer. The memorandum shall indicate the date the equipment is placed into service and the actual method of installation. Submit three copies to the specifying engineer.

- C All surge protective devices for service entrance, distribution, and branch circuit protection within a facility shall be provided by a single manufacturer.
- D The manufacturer must be regularly engaged in the manufacture of surge suppression products for the specified categories for no less than ten (10) years.

1.5 QUALITY ASSURANCE:

- A In case of conflict between this specification and UL Standard 1449 (latest addition), the requirements of UL Standard 1449 (latest edition) shall prevail.

1.6 WARRANTY:

- A The SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of ten (10) years from the date of Final Acceptance of service and activation of the system to which the suppressor is attached. Any additional diagnostic circuits (LEDs, surge counter, etc.) must meet a warranty period of ten (10) years.
- B An SPD that shows evidence of failure or incorrect operation during the warranty period shall be replaced free of charge. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section. That is, the warranty is to cover the effects of lightning, single phasing, and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.
- C The installation of SPDs in or on electrical distribution equipment shall in no way compromise or violate equipment listing, labeling, or warranty of the distribution equipment.

1.7 SUBMITTALS:

- A The transient voltage surge suppression submittals shall include, but shall not be limited to, the following information:
 - 1. Data for each suppressor type indicating conductor sizes, conductor types, and connection configuration and lead lengths.
 - 2. Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification.
 - 3. Drawings, with dimensions, indicating SPD mounting arrangement and lead length configuration, and mounting arrangement of any optional remote diagnostic equipment and assemblies.
 - 4. List and detail all protection systems such as fuses, disconnecting means and protective materials.
 - 5. SPD wiring, bonding, and grounding connections shall be indicated on the wiring diagrams for each system. Include installation details demonstrating mechanical and electrical connections to equipment to be protected.
 - 6. If requested, a sample of each suppressor type shall be submitted for use in testing and evaluation.

PART 2 PRODUCTS

2.1 PERFORMANCE:

- A SPDs shall be listed in accordance with UL 1449 (latest addition), Standard for Safety, Transient Voltage Surge Suppressors and UL 1283, Standard for Safety, Electromagnetic Interference Filters.
- B The SPD shall protect all modes and there shall be seven discrete suppression circuits: 3 modes connected Line to Ground, 3 modes connected Line to Neutral, and 1 mode connected Neutral to Ground for a 3-phase, 4-wire, plus ground voltage system. Line to Neutral to Ground is not an acceptable substitute for Line to Ground. Line to Neutral to Line and Line to Ground to Line (in combination) will be acceptable for Line to Line protection.

- C All SPDs must have passed the UL 1449 (latest addition) Fault Current Test with a Rating of 200,000 AIC. Documentation substantiating this claim must be provided.
- D SPDs shall use a separate path to building ground; the equipment safety ground is not to be used as a transient ground path.
- E All SPDs are to be MOV based and not include SAD technology as a means of suppression.
- F The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 115% for 220, 240, 277, and 480V systems.
- G Standard diagnostic features are to include green LEDs (one per phase - normally on) indicating power and suppression status and a form C dry relay contact.
- H Extended diagnostics must include an audible alarm and surge counter to be displayed on an LCD display on the front of the suppressor. The surge counter must include a reset option. The audible alarm must include a mute option. Products requiring diagnostic test kits will not be acceptable.

2.2 SERVICE ENTRANCE PROTECTION:

- A The SPD for this location (installed upstream of the service disconnecting means) shall be indicated as TVSS Type 1 on project drawings.
- B The service entrance TVSS equipment shall meet or exceed the minimum performance criteria as follows:
 - 1. The single-impulse surge-current rating shall be a minimum of 300,000 Amperes per phase (150,000 Amperes per mode).
 - 2. The UL 1449 (latest edition) Suppressed Voltage Rating for the following configurations shall not exceed the following:

VOLTAGE CONFIGURATION	L-G	L-N	N-G
120/208V (3Y101)	400V	400V	400V
277/480V (3Y201)	800V	800V	800V

- 3. SPDs shall be of compact design. The mounting position of the SPD shall allow a straight and short lead-length connection between the SPD and the point of connection in the panelboard.
- 4. Visual indication of proper SPD connection and operation shall be easily viewed on the front panel of the enclosure. The indicator lights shall indicate suppression circuit status, phase status, phase loss, reduced protection level and suppression fault.
- 5. The SPD shall be equipped with an integral disconnect switch or be available as an option.
- 6. A set of normally open/normally closed Form "C" dry contacts shall be provided for remote monitoring.
- 7. The enclosure type shall be suitable for the environment.
- 8. SPDs shall be equipped with an audible alarm with mute, reset and acknowledge features.
- 9. The device must be certified (report to be submitted) to withstand a minimum of 20,000 Category C3 (Combination wave - 20,000 Volts - 1.2x50 :s OCV and 10,000 Amps - 8x20 :s SCC as defined by ANSI/IEEE C62.41) impulses with less than 10% change in the baseline to final let-through voltage. This data must be submitted as an independently verified and certified test report.
- 10. The maximum value for the attenuation for the suppressor must exceed a minimum of 33 dB. All measurements for this requirement must be taken using the MIL STD 220A method and with only six (6) inches of lead length extending outside of the normal exit location of leads for the enclosure. Test results taken with leads extending past six (6) inches are not acceptable or compliant. Additional or excessive lead length used in the test setup is NOT acceptable.

2.3 DISTRIBUTION PANEL AND VFD PROTECTION:

- A SPD(s) for this application (load side of service overcurrent device), if any is required on drawings, shall be indicated as TVSS TYPE 2 on project drawings.
- B The distribution panel TVSS equipment shall meet or exceed the minimum performance criteria as follows:

1. The single-impulse surge-current rating shall be a minimum of 200,000 Amperes per phase (100,000 Amperes per mode).
2. The UL 1449 (latest edition) Suppressed Voltage Rating for the following configurations shall not exceed the following:

VOLTAGE CONFIGURATION	L-G	L-N	N-G
120/208V (3Y101)	400V	400V	400V
277/480V (3Y201)	800V	800V	800V

3. SPDs shall be of compact design. The mounting position of the SPD shall allow a straight and short lead-length connection between the SPD and the point of connection in the panelboard.
4. Visual indication of proper SPD connection and operation shall be easily viewed on the front panel of the enclosure.
5. The indicator lights shall indicate suppression circuit status, phase status, phase loss, reduced protection level and suppression fault.
6. The SPD shall be equipped with an integral disconnect switch or be available as an option.
7. A set of normally open/normally closed Form "C" dry contacts shall be provided for remote monitoring.
8. The enclosure type shall be suitable for the environment.
9. SPDs shall be equipped with an audible alarm with mute, reset and acknowledge features.
10. The device must be certified (report to be submitted) to withstand a minimum of 15,500 Category C3
11. (Combination wave - 20,000 Volts - 1.2x50 :s OCV and 10,000 Amps - 8x20 :s SCC as defined by ANSI/IEEE C62.41-1991) impulses with less than 10% change in the baseline to final let-through voltage. This data must be submitted as an independently verified and certified test report.
12. The maximum value for the attenuation for the suppressor must exceed a minimum of 33 dB. All measurements for this requirement must be taken using the MIL STD 220A method and with only six (6) inches of lead length extending outside of the normal exit location of leads for the enclosure.

2.4 SUBPANEL PROTECTION:

- A SPD(s) for this location (at the branch panel(s)), if any is required by drawings, shall be provided as TVSS Type 3.
- B The distribution panel TVSS equipment shall meet or exceed the minimum performance criteria as follows:

1. The single-impulse surge-current rating shall be a minimum 100,000 Amperes per phase (50,000 Amperes per mode).
2. The UL 1449 (latest edition) Suppressed Voltage Rating for the following configurations shall not exceed the following:

VOLTAGE CONFIGURATION	L-G	L-N	N-G
120/208V (3Y101)	400V	400V	400V
277/480V (3Y201)	800V	800V	800V

3. SPDs shall be of compact design. The mounting position of the SPD shall allow a straight and short lead-length connection between the SPD and the point of connection in the panelboard.
4. Visual indication of proper SPD connection and operation shall be easily viewed on the front panel of the enclosure.
5. The indicator lights shall indicate suppression circuit status, phase status, phase loss, reduced protection level and suppression fault.
6. The SPD shall be equipped with an integral disconnect switch or be available as an option.
7. A set of normally open/normally closed Form "C" dry contacts shall be provided for remote monitoring.
8. The enclosure type shall be suitable for the environment.
9. SPDs shall be equipped with an audible alarm with mute, reset and acknowledge features.
10. The device must be certified (report to be submitted) to withstand a minimum of 15,000 Category C3
11. (Combination wave - 20,000 Volts - 1.2x50 :s OCV and 10,000 Amps - 8x20 :s SCC as defined by ANSI/IEEE C62.41) impulses with less than 10% change in the baseline to final let-through voltage. This data must be submitted as an independently verified and certified test report.
12. The maximum value for the attenuation for the suppressor must exceed a minimum of 33 dB.
13. All measurements for this requirement must be taken using the MIL STD 220A method using and with six (6) inches of lead length extending outside of the normal exit location of leads for the enclosure.

PART 3 EXECUTION

3.1 INSTALLATION:

- A The installing contractor shall install the parallel SPD with short and straight conductors as practically possible.
- B The contractor shall follow the SPD manufacturer's recommended installation practice as found in the equipment installation instructions.
- C The installation shall apply to all applicable codes.

3.2 COMMISSIONING:

- A This contractor, and the manufacturers of the equipment and materials specified in this section, shall provide the labor, materials, equipment, services and support required by the project commissioning agent to accomplish the successful commissioning of the equipment and systems specified here.

END OF SECTION 26 43 00

January 15, 2026

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SECTION 26 50 00 - BUILDING LUMINAIRES

PART 1 GENERAL

1.1 SUMMARY

- A Section Includes:
 - 1. Interior solid-state luminaires that use LED technology.
 - 2. Lighting fixture supports.

1.2 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.

1.3 SUBMITTALS

- A Shop drawings, product data, assembly drawings, wiring diagrams, performance, maintenance data, etc. shall be submitted in accordance with the provisions of specification Section 260100.
- B 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.
 - 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. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- C Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- D Product Schedule: Refer to drawings for luminaires and lamps.
- E Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved, as applicable:
 - 1. Luminaires.
 - 2. Suspended ceiling components.
 - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 - 4. Structural members to which equipment and or luminaires will be attached.
 - 5. Initial access modules for acoustical tile, including size and locations.
 - 6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Sprinklers.

- d. Access panels.
- 7. Moldings.
- F Qualification Data: For testing laboratory providing photometric data for luminaires.
- G Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- H Product Certificates: For each type of luminaire.
- I Sample warranty.

1.4 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 Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C Provide luminaires from a single manufacturer for each luminaire type.
- D Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 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 for products specified here shall be in accordance with the requirements stated in the General Condition and Supplementary Conditions of the Contract.
- C Special Warranties: Manufacturer's standard form in which manufacturer of specified lighting unit agrees to repair or replace components of such lighting unit that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Final Acceptance. Full warranty shall apply for first year, and prorated warranty for the remaining 4 years.
 - 2. Warranty period for LED Lighting Fixtures: Manufacturer and luminaire distributor agree to repair or replace LED luminaires that fail during the warranty period as qualified here:
 - a. The requested warranty for LED array and driver is a full 7-year warranty for parts and labor from the date of Final Acceptance.
 - b. Warranty for fixture paint, lens, de-coloration or corrosion is three years from the date of Final Acceptance.
 - c. The warranty for LED luminaires is a full warranty. The warranty is for an installation as defined by the Contract Documents for this specific building.
 - d. The method of switching used for the LED luminaires shall not reduce in any way the required 7-year warranty. The switching method is as shown on the drawings.

PART 2 PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B Standards:
 - 1. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

2. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 3. UL Listing: Listed for damp location.
 4. Recessed luminaires shall comply with NEMA LE 4.
 5. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61.
 - C CRI of minimum 70. CCT of 3000 K or 4100 K, as indicated on drawings.
 - D Rated lamp life of 50,000 hours to L70.
 - E Lamps dimmable from 100 percent to 0 percent of maximum light output.
 - F Internal driver.
 - G Nominal Operating Voltage: 120V to 277V, as indicated on drawings.
 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - H Housings:
 1. Extruded-aluminum housing and heat sink.
 2. Finish, as indicated on drawings.
- 1.1 MATERIALS
- I 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.
 - J Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
 - K Diffusers and Globes:
 1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 2. Glass: Annealed crystal glass unless otherwise indicated.
 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - L 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 for all luminaires.
- 2.2 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.
- 2.3 EXIT SIGNS
- A General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with State of Virginia requirements.
 - B Internally Lighted Signs:
 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
- 2.4 LIGHTING FIXTURE SUPPORT COMPONENTS
- A Comply with Section 260529- "Supports and Fasteners" for channel- and angle-iron supports and nonmetallic channel and angle supports.

- B Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.1 INSTALLATION

- A Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.
- B Lighting Fixtures
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- C Temporary Lighting: If it is necessary, and approved by Owner's Representative, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- D Lay-in Ceiling Lighting Fixtures Supports:
 - 1. Where a lighting fixture replaces ceiling tile in lay-in ceilings, support fixture with minimum of two support wires, one at opposite corner of fixture and secure fixture to ceiling grid main runners with sheet metal screw at each corner of the fixture. It is the responsibility of the Division 26 Contractor to arrange with the ceiling installer for the proper location of ceiling grid main runners to accomplish fixture attachments.
 - 1. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 2. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E Suspended Lighting Fixture Support
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F Connect wiring according to Section 260519 – "Building Wire and Cable."
- G Identification
 - 3. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 – "Electrical Identification."

3.2 FIELD QUALITY CONTROL

- A Start-Up Service

4. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by the Owner.

B Adjusting

5. Occupancy Adjustments: When requested within 12 months of date of Final Acceptance, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this Work may be required after dark.
 - a. Adjust aimable luminaires in the presence of Owner's Representative.

1.2 SPARE PARTS

- C Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

END OF SECTION 26 50 00

January 15, 2026

University of North Carolina at Wilmington
Housing Village Phase 3
Complete Package - Construction Documents

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SECTION 26 90 00 – PROJECT CLOSEOUT

PART 1 GENERAL

2.1 RECORD DRAWINGS

- A The Electrical contractor shall keep a record copy of the bid set and fabrication drawings at the job site and shall accurately maintain a record with dimensions and elevations of all changes to the contract drawings as the job progresses. At the completion of the job, the electrical contractor shall obtain a sepia reproducible from the Architect and shall make changes which occurred during construction on drawings and submit three (3) copies to the Engineer. The Engineer will check drawings and will return them to contractor with comments or statement of approval, as applicable. Record drawings shall be submitted to the A/E within 15 days of project acceptance.

2.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS:

- A After installation has been completed, equipment has been tested, systems placed in permanent operation, and all adjustments made, a competent start-up technician shall be provided for a period of two working days. This technician shall operate the systems during this time, and during this time shall instruct the Owner's designated representatives in the operation and maintenance of the equipment. The start-up technician shall be at the site continuously during working hours during the instructional period.
- B Operating and Maintenance Manuals:
1. The form in which the operating maintenance manual is to be presented shall be subject to approval by the Architect.
 2. The following items, together with any other necessary and pertinent data, shall be included in the manual. This list is not necessarily complete and is only to be used as a guide.
 - a. Settings of all control and switches for normal operation with description of control and its location.
 - b. A check list for periodic maintenance of all equipment, with maintenance and cleaning instructions.
 - c. As built wiring diagrams, interlock, and control diagrams for the equipment.
 - d. Parts list for all replaceable service parts, and indicate where they may be purchased.
 - e. Manufacturer's cuts and rating tables for all equipment, including copies of all factory record drawings and all other shop drawings.
 - f. Test data on all equipment.
 - g. Serial numbers of all principal pieces of equipment.
 - h. Manufacturers', suppliers', and subcontractors' names, addresses, and telephone numbers.
 - 1) The first page shall identify project and give name, address and phone number of Architect, Engineer, Mechanical and Electrical sub-contractors and any service companies involved and give name and night phone of each party responsible for service.
 - i. Operating and Maintenance Manual submittal shall comply with ASHRAE Standard 90.1-2004, Section 8.7.2

2.3 WARRANTIES:

- A Deliver to Owner all warranties, guarantees, extended service agreements, etc. and obtain written receipts.

2.4 PUNCH LIST:

- A During construction period the A/E will issue punch lists. These items shall be completed before A/E will approve next application for payment. Final punch list work shall be completed before acceptance.

2.5 FINAL INSPECTION AND ACCEPTANCE:

- A The architect or his authorized representative will entertain the request for final inspection and acceptance only after the following items are done.
 - 1. Submit a list of uncompleted items, if any, and advise when the items will be done.
 - 2. Complete all items on A/E's pre-final punch list.

2.6 FINAL CLEAN UP:

- A During construction this contractor shall keep the site clear of debris and upon completion of construction he shall clean up the premises and to remove all evidence of his work.
- B The contractor shall resolve all questionable items to be corrected prior to an inspection by the Engineer. If items have not been corrected completely, and additional site visits are required for the Engineer to check for compliance, the contractor will be billed by the Owner at \$100.00 per hour plus travel expenses for Engineer's services.

2.7 GUARANTEE:

- A The guarantee shall be as stated in the General Conditions, and the General Provisions of this section.

END OF SECTION 26 90 00

SECTION 27 00 10 - SUPPLEMENTAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 Specification Sections, and Section 26 00 10 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

- A. Division 27 – Communications governs the structured cabling infrastructure for the low-voltage information transport systems, which can include but are not limited to voice, data, cable TV (CATV), audio/video, intercommunication systems, distributed antenna systems, and their pathways.
- B. The installed structured cabling infrastructure should be able to support interconnections to active telecommunications equipment for IP telephony, desktop computers, IP surveillance cameras, and other technologies in a multi-vendor, multi-product environment. The structured cabling infrastructure shall adhere to applicable standards as listed below with respect to performance, pathways, distribution, administration, and grounding of the system. The structured cabling system shall be installed in accordance with local codes and regulations.
- C. Contractor is solely responsible for all parts, labor, testing, documentation and all other processes and physical apparatus necessary to turn over the completed cabling system and associated infrastructure fully warranted and operational for acceptance by Owner.
- D. This specification includes structured cabling design considerations, product specifications, and installation and testing requirements for low-voltage network systems and associated infrastructure including, but not limited to:
 - 1. Horizontal Cabling and Terminations
 - 2. Backbone Cabling and Terminations
 - 3. Telecommunications Pathways
 - 4. Communications Equipment Room Fittings
 - 5. Communications Grounding and Bonding Systems
 - 6. Cable Labeling and Administration
 - 7. Patch cables and Equipment cords
- E. The following equipment is to be owner-furnished; contractor installed.
 - 1. Wireless Access Points
 - 2. Network Switches
- F. The following equipment is to be owner-furnished, owner-installed. This does not alleviate the contractor from fully coordinating with the owner to ensure compatibility of the contractor's systems with the owner's systems and equipment:
 - 1. Client Workstations

1.3 ABBREVIATIONS

AHJ	Authority Having Jurisdiction
EMI	Electromagnetic interference.
IDC	Insulation displacement connector.
IDF	Intermediate Distribution Frame (Telecom Room)
LAN	Local area network.
MDF	Main Distribution Frame (Main Telecomm Room)
RCDD	Registered Communications Distribution Designer
UTP	Unscreened (unshielded) twisted pair

1.4 DEFINITIONS

- A. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
- D. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
- E. Communication Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- F. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
- G. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
- H. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- I. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.

1.5 REFERENCE STANDARDS

- A. Contractor is responsible for knowledge and application of current versions of all applicable standards and codes. In cases where listed standards and codes have been updated, adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.
- B. This document does not replace any code, either partially or wholly. Conform to local codes and regulations that apply to this project

- C. If there is a conflict between applicable documents, then the more stringent requirement shall apply.
- D. Telecommunications Industry Association (TIA):
1. ANSI/TIA-568.0-E, "Generic Telecommunications Cabling for Customer Premises"
 2. ANSI/TIA-568.1-E, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements"
 3. ANSI/TIA-568.2-D, "Balanced Twisted Pair Telecommunications Cabling and Components"
 4. ANSI/TIA-568.3-D, "Optical Fiber Cabling Components"
 5. ANSI/TIA-568.4-D, "Broadband Coaxial Cabling and Components"
 6. ANSI/TIA-569-E, "Commercial Building Standard for Telecommunications Pathways and Spaces"
 7. ANSI/TIA-598-D, "Optical Fiber Cable Color Coding"
 8. ANSI/TIA-606-C, "Administration Standard for Telecommunications Infrastructure"
 9. ANSI-TIA-607-D, "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
 10. ANSI/TIA-758-B, "Customer-Owned Outside Plant Telecommunications Infrastructure Standard"
 11. ANSI/TIA-1152-A, "Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling"
 12. ANSI/TIA-4966, "Telecommunications Infrastructure Standard for Educational Facilities"
- E. Building Industry Consulting Service International (BICSI)
1. BICSI TDMM "Telecommunications Distribution Design Manual"
 2. BICSI ITSIM "Information Technology Systems Installation Manual"
 3. ANSI/BICSI N1, "Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure"
 4. ANSI/BICSI N3, "Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure"
 5. NECA/BICSI 607 "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings"
 6. ANSI/BICSI 001 "Information and Communication Technology Systems Design and Implementation Best Practices for Educational Institutions and Facilities"

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
1. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance configuration with service provider.
 2. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
 3. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- B. Pre-installation Meetings
1. Organize pre-installation meeting with telecommunications and LAN equipment suppliers, Engineer, Owner, and service providers to exchange information and agree on details of equipment arrangements and installation interfaces.
 2. Record agreements reached in meetings and distribute them to project team.
 3. Adjust arrangements and locations of racks, sleeves, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of utility demarcation, and telecommunications and LAN equipment.

4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

1.7 SUBMITTALS

- A. Prior to the start of work the contractor shall submit the following. Work shall not proceed without the Engineer's and Owner's completed review of the submitted items.
- B. For Product Data, Equipment Shop Drawings, and Product Schedules: Comply with 26 00 10 "General Requirements for Electrical Systems".
- C. Coordination Drawings: drawings reviewed and stamped by RCDD with floor plans, sections, riser diagrams, and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 1. Telecommunications room plans and rack elevations including workspace requirements and access for cable connections.
 2. Telecommunications cable tray and pathway layout with relationships to other building elements.
 3. Telecommunications system access points.
 4. Telecommunications grounding system.
 5. Cross Connects
 6. Patch Panels
 7. Telecommunications conductor drop locations.
 8. Typical telecommunications details.
 9. Mechanical, electrical, and plumbing systems.
 10. Firestopping
- D. Qualification Data for Manufacturer, Contractor, Project RCDD, Project Manager, Lead Technician, and Installers along with project roster of personnel assigned to the project.
- E. Sample System Warranties
- F. Closeout Submittals
 1. As-Built Drawings: Plans showing as-built locations that fully represent actual installed conditions and that incorporate modifications made during the course of construction.
 2. Operation and Maintenance Data:
 - a. In addition to items specified in Division 01 and Section 26 00 10 "General Requirements for Electrical Systems" include the following:
 - 1) Cable test results.
 - 2) Manufacturer's recommended maintenance
 3. Product and System Warranty Documentation from both manufacturer and contractor.
 4. Labeling and Administrative printouts and digital copies on USB media.
 - a. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables served from that particular room along with their designations, origins, and destinations. Protect with rigid frame and clear plastic cover.
 - a. Cabling Administration Drawings: Install in a prominent location in each equipment room and wiring closet. Show building floor plans that identify the location and labelling of Communications devices served out of each telecom room. Protect with rigid frame and clear plastic cover. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, backbone and horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

5. Final test result printouts and backup on USB media.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Five continuous years, minimum, design and manufacture of the materials and equipment specified herein.
 - a. Manufacturer(s) of products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that the specifications are met. Including at a minimum:
 - b. Incoming inspection of raw materials
 - c. In-process inspection and final inspection of the cable product
 - d. Calibration procedures of test equipment to be used in the qualifications of the product
 - e. Recall procedures in the event that out of calibration equipment is identified.
2. Conform to government standards on quality assurance for applications within these specifications.

B. Contractor Qualifications: Provide documentation of the following qualifications:

1. Be in business a minimum of 5 continuous years.
2. Provide a minimum of three reference accounts at which similar work, both in scope and complexity, have been completed by The Contractor within the last three years.
3. Demonstrate satisfaction of sound financial condition and can be adequately bonded and insured.
4. Possess licenses/permits required to perform telecommunications installations in the specified jurisdiction.
5. Employ personnel knowledgeable in local, state, province and national codes, and regulations. Comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.
6. Possess current liability insurance certificates.
7. Registered with BICSI and have at least one active RCDD on staff who shall be responsible for the implementation of the project.
8. Employ personnel fluent in the use of Computer Aided Design and possess and operate digital design software.
9. The Contractor shall be a certified installer in good standing with the approved manufacturer.

C. Contractor Training: Provide documentation of the following qualifications:

1. Personnel trained and certified in the design and installation of the approved manufacturer's products.
2. Personnel trained and certified in fiber optic cabling, fusion splicing, termination, and testing techniques. Personnel must have successfully attended an appropriate training program, which includes testing with an OLTS and OTDR, and have obtained a certificate as proof thereof.
3. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.

D. Project Personnel Requirements: Contractor must have the following personnel certified by BICSI on staff and assigned to the project.

1. Project RCDD: Preparation of Shop Drawings, cabling administration Drawings, and field-testing program development by an RCDD who shall be a full-time employee of the installing contractor, shall be familiar with the project, and conduct weekly inspections.

2. Project Manager: Minimum BICSI certified Registered Telecommunications Project Manager (RTPM) who shall attend all project meetings and oversee/coordinate all work at the project site.
3. Lead Technician: Minimum BICSI certified Technician who shall provide direct supervision of Installers and be present at all times when work of this Section is performed at the project site.
4. Installers: Personnel installing any part of the structured cabling system shall be a minimum BICSI certified Level 1 Installer or shall have equivalent training and certification from the approved manufacturer.

- E. References: The Owner may, with full cooperation of The Contractor, visit client installations to observe equipment operations and consult with references. Specified visits and discussion shall be arranged through The Contractor; however, The Contractor personnel shall not be present during discussions with references.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver or install equipment, 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 the remainder of the construction period.
- B. Visually inspect cables upon receipt at Project site. If damage is suspected, test cables to verify and validate the manufacturer's factory testing certifications.
1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
 2. Test each pair of UTP cable for open and short circuits.
 3. Test each coaxial cable on reel for continuity.
- C. Comply with manufacturer's storage and handling requirements for each product.
- D. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Do not install damaged materials and equipment.
- F. Return visibly damaged products to the supplier and replace at no additional cost to the Owner.

1.10 GENERAL PRODUCT WARRANTY

- A. General Requirements: Comply with additional requirements in contract general requirements and extended warranties required in other specification sections. Refer to all other Division 27 sections for specific additional warranty requirements that exceed or are in addition to those of this section.
- B. Provide all services, materials, and equipment necessary for successful operation of entire telecommunications system including but not limited to structured cabling system, pathways, grounding, and bonding system, and firestopping for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, wiring, accessories, software, hardware, installation, programming, and configuration required to maintain a complete and operable system. Provide manufacturer's published recommended preventative maintenance procedures during warranty period. This shall apply to all items except those specifically excluded, or items wherein

a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by Owner and shall not institute warranty period. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to Owner's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty. Additional warranty responsibilities are:

1. Obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's designated name. Replace material and equipment that require excessive service during guarantee period as determined by Owner.
2. Provide 2-business day service beginning on date of Final Acceptance and lasting until termination of warranty period. Service shall be at no cost to Owner. Service can be provided by installing contractor or by a separate service organization. Choice of service organization shall be subject to Owner's approval. Submit name and a phone number that will be answered on a 24-hour basis each day of week, for duration of service.
3. Submit copies of equipment and material warranties to Owner before final acceptance.
4. At end of warranty period, transfer manufacturers' equipment and material warranties still in force to Owner, at no additional costs to the Owner.
5. If warranty work problems cannot be corrected immediately to Owner's satisfaction, advise Owner in writing, describing efforts to correct situation, and provide analysis of cause for problem. If necessary to resolve problem, provide at no cost services of manufacturer's engineering and technical staff at site in a timely manner to analyze warranty issues, and develop recommendations for correction, for review and approval by Owner.

1.11 ADVANCED SYSTEM WARRANTY

- A. The structured cabling system shall be covered by a two-part system performance and extended product warranty guaranteed for a minimum of 25 years. The advanced system warranty shall ensure installation and system performance for the duration of the warranty period.
- B. The first part is an assurance program, which guarantees the end-to-end link transmission performance conforms to the applicable performance standards specified herein and will support the applications for which it is designed for the duration of the warranty period.
- C. The second portion of the certification is an extended product warranty provided by the manufacturer and the contractor on all structured cabling products within the system (cords, telecommunications outlet/connectors, cables, cross-connects, patch panels, fiber panels, etc.).
- D. The contractor shall have the sole responsibility for following the manufacturer's conditions and terms for the installation to qualify for the advanced system warranty. Requirements may include but are not limited to:
 1. Layout and Installation by a manufacturer approved installer with BICSI certification.
 2. Submission of warranty pre-approval, final application, test reports, and bill of materials in a timely manner.
 3. Certification testing of all links to appropriate standards.
 4. Use of manufacturer approved and calibrated test equipment.
 5. Coordination of pre-construction conference.
 6. Coordination of Manufacturer Pre/Post Installation Inspection.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Electrical Components, Devices, and Accessories: Provide listing and labels as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Materials used shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards, other applicable federal, state, and local laws.
- C. Product numbers are subject to change by the manufacturer without notification. In the event a product number is invalid or conflicts with the written description, notify the Engineer in writing prior to ordering the material and performing installation work.

2.2 SUBSTITUTIONS

- A. Conform to the substitutions requirements and procedures outlined in Division 01 and Section 26 00 10 "General Requirements for Electrical Systems".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions, stated under other sections, are acceptable for installation in accordance with manufacturer's instructions.

3.2 DEMOLITION

- A. In addition to demolition requirements in Division 01 and Division 26, disconnect and remove abandoned communications cabling back to its source. This includes sources that are outside of the boundaries of the project area.
- B. For abandoned cabling deemed unfeasible to remove by the Engineer, tag, and label at both ends as Abandoned.
- C. The owner shall have first right of refusal for any components of the telecommunications system removed during demolition.

3.3 INSTALLATION

- A. Comply with NECA 1
- B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications' equipment and other nearby installations. Connect in such a way as to facilitate future maintenance with minimum interference from other items in the vicinity.

- C. Under no condition shall the Contractor install any equipment or component that will void Manufacturer warranty or create such conditions that will reduce equipment performance, longevity, and life.

3.4 FIELD QUALITY CONTROL

- A. Tests: Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Reference individual Specification Sections for required tests. Document tests and include in Operation and Maintenance Manuals.

3.5 3CLEANING

- A. In addition to cleaning requirements in Division 01 and Division 26, thoroughly clean exposed portions of equipment upon completion of installation. Remove temporary labels and traces of foreign substances. Remove construction debris and surplus materials accumulated during work.
- B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.
- C. Repair or replace damaged installed products.

3.6 3SYSTEM ACCEPTANCE

- A. System cannot be considered for final acceptance until work is completed and demonstrated to Engineer that installation is in strict compliance with Specifications, Drawings, and manufacturer's installation instructions, particularly in reference to following:
 - 1. Testing Reports
 - 2. Cleaning
 - 3. Operation and Maintenance Manuals
 - 4. Training of Operating Personnel
 - 5. Record Drawings
 - 6. Warranty Certificates, including extended manufacturer's warranties.

END OF SECTION 27 00 10

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SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 26 00 10 "General Requirements for Electrical", and 270010 "Supplemental Requirements for Communications" apply to this Section.

1.2 SUMMARY

- A. Description: The telecommunications bonding and grounding system and its interconnections to the electrical system provide an electrically continuous, low impedance path for all connected telecommunications equipment and pathways.
- B. Section Includes:
1. Bonding conductors.
 2. Bonding connectors.
 3. Bonding busbars.
- C. Related Requirements:
1. Refer to Section 26 05 26 "Grounding and Bonding for Electrical Systems" for requirements associated with Electrical System Grounding, Equipment Grounding System, and Grounding Electrode System.

1.3 REFERENCES

A. Abbreviations

TBC	Telecommunications Bonding Conductor.
SBB	Secondary Bonding Busbar (Formerly TGB).
PBB	Primary Bonding Busbar (Formerly TMGB).
RBB	Rack Bonding Busbar
TBB	Telecommunications Bonding Backbone
BBC	Backbone Bonding Conductor
TEBC	Telecommunications Equipment Bonding Conductor
RBC	Rack Bonding Conductor

B. Definitions

1. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.
2. Grounding: Establishing a direct or indirect connection to Earth or some conducting body that serves in place of Earth.
3. Bonding: Method by which all non-energized conductive materials are effectively interconnected to create a low impedance path.

- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
 - 1. Building Industry Consulting Service International (BICSI)
 - a. ANSI/BICSI N3 "Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure"

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Field Quality Control Reports: Provide test reports for each test specified in the field quality control section. Include certificate of current equipment calibration.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data: In addition to the items specified in Division 01 and Section 26 00 10 "General Requirements for Electrical" include the following:
 - a. Results of the ground-resistance and bonding resistance tests.
 - b. Include recommended testing intervals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with NFPA 70, TIA-607, and ANSI/BICSI N3.

2.2 CONDUCTORS

- A. Insulated Copper Conductors: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables".
 - 1. Ground wire for custom-length equipment bonding jumpers: minimum No. 6 AWG.

2.3 CONNECTORS

- A. Comply with requirements in 26 05 26 "Grounding and Bonding for Electrical Systems".

2.4 TELECOM BONDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - 1. Harger Lightning and Grounding
 - 2. Panduit Corp.

3. Erico
 4. Chatsworth CPI
 5. Ortronics
 6. Eaton
- B. General Requirements:
1. Predrilled BICSI/TIA-607 style hole pattern for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide a minimum of 4-inch clearance to access the rear of the busbar. Provide stainless steel brackets and bolts.
 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.
 4. Busbar length: Size to accommodate initial conductors plus a 50% growth factor.
- C. Primary Bonding Busbar (PBB): Predrilled, wall-mounted, rectangular bars of electro-tin plated copper, 1/4 by 4 inches in cross section, minimum 24 inches in length or as indicated on Drawings. NRTL listed for use as PBB, complying with UL 467 and TIA-607.
- D. Secondary Bonding Busbar (SBB): Predrilled, wall-mounted rectangular bars of electro-tin plated copper, 1/4 by 2 inches in cross section, minimum 12 inches in length or as indicated on Drawings. NRTL listed for use as a SBB, complying with UL 467 and TIA-607.
- E. Rack Bonding Busbar (RBB): Comply with requirements for rack busbars in Section 27 11 00 "Communications Equipment Room Fittings".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac 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 the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of TBC connection.
- C. Prepare written report, endorsed by Installer, listing any conditions detrimental to performance of the Work.
- D. Proceed with connection of the TBC only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with NFPA 70, TIA-607, and ANSI/BICSI N3.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the PBB/SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. 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.
- C. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- D. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than ten times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. Install grounding and bonding conductors in minimum 1-inch PVC conduit where exposed to physical damage or where routed through building walls or footings. Provide EMT conduit for the grounding and bonding conductor pathway where installed in a plenum.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit bond the conductor to the conduit at both ends using a grounding bushing that complies with requirements in Section 27 05 28, "Pathways for Communications Systems".

3.4 GROUNDING ELECTRODE SYSTEM

- A. Provide a Telecommunications Bonding Conductor (TBC) between the PBB and the electrical service equipment ground busbar no smaller than No. 1/0 AWG and no smaller than the Telecommunications Bonding Backbone (TBB).
- B. Where external equipment ground busbar is not available, provide intersystem bonding termination (IBT) device for connecting telecommunications bonding conductor (TBC) with service busbar.
- C. Comply with requirements in article 250.94 of the National Electric Code (NEC)

3.5 TELECOM BONDING BUSBARS

- A. Provide PBB in main telecommunications equipment room and locate to minimize length of TBC.
- B. Provide SBB in each telecom room.
- C. Install PBB/SBB horizontally, on insulated spacers 4 inches minimum from wall, 48 inches above finished floor unless otherwise indicated.
- D. Install RBB on rack or cabinet using stand-off block insulators to provide a minimum of 0.75

inches of separation for dissimilar metals and to facilitate conductor attachment to RBB. The RBB may be directly mounted/bonded to the rack or cabinet only if doing so allows adequate space for attaching grounding conductors and does not create a dissimilar metals reaction.

3.6 CONNECTIONS

- A. Bond all metallic equipment and pathways in each telecommunications room to the bonding busbar in that room, using insulated grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pre-twist the conductor.
- D. Clean and apply an antioxidant compound to all bolted and compression connections.
- E. Building Entrance Protectors: Bond to the PBB/SBB with insulated bonding conductor.
- F. Busbar Interconnections: Interconnect all SBBs with the PBB using a continuous telecommunications bonding backbone (TBB). If more than one TBB is installed, interconnect TBBs using the backbone bonding conductor (BBC) conductor at the top floor and at every third floor in between. The telecommunications bonding backbone and backbone bonding conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of 750 kcmil unless otherwise indicated.
- G. Telecommunications Enclosures and Equipment Racks/Cabinets: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Connect the Telecommunications Equipment Bonding Conductor (TEBC) to the Rack Bonding Busbar (RBB) and to the rack/cabinet using a Rack Bonding Conductor (RBC) and listed compression two-hole lugs.
- H. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.
- I. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each PBB/SBB to the equipment ground bar of the panelboard.
- J. Shielded Cable: Bond the shield of shielded cable to the PBB/SBB in communications rooms and spaces. Comply with TIA-568.1 and TIA-568-.2 when grounding shielded balanced twisted-pair cables.
- K. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the rack bonding busbar (RBB) using unit bonding conductors (UBC). Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- L. Ladder Rack and Cable Tray: Bond ladder rack/cable tray system to the PBB/SBB using manufacturer approved ground lugs and bonding conductors. Remove paint from the ladder rack/cable tray to ensure ground lugs contact bare metal.
- M. Metallic Conduits: In telecommunications rooms, bond metallic conduits longer than 24-inches to

the PBB/SBB using insulated ground bushing sized for the conduit and ground conductor to be attached.

3.7 IDENTIFICATION

- A. Comply with requirements in Section 27 05 53 - Identification for Communications Systems.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Bond Resistance Test: Test the bonding connections of the system using a certified micro-ohmmeter, taking two-point bonding measurements in each telecommunications equipment room containing a PBB/SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - 3. Measure the resistance between the following:
 - a. Each PBB/SBB to the nearest electrical equipment ground.
 - b. Each PBB/SBB to the structural steel.
 - c. PBB to each SBB.
 - d. Structural steel to the electrical ground.
 - 4. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 5. Test for ground loop leakage currents using a certified digital clamp-on earth ground tester, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - 6. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1 A.
- B. Excessive Ground Resistance: If resistance to ground at the TBC exceeds 5 ohms, notify Engineer promptly and include recommendations to reduce ground resistance.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 27 05 26

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 26 00 10 "General Requirements for Electrical Systems", and 270010 "Supplemental Requirements for Communications" apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Conduits and fittings.
 - 2. Metallic surface pathways.
 - 3. J-Hooks.
 - 4. Boxes, enclosures, and cabinets.

1.3 REFERENCES

- A. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
 - 1. Building Industry Consulting Service International (BICSI)
 - a. ANSI/BICSI N1 "Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure."

1.4 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

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

2.2 CONDUITS AND FITTINGS

- A. Comply with 26 05 33 "Raceways and Boxes for Electrical Systems".

- B. Conduit Bodies
 - 1. Telecommunications style with standards based internal bend radius control.

2.3 J-HOOKS

- A. Description: Comply with UL 2239, single and multi-tiered prefabricated sheet metal wide base cable supports with integral bend radius support for telecommunications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or an approved equal:
 - 1. Panduit
 - 2. Legrand
 - 3. Eaton B-Line
 - 4. nVent Caddy
 - 5. Thomas & Betts
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Material: Galvanized steel.
- E. J shape.
- F. UL 2043 and CAN/ULC S102.2 listed and suitable for use in air handling spaces.
- G. Pre-riveted assembly allowing for attachment to walls, ceilings, beams, threaded rods, drop wires and underfloor supports to meet requirements of application indicated.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Comply with 26 05 33 "Raceways and Boxes for Electrical Systems".
- B. General Requirements for Boxes, Enclosures, and Cabinets used for communications:
 - 1. Device Box Dimensions:
 - a. Minimum 4 inches square by 3-1/2 inches for 1-inch pathways.
 - b. Minimum 4-11/16 inches square by 3-1/2-inch deep box for pathways 1-1/4 inches and larger.
 - 2. Gangable boxes are prohibited.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Comply with requirements in Section 26 05 33 - Raceways and Boxes for Electrical Systems for pathway application except as noted below.
- B. Minimum Pathway Size: 1-inch trade size.
 - 1. For Cat6A cable applications: minimum 1-1/4-inch trade size.
- C. Install surface pathways only where indicated on Drawings or where approved by Engineer.

- D. Use of flexible conduit is prohibited.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements indicated on Drawings or in this Section are more stringent:
1. ANSI/BICSI N1.
 2. TIA-569.
- B. Comply with requirements in Section 26 05 00 – Common Work Results for Electrical Systems for hangers, supports, and sleeves.
- C. Comply with requirements in Section 26 05 33 - Raceways and Boxes for Electrical Systems for installation of raceways and fittings except as noted below:
- D. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction.
- E. Utilize manufactured sweeps and long radius elbows for all optical-fiber cables.
- F. Raceways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid, and flexible, as follows:
1. 1-Inch Trade Size and Larger: Install pathways in maximum continuous lengths of 100-feet.
 2. 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.
 3. Minimum Bend Radius
 - a. For trade size conduits 2-inch or less, provide inside bend radius at least 6 times the internal diameter of the raceway.
 - b. For trade size conduits greater than 2-inch, provide inside bend radius at least 10 times the internal diameter.
 4. Pull boxes should be readily accessible and should be installed in straight sections of conduit and not used in place of a bend.
 5. Provide a conduit stub-up for each outlet box unless noted otherwise.
- G. J-Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 2. Provide dedicated support wires, threaded rod, beam clamps, or strut. Do not use ceiling grid support wire or support rods.
 3. Install at spacing intervals to allow no more than 6-inches of slack and to provide a minimum of 6-inches of clearance from the lowest point of the cables to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power, and telecommunications outlets, and other electrical and communications equipment.
 4. Maximum Spacing: 4-feet on center.
 - a. For Cat6A installations: 3-foot on center.
 5. Provide a hook at each change in direction.
 6. Do not exceed load ratings specified by manufacturer.
 7. Do not install J-hooks that cannot be maintained without removal of another system.
 8. Provide additional tiers where required to meet fill capacity and load rating requirements or to separate low voltage systems with varying voltage and power limitations.

3.3 PROTECTION

- A. Protect installed cables in open cabling systems:
 - 1. Install temporary protection for cables in open pathways to safeguard exposed cables against paint overspray, falling objects or debris during construction.
 - 2. Replace any cable exposed to paint overspray or other foreign substance that voids the cable warranty, at no cost to the owner.
 - 3. Temporary physical protection for cables and J-hooks can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

END OF SECTION 27 05 28

SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 26 00 10 "General Requirements for Electrical", and 270010 "Supplemental Requirements for Communications" apply to this Section.

1.2 SUMMARY

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

1.3 REFERENCES

- A. Definitions
 - 1. Grounding: Establishing a direct or indirect connection to Earth or some conducting body that serves in place of Earth.
 - 2. Bonding: Method by which all non-energized conductive materials are effectively interconnected to create a low impedance path.
- B. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
 - 1. National Electrical Manufacturer's Association (NEMA)
 - a. NEMA VE 1 "Metal Cable Tray Systems"
 - b. NEMA VE 2 "Cable Tray Installation Guidelines"

1.4 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
- B. Source Limitations: Obtain cable trays, components, and accessories from single manufacturer.
- C. Sizes and Configurations: Refer to Drawings for specific requirements for types, materials, sizes,

and configurations.

2.2 WIRE-MESH CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton B-Line
 2. Cablofil
 3. Chatsworth
 4. MP Husky
 5. Siemon
 6. Snake Tray
- B. Description:
1. Configuration: steel wire mesh, complying with NEMA VE 1.
 2. Minimum Width: 12 inches unless otherwise indicated on Drawings.
 3. Minimum Usable Load Depth: 4 inches unless otherwise indicated on Drawings.
 4. Straight Section Lengths: 10 feet, 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 concentrated load, when tested according to NEMA VE 1.
 6. Splicing Assemblies: UL classified bolted type, using serrated flange locknuts.
 7. Splice-Plate Capacity: UL Classified splices located within support span shall not diminish rated loading capacity of cable tray.
- C. Materials and Finishes:
1. Steel:
 - a. ASTM A 1011/A 1011M for 14 gage and thicker; ASTM A 1008/A 1008M for 16 gage and thinner.
 - b. Straight Sections and Fittings: Comply with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
 - c. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - d. Fasteners: Comply with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - e. Finish: Electrogalvanized after fabrication, complying with ASTM B 633 for use in indoor locations.
 - 1) Hardware: Galvanized, ASTM B 633.

2.3 TROUGH CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton B-Line
 2. Cablofil
 3. Chatsworth
 4. MP Husky
 5. Siemon
 6. Snake Tray
- B. Description:
1. Configuration:
 - a. Retain one of first two subparagraphs below. Second subparagraph is more common.

- b. A flat bearing surface with a solid bottom contained within two longitudinal side rails, with both edges welded to the side rails complying with NEMA VE 1.
 - c. Single, formed sheet with a solid bottom, complying with NEMA VE 1.
 - 2. Covers: Solid type made of same materials and with same finishes as cable tray.
 - 3. Width: 12 inches unless otherwise indicated on Drawings.
 - 4. Minimum Usable Load Depth: 4 inches
 - 5. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
 - 6. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 7. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
 - 8. Covers: Solid type made of same materials and with same finishes as cable tray.
- C. Materials and Finishes:
 - 1. Steel:
 - a. ASTM A 1011/A 1011M for 14 gage and thicker; ASTM A 1008/A 1008M for 16 gage and thinner.
 - b. Straight Sections and Fittings: Comply with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
 - c. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - d. Fasteners: Comply with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - e. Finish: Electrogalvanized after fabrication, complying with ASTM B 633 for use in indoor locations.

2.4 Hardware: Galvanized, ASTM B 633.CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings indicated, of same materials and finish as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays to provide a minimum of 12-inch clear space above the top of the cable tray for

cable installation.

- D. Install cable trays with enough horizontal workspace to permit access for installing cables.
- E. Install cable trays so all splices are accessible for inspection and adjustment.
- F. Install cable trays to provide a minimum of 3-inch (6-inch recommended) clear space above ceiling tile and grid.
- G. Remove burrs and sharp edges from cable trays.
- H. Fasten cable tray supports to building structure.
- I. Design fasteners and supports to carry cable tray, number of cables at full capacity, and a concentrated load of 200 lb. Comply with requirements in Section 26 05 00 – Common Work Results for Electrical Systems.
- J. Place supports so spans do not exceed maximum spans and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- K. 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.
- L. Support assembly to prevent twisting from eccentric loading.
- M. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice point between supports.
- N. Support wire-basket cable trays with trapeze hangers, or wall brackets.
- O. Support trapeze hangers for wire-basket trays with minimum 1/4-inch diameter rods.
- P. 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.
- Q. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- R. Make changes in direction and elevation using manufacturer's recommended fittings and integral bend radius control.
- S. Make cable tray connections using manufacturer's recommended fittings.
- T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- U. Install barriers to separate cables of different systems or of different insulation levels.
- V. Where indicated, install permanent covers, after installing cable. Install cover clamps according to NEMA VE 2. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 27 05 26 - Grounding and Bonding for Communications Systems.
- B. Bond cable trays 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.

3.3 CABLE INSTALLATION

- A. Install cables after each cable tray run has been completed and inspected.
- B. Initial fill ratio shall not exceed 25%.
- C. Initial cable fill shall not exceed 50% of the manufacturer's listed load rating.
- D. Fasten cables on vertical runs with cable clamps or cable ties every 18-inches according to NEMA VE 2. Fasten cables on horizontal runs where required to maintain a neat and workman-like installation.
- E. Tighten clamps and ties only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device and trim excess to prevent further tightening.
- F. 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.
- G. Provide radius drop-outs wherever multiple cables are existing from the cable tray.
- H. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
 - 1. After installing cable trays, provide visual survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 3. Verify that communications cabling is separated from power circuits by barriers or are installed in separate cable trays.
 4. Verify there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 5. Remove dust deposits, trash of any description, and any blockage of tray ventilation.
 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 7. Check for improperly sized or installed bonding jumpers.
 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays.
- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against paint overspray, falling objects, or debris during construction.
 2. Replace any cable exposed to paint overspray or other foreign substance that voids the cable warranty, at no cost to the owner.
 3. Temporary physical 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.
 4. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 5. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 05 36

SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 26 00 10 "General Requirements for Electrical", and 270010 "Supplemental Requirements for Communications" apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for labels and signs.
 - 2. Labels.
 - 3. Signs.
 - 4. Cable ties.
- B. Related Requirements
 - 1. Refer to Section 26 05 53, "Identification for Electrical Systems" for additional requirements related to labeling of electrical equipment and cabling.

1.3 REFERENCES

- A. Definitions
 - 1. Identifier: An item of information that links a specific element of the telecommunications infrastructure with its corresponding record.
- B. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
 - 1. Underwriters Laboratories Inc (UL)
 - a. UL 969, "Marking and Labeling Systems"

1.4 SUBMITTALS

- A. Product Data: For each product type.
- B. Identification Schedule: System Labeling Schedules with proposed designations for cables, outlets, terminations, and equipment.

1.5 COORDINATION

- A. All identifications shall be consistent with the owner's standard practices, especially within existing facilities, unless otherwise required by codes. Where the requirements herein are in conflict, the contractor shall notify the engineer in writing prior to ordering any material.

- B. All room names and/or numbers for labeling or programming shall use the Owner's approved room name and numbering scheme, not names and numbers indicated on floor plans. All reprogramming shall be included as required to accommodate construction phasing.
- C. Coordinate with Owner for approval of all labelling codes and schemes prior to creation and installation of labeling system.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606 for a Class 3 system.
- B. Comply with UL 969 for Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Labels shall be designed to remain permanently affixed and shall not fade under typical environmental conditions for the life of the product identified.
- D. Thermal Movements: Allow for thermal movements from ambient temperatures up to 120-deg F and surface temperatures up to 180-deg F.
- E. Provide mechanically printed black letters on a white field unless noted otherwise.
- F. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady
 - 2. Brother
 - 3. Dymo
 - 4. HellermanTyton
 - 5. Panduit

2.2 LABELS AND TAGS

- A. Heat Shrink Tubes: Flame-retardant shrinkable polyolefin tube with thermal transfer-printed identification label. Sized to suit diameter of cable and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F.
- B. Self-Adhesive Labels: Thermal transfer-printed, minimum 3-mil-thick, flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Wraparound Vinyl or Nylon Cloth Type: Repositionable for wrapping and flagging flexible cables.
 - 2. Self-Laminating Vinyl Type: Clear wrap around tail shield laminates the entire printed legend for abrasion, UV-, weather- and chemical-resistance on flexible cables.
 - 3. General Purpose Polyester Type: for component labelling on flat surfaces.
- C. Marker Plate Tags: Thermal transfer printed, UV, weather, and chemical resistant polyolefin suitable for large cables or bundles. Pre-punched holes for attachment with cable ties.

2.3 SIGNS AND NAMEPLATES

- A. Engraved Plastic Signs and Nameplates:
 - 1. 3-layer melamine plastic laminate
 - 2. Weather and UV-resistant for Wet and Damp Locations.
 - 3. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in. or 8 inches in length, 1/8 inch thick.
 - c. Engraved designation with black letters on white face
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting. Exception for locations where specifically approved contact type permanent adhesive may be used where screws cannot or should not penetrate substrate.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system suitable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs:
 - 1. Self-tapping, stainless-steel screws, or stainless-steel machine screws with nuts and flat and lock washers.
 - 2. Pop-Rivets.
 - 3. Two-Part Epoxy Adhesive
- C. Cable Ties: Self-extinguishing, one-piece, self-locking, UV-stabilized or plenum rated where required by installed environmental conditions. 3/16-inch minimum width.

PART 3 - EXECUTION

3.1 CABLING ADMINISTRATIVE DRAWINGS

- A. Provide professionally produced, scaled drawings using Computer Aided Design software identifying the location and labelling of Communications devices served out of each telecom room.
- B. Print on Arch D or E1 size paper and install in a prominent location in each equipment room and wiring closet so as not to interfere with future equipment installation.
- C. Provide rigid frame and 1/8-inch clear plastic protective overlay.
- D. Supply separate drawings for each Communications Room.

3.2 INSTALLATION

- A. Mechanically produce all labels. Write-on labels are not permitted.
- B. Install identifying devices before installing acoustical ceilings or similar concealment.

- C. Verify identity of each item before installing identification products.
- D. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond using materials and methods recommended by manufacturer of identification product and manufacturer of substrate to retain product warranties.
- E. For surfaces that require a finish, apply identification devices to surfaces after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- G. Install all labels in a neat manner, plumb and parallel to equipment lines.
- H. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- I. Provide labels within 12-inches from cable termination points and secure tight to surface at a location with high visibility and accessibility for ease of identification after termination.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Equipment Room Racks, Cabinets, and Frames:
 - 1. Identify top and bottom, front, and rear of each with self-adhesive engraved laminated plastic nameplate containing rack or cabinet identifier (xy).
 - 2. Label Size: minimum 2-inches in height with letters no less than 1-1/2-inches tall.
- C. Rack Patch Panels and Fiber Enclosures:
 - 1. Label each fiber enclosure and patch panel with a letter (-r) designating the order of the panel from the top of the cabinet or frame.
 - 2. Label each fiber enclosure adapter panel with self-adhesive label indicating range of port numbers.
 - 3. Label fiber enclosure cover with self-adhesive labels indicating each backbone cable link identifier including:
 - a. Near end port numbers
 - b. Far end building identifier (b) for inter building cable
 - c. Far end Telecomm space identifier (fs)
 - d. Far end rack identifier (xy)
 - e. Panel identifier (-r)
 - f. Panel port numbers (:p)
 - 4. Label each patch panel port or group of ports with a self-adhesive label or manufacturer provided insert indicating the following:
 - a. Room number of outlet being served.
 - b. Faceplate number.
 - c. Patch panel port number
 - 5. Use manufacturer provided labels and mounting surfaces wherever possible.
- D. Wall Punch down Blocks
 - 1. Label each cable termination position with a sequential number designator.

2. Where insert type labels are used, install clear plastic cover over mechanically produced labels.
 3. Use manufacturer provided labels and mounting surfaces wherever possible.
- E. Backbone Cables:
1. Label each cable with a thermal transfer marker tag indicating the backbone cable link identifier including the following:
 - a. Strand/pair count and cable type
 - b. Near end identifier and far end identifier including:
 - 1) Building identifier (b) for inter building cable.
 - 2) Telecomm space identifier (fs)
 - 3) Rack identifier (xy)
 - 4) Panel identifier (-r)
 - 5) Port grouping(:p)
 2. Label Backbone cables at termination points and entrance/exit point of telecom space.
 3. Outside plant pathways: In addition to labels at termination points, label each backbone cable at all manholes, handholes, and pull points where cable enters and exits pathway.
- F. Horizontal Cables:
1. Label each cable termination point with a vinyl self-laminating label indicating the horizontal cabling link identifier including:
 - a. Room and faceplate number.
 - b. Telecomm Space identifier (fs)
 - c. Rack identifier (xy)
 - d. Patch Panel identifier (-r)
 - e. Patch Panel port number (: p)
 2. Outside plant pathways: In addition to labels at termination points, label each cable at manholes, handholes, and pull points where cable enters and exits pathway.
- G. Faceplates:
1. Label individual faceplates with self-adhesive labels or manufacturer provide insert. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, indicating the following:
 - a. Room number of outlet
 - b. Faceplate number.
 2. Label each individual jack within the same faceplate with its horizontal link identifier.
- H. Telecommunications Bonding Busbars and Conductors
1. Label each Busbar with a self-adhesive label indicating the following:
 - a. Telecomm space identifier (fs)
 - b. Busbar identifier
 2. Label each bonding conductor with a vinyl self-laminating label indicating the far end busbar or object identifier.
 3. Label each bonding conductor at its attachment point with a thermal transfer marker tag with the following.
 - a. WARNING: IF CABLE OR CONNECTOR IS LOOSE OR MUST BE REMOVED, PLEASE CONTACT TELECOMMUNICATIONS MANAGER.
 4. Warning labels: yellow marker plate type with black print.
- I. Underground duct and raceway
1. Label both ends of each underground duct and raceway with self-adhesive label indicating the following:
 - a. Pathway Identifier and sequence number
 - b. Far End Building Identifier (b)

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- c. Far End Telecomm Space Identifier (fs)
- d. Far End Outdoor Space Identifier (T)

END OF SECTION 27 05 53

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 26 00 10 "General Requirements for Electrical", and 270010 "Supplemental Requirements for Communications" apply to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Backboards
 2. 19-inch equipment racks.
 3. 19-inch freestanding equipment cabinets.
 4. Cable Management.
 5. Ladder Rack/Cable Runway.
 6. Rack Power Distribution.
 7. Rack Bonding Busbars.
 8. Building Entrance Protection.
- B. Related Requirements:
1. Section 27 05 36 "Cable Trays for Communications Systems" for cable trays and accessories.
 2. Section 27 13 00 "Communications Backbone Cabling" for copper, optical fiber, and coaxial data cabling and termination devices.
 3. Section 27 15 00 "Communications Horizontal Cabling" for copper and coaxial data cabling and termination devices.

1.3 REFERENCES

A. Abbreviations

RCDD	Registered communications distribution designer.
SBB	Secondary Bonding Busbar (Formerly TGB).
PBB	Primary Bonding Busbar (Formerly TMGB).
RBB	Rack/Cabinet Bonding Busbar.

B. Definitions

1. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
2. Ladder Rack: A specialized cable tray with side stringers and cross members, resembling a ladder, which supports cable either vertically or horizontally within an equipment room.
3. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

- C. Reference Standards: The following publications are referred to in the text by the basic

designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.

1. Building Industry Consulting Service International (BICSI)
 - a. ANSI/BICSI N1 "Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure"

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For custom equipment racks and cabinets.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. TR and MDF shall be conditioned to 68-75°F, 30-55% RH, 24 hours/day, 365 days/year.
- B. TR shall not be served by building economizer shut-down.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. UL Listed.
- B. RoHS compliant.

2.2 BACKBOARDS

- A. Backboards: AC grade plywood, fire-retardant treated, 3/4 by 48 by 96 inches
- B. Backboard Paint: (2) coats of white, fire-retardant paint.

2.3 19-INCH EQUIPMENT RACKS

- A. Description: Two- and four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.
- B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:
 1. Middle Atlantic
 2. Chatsworth CPI
 3. Ortronics
 4. Panduit
- C. General Requirements:
 1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

2. Material: Extruded aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Floor-Mounted Racks:

1. Overall, Height: 84 inches or as indicated on Drawings.
2. Overall Depth: 30, adjustable to 36 inches.
3. Upright Depth: 3 inches
4. Two-Post Load Rating: 1000 lb minimum.
5. Four-Post Load Rating: 2000 lb minimum.
6. Number of Rack Units per Rack: 45U or as indicated on Drawings.
 - a. Numbering: Every rack unit, on interior of rack.
7. Threads: #12-24 universal hole pattern.
8. Provisions for attaching vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
9. Base shall have a minimum of four mounting holes for permanent attachment to floor.
10. Top shall have provisions for attaching to cable tray or ceiling.
11. Self-leveling.
12. Four post rack shall be adjustable in depth in 1" increments.
13. Horizontal RBB for two post racks, Vertical RBB for four post racks.

E. Wall-Mounted Racks:

1. Height: 40" minimum or as indicated on Drawings.
2. Depth: 29 inches minimum.
3. Load Rating: 150 lbs. minimum.
4. Number of Rack Units per Rack: 19U minimum or as indicated on Drawings.
5. Threads: #12-24 universal hole pattern.
6. Wall Attachment: Four mounting holes.
7. Equipment Access: Integral swing.
8. Horizontal RBB.

2.4 19-INCH EQUIPMENT CABINETS

- A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inchequipment mounting with an opening of 17.72 inches between rails.
- B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:
1. Middle Atlantic
 2. Chatsworth CPI
 3. Ortronics
 4. Panduit
- C. General Cabinet Requirements:
1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 2. Material: Steel.
 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 4. Color: Black.
- D. Modular Freestanding Cabinets:
1. Overall, Height: 84 inches or as indicated on Drawings.
 2. Overall Depth: minimum 36-inches.

3. Load Rating: 2500 lb minimum.
 4. Number of Rack Units: 45 or as indicated on Drawings.
 - a. Numbering: Every rack unit, on interior of rack.
 5. Threads: #12-24 universal hole pattern.
 6. Removable and lockable side and top panels.
 7. Perforated, hinged, and lockable front and rear doors.
 8. Adjustable feet for leveling.
 9. Cable ports with sealed grommets in top panel.
 10. Integral lashing brackets and vertical cable management.
 11. Vertical RBB.
 12. Rack-mounted, minimum 550-cfm fan with filter.
 13. Power strip.
 14. All cabinets keyed alike.
 15. Bonding wires for all panels.
- E. Modular Wall Mounted Cabinets:
1. Height: 36 inches or as indicated on Drawings.
 2. Depth: 30 inch minimum.
 3. Load Rating: 200 lb minimum.
 4. Number of Rack Units: 18U or as indicated on Drawings.
 5. Threads: #12-24 universal hole pattern.
 6. Dual Hinged swing out body
 7. Lockable front and rear doors.
 8. Louvered side panels.
 9. Knockouts for conduit or cable entry grommets in top and bottom rear.
 10. Integral lashing brackets and vertical cable management.
 11. Grounding lugs.
 12. Horizontal RBB.
 13. Side-mounted, minimum 100-cfm fan.
 14. All cabinets keyed alike.
 15. Bonding wires for all panels.

2.5 CABLE MANAGEMENT

- A. Description: accommodates the support and orderly routing of cabling inside equipment racks and/or cabinets within the communications rooms. Managers shall protect network equipment by controlling cable bend radius and providing cable strain relief.
- B. Source Limitations: Obtain rack/cabinet cable management from same manufacturer or alliance partner as the rack/cabinet.
- C. Vertical Cable Management for Racks and Cabinets
1. Double sided, front and rear
 2. Mounts to side of rack/cabinet
 3. Material: Steel panels and Plastic fingers
 4. Cable fingers with rounded edges at 1U intervals
 5. Height to match rack/cabinet
 6. Width: 6" or as indicated on drawings
 7. Cable distribution spools
 8. Color: Black
 9. Hinged front and rear doors
- D. Horizontal Cable Management for Racks and Cabinets
1. Double sided, front and rear

2. Cable finger with rounded edges along top and bottom surfaces
 3. Hinged front and rear cover
 4. Height: 2U or as indicated on drawings
 5. Color: Black
- E. Cable Support Rings: NTRL labeled. Designed to prevent degradation of cable performance and pinch points that could damage cable.
1. D-shaped wall mount loop designed for cable management.
 2. Continuous loop for pull through cable installation or open slot insertion type cable installation.
 3. Size: various pre-manufactured sizes
 4. Mounting holes for attachment with screws
 5. Material: Rigid nylon or zinc covered steel

2.6 LADDER RACK/CABLE RUNWAY

- A. Description: Accommodates the support and orderly routing of cabling within the communications rooms from the cable pathway to the equipment racks and/or cabinets.
- B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:
1. Chatsworth CPI
 2. Eaton B-Line
 3. Ortronics
 4. Panduit
- C. General Requirements
1. 1-1/2 inch high by 3/8-inch-wide tubular steel
 2. Rung spacing: minimum 12-inches on center.
 3. Color: Black powder coat
 4. Width: 12-inches or as indicated on Drawings
 5. Minimum linear cable bearing surface of 1-1/2 inches per linear foot.
- D. Fittings and Accessories:
1. Install all fittings, supports, splices, etc. for the ladder rack system to provide a complete assembly- including fasteners, hardware, and other items required to complete the installation as indicated on the drawings.
 2. Fittings shall be pre-manufactured, and match rung size and spacing, material, and finish of ladder rack.
 3. Mechanically connect ladder rack sections and turns together with splices and jumpers to form an electrically continuous pathway.

2.7 RACK POWER DISTRIBUTION

- A. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:
1. Tripp Lite
 2. Panduit
 3. Chatsworth CPI
 4. Middle Atlantic
 5. Geist
- B. Power Distribution Unit: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Height: 1 RU.
4. Housing: Metal
5. Minimum Two front-facing 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R and Ten rear facing 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
6. LED indicator lights for power and protection status.
7. LED indicator lights for reverse polarity and open outlet ground.
8. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
9. Cord connected with 10-foot line cord.
10. Rocker-type on-off switch illuminated when in on position.
11. Surge Protection: UL 1449, Type 3.
 - a. Maximum Surge Current, Line to Neutral: 96 kA and neutral to ground.
 - b. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall not be more than 330 V.
 - c. EMI/RFI noise filtering: 40-80dB.
 - d. AC Suppression Joule Rating: 3800 J minimum.

2.8 RACK BONDING BUSBAR

- A. Comply with requirements in Section 27 05 26 - Grounding and Bonding for Communications Systems for bonding conductors and connectors.
- B. Source Limitations: Obtain rack/cabinet grounding hardware from same manufacturer or alliance partner as rack/cabinet.
- C. Rack and Cabinet Bonding Busbars (RBB): Rectangular bars of electro-plated copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-C. Predrilling shall be with holes for use with lugs specified in this Section.
 1. Rack-Mounted Horizontal RBB: Designed for mounting in 19-inch equipment racks. Include stainless-steel or copper-plated hardware and insulator blocks for attachment to the rack.
 2. Rack-Mounted Vertical RBB: 72 inches long, with stainless-steel or copper-plated hardware and insulator blocks for attachment to rack.
- D. Stand-Off Brackets: Non-conductive nylon "L" brackets mounted to back channel of rack/cabinet, providing tie-down point for grounding and bonding cable runs.

2.9 BUILDING ENTRANCE PROTECTION

- A. Description: The building entrance protection terminals safeguard communication equipment from damaging electrical surges on outside plant cables.
- B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:
 1. Circa Telecom
 2. Tii Technologies
 3. Vertiv
- C. Terminals: Comply with UL497 for primary and secondary protection.

1. Accept UL listed industry standard 5-pin protection modules.
 2. Built in splice chamber for input cable
 3. 66 block style quick clip connectors for input and output terminals
 4. Available in 25, 50, and 100 pair counts
 5. Stackable to accommodate future growth
 6. Internal 26AWG fuse link.
- D. Protection Modules
1. Solid State protector module with self-resetting current limiters.
 2. Minimum 5 ns transient surge response time

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Comply with requirements in Section 27 05 28 - Pathways for Communications Systems and Section 26 05 43 - Underground Pathways and Structures for Electrical Systems for materials and installation requirements for raceways.

3.2 INSTALLATION

- A. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- B. Backboards:
1. Install from 6-inches to 8-feet, 6-inches above finished floor on all walls of communications space with A side exposed to the interior. Ensure that fire-rating stamp is visible after installation.
 2. Paint all sides of backboard with two coats of fire-retardant paint, leaving fire rating stamp visible.
- C. Racks and Cabinets
1. Provide racks and cabinets with a minimum 36-inches of clear, unobstructed space from the front and rear of the rack/cabinet.
 2. Securely fasten floor mounted racks and cabinets to the structural floor using manufacturers recommended anchors or as required by local codes.
 3. Install wall mounted racks and cabinets with hinged enclosures or frames so that it can be accessed fully without obstruction by other building, storage, or architectural components. Follow the manufacturer's installation instructions for securing the rack/cabinet to the wall and backboard.
 4. Install and adjust to position all rack/cabinet accessories including cable management, power distribution, mounting rails, thermal management, and grounding prior to installing any equipment into the rack/cabinet.
- D. Cable Management
1. Attach vertical cable managers to the side of the rack/cabinet using the manufacturer's installation instructions and included hardware.

2. When a single vertical cable manager is used between two racks/frames, attach the vertical cable manager to both racks/frames.
3. Locate horizontal managers so that the number of ports (cables) that each manager supports does not exceed each cable manager's cable fill capacity. Provide a minimum of one horizontal cable manager above each patch panel.
4. The color of the rack(s)/cabinets(s) and cable manager(s) must match.
5. Securely attach covers to the cable manager(s) after cabling is complete.
6. Space rings at maximum intervals of 12 inches along the path of the cables served.
7. Provide rings of sufficient size and quantity so that no ring is utilizing more than 25% of the rated capacity.

3.3 LADDER RACK/CABLE RUNWAY

- A. Secure to the structural ceiling, building truss system, wall, or floor and to the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware.
- B. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.
- C. Support ladder rack in accordance with TIA-569-E and the following:
 1. A minimum of every 5-feet for straight runs.
 2. Within 2-feet of every splice.
 3. Within 2-feet on all sides of every intersection.
 4. Within 2-feet on both sides of every change in elevation.
 5. Every 2-feet when attached vertically to a wall.
- D. Leave a minimum of 12-inches in between ladder rack and ceiling/building truss structure. Install multiple tiers of ladder rack with a minimum clearance of 12-inches in between each tier of ladder rack.
- E. Provide an elevation kit to maintain a minimum of 6-inches in between ladder rack and the tops of equipment racks and/or cabinets.
- F. Provide vertical ladder rack and supports where vertical distance between sleeves/pathways and horizontal ladder rack exceeds 5-feet.
- G. Within each telecommunications room, bond ladder rack together with manufacturer's recommended ground straps, and bond to the PBB/SBB, unless otherwise noted in the specifications and contract documents.
 1. Bond ladder rack and turns across each splice with a bonding kit.
 2. Bond ladder rack to the PBB/SBB using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the AHJ.
 3. Remove paint from the ladder rack where bonding/ground lugs contact the ladder rack so that the lug will contact bare metal.
 4. Use antioxidant joint compound in between the bare metal on the ladder rack and ground lug and in between the bus bar and the ground lug.
 5. Verify continuity through the bonds at splices, intersections between individual ladder rack sections and turns, and through the bond to the PBB/SBB.
- H. Use a radius drop to guide cables wherever cable exits overhead ladder rack to access a rack, cabinet, or termination field. Provide a moveable cross member to attach and align the radius drop in between the welded cross members of a ladder rack.

- I. Cover the exposed ends of the ladder rack that do not terminate against a wall, the floor, or the ceiling with end caps made from a rubberized material or an end closing kit.
- J. Provide touch-up paint color-matched to the finish on the ladder rack and correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner.
- K. Initial cable fill shall not exceed 2-inches in height and shall not exceed 25% of the interior area of the ladder rack. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2-inches. Provide cable retaining posts where initial cable fill is exceeded.
- L. Do not exceed load ratings specified by manufacturer.

3.4 GROUNDING

- A. Provide bonding conductors and connectors in accordance with requirements in Section 27 05 26 - Grounding and Bonding for Communications Systems.
- B. Clean the rack bonding busbar (RBB) and apply a compatible antioxidant prior to fastening connectors to the busbar.
- C. Install RBB on rack or cabinet using block insulators to provide a minimum of 0.75 inches of separation.
- D. Connect RBB to either the Rack Bonding Conductor (RBC) or Telecommunications Equipment Bonding Conductor (TEBC) and to the rack using listed compression two-hole lugs.

3.5 IDENTIFICATION

- A. Provide component labelling in accordance with requirements in Section 27 05 53 - Identification for Electrical Systems.

END OF SECTION 27 11 00

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SECTION 27 13 00 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 26 00 10 "General Requirements for Electrical", and 270010 "Supplemental Requirements for Communications" apply to this Section.

1.2 SUMMARY

- A. Backbone Cabling Description:
 - 1. The backbone cabling system shall provide intra- and/or inter-building connections between communications equipment rooms, main terminal space, and entrance facilities in an multi room telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection. Backbone fiber shall terminate in Corning LANscape rack-mounted hardware with LC pigtail fusion splices.
- B. Section Includes:
 - 1. Single-mode, optical fiber cable.
 - 2. Optical fiber cable hardware.

1.3 REFERENCES

- A. Abbreviations
 - 1. OTDR: Optical Time Domain Reflectometer
 - 2. OSP: Outside Plant
- B. Definitions
 - 1. Backbone Cable: Cable and connecting hardware that provide interconnections between telecommunications rooms, equipment rooms, and entrance facilities.
- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
 - 1. Building Industry Consulting Service International (BICSI)
 - a. ANSI/BICSI N1, "Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure"
 - 2. National Electrical Contractors Association (NECA)
 - a. NECA 301, "Installing and Testing Fiber Optics"

1.4 SUBMITTALS

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

- B. Product Schedule: For each type of cable, identify intended location and use.
- C. Optical Fiber, Twisted Pair Cable Testing Plans:
 - 1. Sample test report sheet for each type of test required.
 - 2. Description of the cable testing procedures to be used including equipment to be used and testing standards equipment will test to.
- D. Closeout Submittal
 - 1. Operation and Maintenance Data: In addition to the items specified in Division 01 and Section 26 00 10 "General Requirements for Electrical" include the following:
 - a. Cable Test Results

PART 2 - PRODUCTS

2.1 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - 1. Plenum Applications: Type OFNP, OFCP, or CMP complying with NFPA 262
 - 2. Non-plenum applications: Type OFNR, OFCR, or CMR complying with UL 1666
 - 3. Wet Location or Outdoor Applications: OSP.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings from an applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.

2.2 OPTICAL FIBER PERFORMANCE REQUIREMENTS

- A. General Performance: Optical Fiber Backbone cabling system shall comply with minimum performance values below as well as transmission standards in TIA-568.1 and TIA-568.3, when tested according to test procedures in TIA-568.
- B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following:
 - 1. Corning
 - 2. General Cable
 - 3. Panduit
 - 4. Superior Essex
- C. Jacket Identification
 - 1. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
 - 2. Provide cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
 - 3. Color:
 - a. OM4: Violet
 - b. OS2: Yellow
- D. 50 Micrometer cabling and connectivity products shall use bend insensitive fiber.

- E. 850nm Laser Optimized 50/125 Micrometer, Multimode, Optical Fiber (OM4)
 - 1. Comply with TIA-492AAAD for detailed specifications.
 - 2. Maximum Attenuation Coefficient: 3.0 dB/km at 850 nm; 1.0 dB/km at 1300 nm.
 - 3. Minimum Over-Filled Launch Bandwidth: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
 - 4. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.
- F. 9/125 Micrometer, Single-Mode, Optical Fiber (OS2)
 - 1. Comply with TIA-492CAAB for detailed specifications.
 - 2. Maximum Attenuation Coefficient: 0.4 dB/km at 1310 nm; 0.4dB/km at 1550 nm.

2.3 INDOOR OPTICAL FIBER CABLE

- A. Description: Tight Buffer, armored distribution optical fiber cable suitable for use in indoor applications.
- B. Comply with ICEA S-83-596 for mechanical properties.
- C. Tight Buffer Cable Construction
 - 1. 900 μ m thermoplastic buffered fibers
 - 2. Lightweight aramid yarn overall strength member.
 - 3. Ripcord to facilitate jacket removal.
 - 4. Multiple subunits with central dielectric strength member for cables with greater than 24 fibers.
 - 5. Flame retardant jacket.
- D. Armor
 - 1. Aluminum Interlocking Armor with additional outer jacket

2.4 INDOOR/OUTDOOR OPTICAL FIBER CABLE

- A. Description: Tight Buffer, armored distribution optical fiber cable suitable for use in indoor or outdoor applications.
- B. Comply with ICEA S-104-696 for mechanical properties.
- C. Tight Buffer Cable Construction
 - 1. 900 μ m thermoplastic buffered fibers
 - 2. Water blocking aramid yarn overall strength member.
 - 3. Ripcord to facilitate jacket removal.
 - 4. Multiple subunits with central dielectric strength member for cables with greater than 24 fibers.
 - 5. UV-, Moisture-resistant, Flame-retardant jacket.
- D. Armor
 - 1. Aluminum Interlocking Armor with additional outer jacket

2.5 OPTICAL FIBER CABLE HARDWARE

- A. Source Limitations: Obtain optical fiber cable hardware from same manufacturer or alliance partner as optical fiber cable.

- B. Standards:
 - 1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
 - 2. Comply with TIA-568.3.
- C. Modular Patch Panels:
 - 1. Rack mount, metal patch panel with numbered units that accept adapter panels or individual adapter modules.
- D. Fiber Enclosures
 - 1. Steel Enclosure used to protect and manage fiber optic terminations and splices.
 - 2. Provide integral bend radius control and cable management for fiber patch cords.
 - 3. Include grommets, cable ties, spools, and brackets to provide strain relief for cable routing.
 - 4. Rack Mount
 - a. Enclosure with slide-out, tilt down tray suitable for installation in standard EIA 19" rack rails
 - b. Front and rear access with latching hinged doors.
 - 5. Wall Mount
 - a. Compact enclosure segmented into service and user sides with latching door for each segment.
- E. Fiber Adapter Panels
 - 1. Snap-in installation into fiber enclosures and fiber patch panels.
 - 2. Contains compatible simplex or duplex fiber optic adapter modules and meets or exceeds TIA-568.3 requirements.
- F. Adapter Modules:
 - 1. Female; simplex and duplex; ceramic sleeve, modular adapter designed for mating two fiber optic connectors.
 - 2. Follow the TIA-568.3 suggested color identification scheme.
 - 3. Designed to snap into an adapter panel or faceplate.
- G. Connectors:
 - 1. Pre-polished, factory terminated, Fusion splice-on connectors with integral strain relief boot for termination of 900 μ m buffered fibers.
 - 2. Type: Type SC complying with TIA-604-10-B connectors.
 - 3. Maximum Insertion loss: 0.4 dB for multi-mode or single-mode connectors.
- H. Pigtail Assemblies:
 - 1. Multi-leg, factory terminated, fiber connector assembly for termination of tight buffered or loose tube cables.
 - 2. Maximum Insertion loss: 0.4 dB for multi-mode or single-mode connectors.
- I. Buffer Tube Fan-Out Kits:
 - 1. 900 μ m fan out assembly for use when terminating 250 μ m coated fibers in loose buffer tubes.
 - 2. Color coded to match fiber color scheme.
 - 3. Rated for installed environment.
- J. Patch Cords: Factory-made, push-pull type, dual-fiber cables in varying lengths.
 - 1. Provide two (2) OM3 duplex fiber jumpers for each IDF.
- K. Splices
 - 1. Type: Fusion

2. Maximum Insertion loss: 0.3 dB for multi-mode or single-mode splices.
 3. Provide heat shrinkable sleeve to secure and protect splice while maintaining individual access.
- L. Splice Trays
1. Metal enclosure with integral strain relief, cable management, and fiber spooling for protection of splices.
 2. For use with both loose-tube and tight buffered fiber optic cable in indoor fiber enclosures or outdoor splice enclosures
- M. Outdoor Splice Closures
1. Non-metallic housing with hinged case, re-usable seal, and locking clips for easy access.
 2. Provide re-enterable sealing components to prevent water penetration into the closure. Injected encapsulate is not permitted.
 3. Suitable for aerial, underground, or direct buried applications.
 4. Size to accommodate the number of fiber splices indicated plus 25% spare capacity.
 5. Accommodate splice trays suitable for single fiber, heat shrink, mechanical, or fusion splices.
 6. The cable clamping and sealing hardware used to terminate the optical fiber cable shall not cause an attenuation change greater than ± 0.05 dB per fiber.
 7. Provide appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the closure and any armored cable sheath.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

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

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements for pathways specified in Section 27 05 28 "Pathways for Communications Systems."
 3. Unenclosed wiring methods may be used in accessible ceiling spaces.
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within 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. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 GENERAL REQUIREMENTS FOR BACKBONE CABLING INSTALLATION

- A. Comply with NECA 1, NECA 301, and BICSI N1.

- B. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
- C. Cables may not be spliced unless noted otherwise.
- D. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- E. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- F. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
- G. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
- H. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
- I. In each telecommunications space, securely fasten all backbone cables and provide a 30-foot-long service.
- J. Backbone cables shall be installed separately from horizontal cables:
 - 1. Where backbone cables and horizontal cables are installed in a cable tray or wireway, backbone cables shall be installed first and segregated from the horizontal cables.
 - 2. Where cables are routed using conduits or j-hooks, the backbone and horizontal cables shall be installed in separate conduits/j-hooks.
- K. Open Cable Installation
 - 1. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
 - 2. Cable and support hardware shall not obstruct access to panels, equipment, valves, boxes, or other control devices.
- L. Support vertical runs of cable with a wire mesh grip, messenger strand, cable ladder, or other method to provide proper support for the weight of the cables.
- M. Provide inner duct for installation of new cabling in conduit with existing cables. Do not install new cabling in same conduit or innerduct with existing cables.
- N. Under no circumstances shall the cable or patch cords be painted, treated, or covered with other material unless approved by the manufacturer, Owner, and Engineer.

3.4 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Strip each fiber cable upon entering the splice tray and route the individual fibers in the splice tray.
- B. Provide 20-inch slack loop and neatly coil fiber within the fiber splice tray or enclosure. Unprotected fiber shall not be allowed external to the fiber enclosure.

- C. Attach each individual cable to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- D. A maximum of 12 strands shall be spliced in each tray.
- E. All spare strands shall be installed into spare splice trays or adapter panels.
- F. Provide blank adapter panels for all un-used spaces in fiber enclosures.
- G. After system testing and acceptance, seal outdoor splice closures and flash test with a maximum of 10 PSI to ensure water-proof seal.

3.5 IDENTIFICATION

- A. Provide identification of cabling and devices in accordance with Section 27 05 33 "Identification for Communications Systems".

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections on all new and modified cabling and termination hardware.
- B. Tests and Inspections:
 - 1. Visually inspect optical fiber and twisted pair jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding and inspect cabling connections for compliance with TIA-568.
 - 2. Visually confirm Category marking of outlets, cover plates, outlet/connectors, and patch panels.
 - 3. Visually inspect cable placement, cable termination, cable bend radius, grounding and bonding, equipment, and patch cords, and labeling of all components.
 - 4. Field-test instruments shall be approved by the cable manufacturer, be within the calibration period recommended by the instrument manufacturer and meet a minimum Level III accuracy in accordance with TIA-1152-A. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 5. Optical Fiber Performance Tests:
 - a. Optical Fiber Cable Tests shall be performed on all fiber strands.
 - b. Fiber end faces shall be inspected using a video scope and recorded in the memory of the test instrument for subsequent reporting.
 - c. Link Tier 1 Attenuation Tests:
 - 1) Testing shall be performed on each cabling segment (connector to connector) individually as its installed and on each end-to-end cabling channel (equipment to equipment) for final acceptance.
 - 2) Multimode backbone link measurements: Test at 850 and 1300 nm in both directions according to TIA-526-14-B, Method B, one-cord reference method, with an Encircled Flux compliant launch.
 - 3) Single mode backbone link measurements: Test at 1310 and 1550 nm in both directions according to TIA-526-7, Method A.1, one-cord reference method.
 - 4) Attenuation test results shall be less than those calculated according to equation in TIA-568 with a maximum allowable connector loss of 0.4dB and maximum allowable splice loss of 0.3dB.

- d. For all OSP cable, backbone cable with splices, or fiber strands that exceed specified maximum power loss, perform Tier 2 testing utilizing an OTDR bi-directional tester at the wavelengths specified above to ensure uniformity of cable attenuation, connector insertion loss and reflectance. Overall, the OTDR test results shall be made up of the wavelength of the conducted test, the link length, attenuation, cable identification, the locations of the near end, the far end and each splice point or points of discontinuity.
- e. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of TIA-568. The polarity of the paired duplex fibers shall be verified using an OLTS.
- 6. Final Verification Tests: Perform verification tests for optical fiber and twisted pair systems after the complete communication cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: After dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: After Owner's Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report or shall be transferred from the instrument to the computer, printed, and submitted unaltered.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections. Marginal passes are not acceptable.
- E. Remove, replace, and re-test cabling and terminations where test results indicate that it does not comply with specified requirements.
- F. Prepare test and inspection reports.
- G. The Engineer may request that a 10% random field re-test be conducted on the cabling system, at no additional cost, to verify documented findings. Tests shall conform to the requirements listed above. If findings contradict the documentation submitted by the contractor, additional testing can be requested to the extent deemed necessary by the Engineer, including a 100% retest. Any re-testing shall be at no additional cost to the Owner.

END OF SECTION 27 13 00

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General, Special and Supplementary Conditions, Division 01 Specification Sections, Section 26 00 10 "General Requirements for Electrical", and 270010 "Supplemental Requirements for Communications" apply to this Section.

1.2 SUMMARY

A. Horizontal Cabling Description

1. Horizontal cable and its connecting hardware provide means of transporting signals between a telecommunications outlet/connector and the horizontal cross connect located in a telecommunications room. The cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
2. A work area is approximately 100 sq. ft. includes the components that extend from the equipment outlets to the station equipment.
3. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

B. Section Includes:

1. Twisted Pair Cabling
2. Twisted pair cable connecting hardware, including patch panels and cross connects.
3. Telecommunications outlets/connectors, including plugs and jacks.
4. Grounding provisions for twisted pair cable.
5. Source quality control requirements for twisted pair cable.

1.3 REFERENCES

A. Abbreviations

EMI	Electromagnetic Interference
IDC	Insulation Displacement Contact
UTP	Unshielded Twisted Pair

B. Definitions

1. Horizontal Cabling: Distribution media that connects the telecommunications outlet/connector at the work area and the horizontal cross-connect in the telecommunications room or enclosure.
2. Telecommunications Outlet: An assembly consisting of a faceplate, backbox, or supporting bracket, and one or more receptacles or jacks of a telecommunication connector. Also known as a work area outlet.

- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
 - 1. Building Industry Consulting Service International (BICSI)
 - a. ANSI/BICSI N1, "Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure"

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Twisted Pair Cable Testing Plans:
 - 1. Sample test report sheet for each type of test required.
 - 2. Description of the cable testing procedures to be used including equipment to be used and testing standards equipment will test to.
- C. Closeout Submittal
 - 1. Operation and Maintenance Data: In addition to the items specified in Division 01 and Section 26 00 10 "General Requirements for Electrical" include the following:
 - a. Cable Test Results

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with minimum performance values listed herein and transmission standards in TIA-568.1, when tested according to test procedures of this standard.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard, UL 444, and NFPA 70 for the following types:
 - 1. Plenum Applications: Type CMP complying with NFPA 262.
 - 2. Non-plenum applications: Type CMR complying with UL 1666.
 - 3. Wet Location and Outdoor Applications: OSP.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 STANDARDS COMPLIANT CATEGORY 6a TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal separator, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

- B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following
 - 1. SYSTIMAX
 - 2. Belden
 - 3. Legrand
- C. Standard: Comply with TIA-568.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP) unless noted otherwise.
- F. Jacket: Blue thermoplastic unless noted otherwise.

2.4 ENHANCED SMALL DIAMETER CATEGORY 6a TWISTED PAIR CABLE

- A. Description: Four-pair, small diameter, balanced-twisted pair cable, with internal separator, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz and minimum +4 dB margin for alien crosstalk parameters.
- B. Manufacturers: Subject to compliance with requirements, provide product indicated or approved equal by one of the following
 - 1. SYSTIMAX
 - 2. Belden
 - 3. Legrand
- C. Standard: Comply with TIA-568.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP) with overall discontinuous shield.
- F. Jacket: Blue thermoplastic unless noted otherwise.

2.5 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of the twisted pair cabling.
 - 2. Comply with TIA-568.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer or alliance partner as twisted pair cable.
- D. Expansion Criteria: Unless otherwise noted, provide spare positions in cross connects and patch panels to accommodate 20% future growth.
- E. Connecting Blocks:
 - 1. 110-style IDC

2. 50, 100, and 300 pair footprints.
 3. Supports termination of 22-24 AWG solid conductors.
 4. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between horizontal and backbone cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.
 2. Management rings shall be provided between vertical columns of blocks to provide management of cross connect wire.
- G. Modular Patch Panel: Metal patch panel with numbered jack units that accept modular type connectors at each jack location for permanent termination of pair groups of installed cables.
1. Features:
 - a. Universal T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - e. Strain Relief Bar
 2. Construction: 16-gauge steel and mountable on 19-inchequipment racks.
 3. Number of Jacks per Field: One for each four-pair cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
- H. Patch Cords: Factory-made, four-pair cables in various lengths; terminated with an eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification.
 3. Patch cords shall match performance rating of horizontal link.
- I. 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 twisted pair cable, rated to match performance of horizontal link.
 2. Standard: Comply with TIA-568.2.
 3. Marked to indicate transmission performance.
- J. Modular Jacks and Jack Assemblies:
1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable, rated to match performance of horizontal link.
 2. Designed to snap-in to a patch panel or faceplate.
 3. Standard: Comply with TIA-568.2.
 4. Marked to indicate transmission performance.
- K. Faceplate:
1. Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
 2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
 3. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
 4. For use with snap-in modular jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
- L. Surface Mount Box

1. Two port, low profile, surface mount housing, with removeable cover.
2. Plastic housing suitable for installation in plenum air handling spaces. Coordinate color with Section 26 27 26 "Wiring Devices."
3. For use with snap-in modular jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

M. Legend:

1. Machine printed, in the field, using adhesive-tape label.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. 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.
 2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."
 3. Unenclosed wiring methods may be used in accessible ceiling spaces.
- B. Wiring within 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. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. General Requirements for Cabling:
1. Provide a minimum of two equipment jacks for each work area outlet unless noted otherwise.
 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 5. Maintain the cable jacket to within 1-inch of the termination point.
 6. Provide horizontal cabling with the following minimum bending radius:
 - a. Twisted Pair Cable: 4 times the outside diameter of the cable.
 - b. Coax Cable: 10 times the outside diameter of the cable.
 7. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 8. Coordinate with owner requirements for use of T568A or T568B standard for terminations.
 9. Coil cables in the outlet boxes if adequate space is present to house the cable coil without exceeding the cable bend radius.
 10. Store no more than 12-inches of twisted pair and 36-inches of fiber optic cable in an outlet box or modular furniture raceway after termination. Loosely store excess slack in the ceiling above each drop location.
 11. In the telecommunications room, provide minimum 10-foot of slack for all horizontal cables and dress/store on ladder rack system without exceeding the cable bend radius.
 12. Store cable slack in a Figure 8, "U" or "S" pattern.
 13. MUTOAs shall not be used as a cross-connect point.

14. Provide consolidation point and cabling listed for wet locations at floor boxes in slab-on grade construction:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
 15. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
 16. Provide blank filler inserts for all unused work area faceplate ports.
 17. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 18. Cables shall be neatly bundled and dressed into groups of no more than 48 cables and routed from the point of entrance into the telecommunications space to their respective patch panel or connecting block.
 19. Each patch panel or connecting block shall be fed by individual bundles separated and dressed with hook and loop straps.
 20. Install lacing bars and distribution spools to restrain cables, prevent straining connections, and maintain minimum bending radii.
 21. 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.
 22. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
 23. Pulling Cable: Comply with BICSI Information Technology Systems Installation Methods Manual (ITSIMM), "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
 24. Under no circumstances shall the cable or patch cords be painted, treated, or covered with other material unless approved by the manufacturer, Owner, and Engineer.
- B. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable management in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Cable shall not be run through structural members, attached to ceiling grid/luminaire supports, or in contact with pipes, ducts, or other potentially damaging items.
 3. Cable and support hardware shall not obstruct access to panels, equipment, valves, boxes, or other control devices.
- C. Group connecting hardware for cables into separate logical fields.
- D. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569 for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 IDENTIFICATION

- A. Provide identification of cabling and devices in accordance with Section 27 05 33 "Identification for Communications Systems".

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections on all new and modified cabling and termination hardware.
- B. Tests and Inspections:
 1. Visually inspect jacket materials for NRTL 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 confirm Category marking of outlets, cover plates, outlet/connectors, and patch panels.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 4. Field-test instruments shall be approved by the cable manufacturer, be within the calibration period recommended by the instrument manufacturer and meet a minimum Level IV accuracy in accordance with TIA-1152. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 5. Twisted Pair Continuity Tests:
 - a. Test twisted pair cabling for shorts, opens, intermittent faults, polarity, and pair reversals, crossed pairs, and split pairs. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 6. Twisted Pair Performance Tests:
 - a. Test each cable link to the performance requirements outlined in this specification and manufacturer's warranty requirements. Perform the following tests according to TIA-568.1, TIA-568.2, and TIA-1152:
 - 1) Wire Map
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) DC resistance.
 - 4) DC resistance unbalance.
 - 5) Insertion loss.
 - 6) Near-end crosstalk (NEXT) loss.
 - 7) Power sum near-end crosstalk (PSNEXT) loss.
 - 8) Equal-level far-end crosstalk (ELFEXT).
 - 9) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 10) Return loss.
 - 11) Propagation delay.
 - 12) Delay skew.

7. Final Verification Tests: Perform verification tests for UTP systems after the complete communication cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: After dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: After Owner's Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, printed, and submitted unaltered.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections. Marginal passes are not acceptable.
- E. Remove, replace, and re-test cabling and terminations where test results indicate that they do not comply with specified requirements.
- F. Prepare test and inspection reports.
- G. The Engineer may request that a 10% random field re-test be conducted on the cabling system, at no additional cost, to verify documented findings. Tests shall conform to the requirements listed above. If findings contradict the documentation submitted by the contractor, additional testing can be requested to the extent deemed necessary by the Engineer, including a 100% re-test. Any re-testing shall be at no additional cost to the Owner.

END OF SECTION 27 15 00

SECTION 27 32 26 - EMERGENCY TELEPHONES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work covered by this Section includes all labor, materials, and equipment required for a complete and operational emergency call station system integrated with the facility's fire alarm/mass notification system. Work includes, but is not limited to:
 - 1. Furnishing and installing outdoor, pole- or wall-mounted emergency call stations with blue beacon and integral speaker/microphone assembly.
 - 2. Providing power, data, and signal interfaces necessary for integration with the MNS and network communication systems.
 - 3. Coordination with Division 28 Fire Alarm System and Division 27 Communications infrastructure for power, signal, and network routing.

1.2 QUALITY ASSURANCE

- A. Refer to Section 27 00 10 for general details.

1.3 CODES, STANDARDS, AND GUIDELINES

- A. North Carolina State Building Code 2018 edition
- B. NFPA 72, National Fire Alarm and Signaling Code, 2013 edition
- C. UL 62368-1 – Information Technology Equipment safety standard
- D. UL 1638 – Visual Signaling Appliances
- E. UL 464 – Audible Signaling Appliances
- F. FCC 47 CFR Part 15 – Radio Frequency Devices
- G. TIA-568 and TIA 607 – Structured Cabling and Grounding/Bonding Standards
- H. ADA Standards for Accessible Design

1.4 SUBMITTALS

- A. Product Data: For each type and model of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
- B. Shop Drawings: Including plans, elevations, sections, details, and attachment to other work.
- C. Submit Manufacturer's Cut Sheets for the following.
 - 1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturers cut sheets.

- D. Provide manufacturer s warranty statement.
- E. Provide all user/installation/programming manuals for all installed equipment.

1.5 IDENTIFICATION

- A. All cables, protectors, handholes, and other communications infrastructure are to be labeled per Section 27 05 53 "Identification of Communication Systems" and Section 26 05 53 "Electrical Identification".

1.6 WARRANTY

- A. Manufacturer shall warrant emergency call stations, electronics, and accessories against defects in materials and workmanship for not less than two (2) years from date of Beneficial Occupancy.
- B. Warranty shall include full replacement of defective components, including parts, labor, and freight.
- C. Provide manufacturer's extended warranty coverage where available at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 PRODUCT CONSISTENCY

- A. Product Consistency. Any given item of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted.

2.2 EMERGENCY TELEPHONE

- A. General
 - 1. Unit must be an easily identifiable, outdoor rated, vandal resistant communications device that is ADA compliant.
 - 2. Faceplate shall be constructed of 12 Gauge Steel or Aluminum with a brushed finish
 - 3. The entire unit shall be vandal resistant and include vandal resistant screws.
 - 4. Mounting holes shall be pre-drilled and be of a standard pattern for installation in the vendor's entire product line.
- B. Color & Signage
 - 1. The emergency phone shall have the word "EMERGENCY" in and a red button as a permanent part of the faceplate assembly.
 - 2. Labeling shall include Braille, be cast metal with writing raised 3/32" for ADA compliance.
- C. Communications
 - 1. Unit activated via a single mushroom "EMERGENCY" pushbutton; hands-free speakerphone operation.

2. Provide two auxiliary outputs and one auxiliary input (dry contacts) for strobe, CCTV preset, or MNS triggers.
 3. Provide SIP/IP network interface with PoE input; integral surge protection per manufacturer.
 4. The speaker and microphone shall be protected from the environment and vandalism with a grill and protected from pest intrusion with a screen.
 5. Speakerphone shall operate hands-free once the call is placed.
 6. Unit shall operate via SIP 2.0 compatibility; configuration via secure web UI or provisioning; dual network addressing (static/DHCP).
 7. If rollover dialing is required, provide this functionality within the SIP phone module. All configuration data and programming shall be stored in non-volatile memory to retain settings after power loss.
 8. Speaker output shall be greater than 80db at 1 meter.
 9. Unit shall feature a LED that shall illuminate to indicate that the call has been received.
 10. Unit shall have a programmable call timer to disconnect the call.
 11. Unit shall have adjustable volume controls separately for the microphone and speaker.
 12. Unit shall be capable of silent monitoring.
 13. Unit shall utilize SIP signaling.
 14. When a call is finished the Unit shall automatically shut off.
 15. Unit must be able to answer a call from any other phone.
 16. Two levels of programmable passwords shall be available.
 17. Unit shall have a RJ-45 Ethernet connector for quick installation
 18. Unit shall have a 3.5 inch waterproof speaker. Magnet and solid aluminum voice coil area shall be protected from ferrous and non-ferrous particles by special design. Speaker shall operate at temperatures of -20°F to 140° F Steel basket shall have a zinc dichromate finish for protection from corrosion.
 19. Unit shall include gold water resistant microphone.
 20. Push Button/Switch shall be a single assembly. Epoxy seals shall protect internal contacts and terminals from moisture and dust penetration. Assembly shall have a mechanical life of 1,000,000 cycles. Push button shall be made of steel or aluminum and red in color. Push Button/Switch shall operate in a temperature range of -20°F to 140° F.
 21. Button shall provide tactile feedback.
 22. PC Boards and Electrical Components shall be designed to operate in a temperature range of - 20°F to 140° F. and humidity levels up to 94% at 110° F.
 23. Protective Sealing of PC boards and electrical Components. After final assembly the entire circuit board shall be conformally dipped rather than by spraying. The microprocessor chip shall be sealed in place with electrical grade silicone sealant after insertion into the circuit board.
 24. A single touch to the communications devices button shall immediately dial to predetermined phone number. Upon activation of the communication devices, the following function shall immediately occur.
 - a. Dial to a predetermined phone number.
 - b. Activation of the associated blue strobe light.
 - c. Upon establishing connections to a predetermined phone number, the communication device shall send a signal identifying that the unit has been activated.
 - d. The strobe light shall continue to flash until the call is terminated
- D. Network & Power
1. Provide IEEE 802.3af PoE to WEBS-CM-2 or local 120 VAC circuit to tower as scheduled; coordinate any internal power supplies with manufacturer's instructions.
- E. MNS / Fire Alarm Integration

1. Provide IP/SIP endpoint registration for WEBS paging into the MNS platform; provide dry-contact I/O mapping for strobe and camera preset. Device shall support browser-based provisioning and role-based access.

2.3 EMERGENCY TELEPHONE TOWER (PEDESTAL)

- A. Unit must be a freestanding, multifunctional, easily identifiable, vandal resistant communications device that is fully ADA compliant.
- B. Construction
 1. Unit must be constructed of 0.25" steel tubing with radiused corners.
 2. Unit must have multi-coat rust-inhibitive coating
 3. Unit must have the capability to support an overhead camera mount and CCTV camera(s).
 4. Unit must have a recessed mounting area for the phone instrument.
- C. Lighting
 1. Unit must have an LED blue beacon, steady-on with flashing during call..
 2. Unit must have a polycarbonate refractor/housing with a prismatic pattern IO increase visibility at greater distances. Refractor housing shall further be enclosed in a clear polycarbonate security enclosure.
 3. Unit must include a lighted faceplate for the phone instrument.
- D. Color & Signage
 1. Coating shall be a high gloss with resistance to corrosion, UV fade, and graffiti protection.
 2. Color of the unit shall be Safely Blue.
 3. The word 'EMERGENCY' shall be emblazoned on all four sides with factory applied 3.25' high reflective white letters.
- E. Power
 1. Voltage requirements. 120VAC.
- F. Mounting
 1. Provide surface-mount base-plate installation on a concrete foundation flush with finished grade, with manufacturer's anchor kit and template.
 2. Conduit stub-up shall emerge within the tower footprint; provide drain/weep per manufacturer.
 3. Embedded (direct-bury) options are not permitted unless noted.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation at minimum shall be as specified by the manufacturer.
- B. Do not install emergency phones until after their installation location has been accepted by the campus telecommunications representative.
- C. Electrical circuits used to provide power to emergency phone installations are to be fulltime powered circuits. Electrical circuits that are activated by timer or photocell are not acceptable.

- D. All access panels for pedestal mounts shall be completely accessible with at least 3 feet of clearance for maintenance access.
- E. ADA Compliance
 - 1. Installation of the pedestal, phone instrument, foundation. and mounting hardware shall not impede ADA accessibility requirements.
- F. Post Project Cleanup
 - 1. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.
 - 2. Restore any landscape, concrete, asphalt or aesthetic elements disturbed during installation

3.2 QUANTITIES

- A. Quantities of system elements shown on the drawings are illustrative only and are meant to indicate the general configuration of the work The Contractor is responsible for providing the correct quantities of materials to construct a system that meets the intent of these Specifications and the relevant codes.

3.3 INSTALLATION

- A. Pedestal Installation
 - 1. Installation is to include a dedicated 1" conduit with pull string for Telecom. This conduit is to connect directly to the nearest telecommunications infrastructure. Refer to project drawings for specific connection location.
 - 2. Installation is to include a dedicated 1" conduit for electrical service This conduit is to connect directly to the nearest electrical infrastructure. Refer to project drawings for specific connection location
 - 3. Electrical circuit shall be continuously enclosed in conduit for its entire run until it terminates in an outlet or junction box inside the pedestal
 - 4. No conduits shall enter the top or side of a pedestal mount phone enclosure. Conduits shall only enter the bottom of the enclosure.
 - 5. Footings & Mounting
 - a. Follow all manufacturer s written recommendations for installation.

3.4 GROUNDING & BONDING

- A. Pedestal Mount Phone
 - 1. Pedestal is to be grounded with a #6AWG copper ground wire. Wire is to be terminated on the provided grounding stud in the tower, and terminated on the ground rod in the accompanying signal hand hole.
 - 2. All entrance protectors located inside the tower shall be bonded to the grounding stud using a #6 AWG copper ground wire.
 - 3. Bond all metal components of the pedestal, including the whip from the steel reinforcing in the footing. to the grounding rod.
- B. Refer to Section 27 05 26 for additional details.

3.5 TESTING

- A. Testing shall require a demonstration of a call from each device proving proper functioning of all accessories and visual notification devices. Each demonstration will be in the presence of the campus telecommunications representative.

3.6 ACCEPTANCE

- A. Upon receipt of the Contractors documentation of testing, the campus representative will review/observe the installation and randomly request tests of the device as installed. Once the installation and testing has been completed and the campus telecommunications representative is satisfied that all work is in accordance with the Contract Documents, the representative will notify the Contractor and/or campus project manager in writing or via email.

END OF SECTION 27 32 26

SECTION 276410 – Emergency Responder Radio Antenna System (ERRAS)

PART 1 GENERAL

1.1 SUMMARY

- A The Emergency Responder Radio Antenna System (ERRAS) is a standalone system.
- B The system must meet the requirements of UNCW Emergency Communications.
 - 1. Compliant Public Safety In-Building Two-Way Radio Communications Enhancement Systems Requirements.
- C The contractor will design, furnish, install, and provide a five (5)-year warranty for a Comba Class A RXxxxV2 PS 700/800 MHz Emergency Responder Radio Antenna System (ERRAS) In-Building First Responder Network (public safety use). See other sections in this specification for additional warranties relating to other system components. The installed system will include cabling in conduits, roof mount tower, tower mounted antenna, indoor antenna, antenna system integrity alarm, 70% of battery capacity remaining alarm, alarms remotored to fire control room using an independent fire control panel, alarm interface compatibility to standard fire alarm panels, all hardware, bi-directional amplifiers, band-pass filters, surge suppressors, lightning protection, transmission lines, power cabling, coaxial cabling in j-hooks or conduits in walls or inaccessible ceiling spaces, UPS, repeaters, design/installation labor, etc. Areas that typically need to be evaluated for poor communications are:
 - 1. Below grade rooms.
 - 2. Elevators.
 - 3. Areas surrounded by metal or concrete.
- D System shall operate at the fire command center, elevators, elevator lobbies, emergency and stand-by power rooms, standpipe hose connections, building engineer's office, mechanical rooms, elevator equipment rooms/closets, fire pump rooms, areas of rescue assistance, entries into exit stairways, main mechanical room, main electrical room, stair enclosures,
- E The contractor must provide the turnkey, ready to use, installation of a complete, working, in-building fiber based ERRAS-based signal booster system including design, installation with UPS to hold ERRAS operational for a minimum of 24 hours setup and optimization per NFPA72-2010 10.5.6.3.1. The secondary power supply shall have sufficient capacity to operate the system under quiescent load (system operating in a non-alarm condition) for a minimum of alarm condition) for a minimum of 24 hours and, at the end of that period, shall be capable of operating all alarm notification capable of operating all alarm notification appliances used for evacuation or to direct aid to the location of an emergency for 5 minutes.
- F This Contractor shall furnish and install all fiber optic cable in conduit for the entire run. Minimum conduit size for fiber optic cable shall be 3/4-inch.
- G System design shall take into account:
 - 1. External macro signals.
 - 2. Potential sources of interference.
 - 3. Actual building construction materials.
 - 4. Expected traffic in every area and density will be provided to accommodate a 30% increase in capacity.
- H The purpose of this system is to provide communication coverage for public safety personnel when performing their duties in the building per NFPA 72-2010 Chapter 24 5.2 requirements. The intent of this system is to provide the coverage, so that these personnel will be able to communicate anywhere within the building, to exterior commanders, personnel, and dispatchers under the worst of conditions.
- I Active Distribution. Active components shall be interconnected only with plenum rated cable and connectors meeting manufacturer's recommendations.
- J Perform and provide a RSSI signal level map at the donor location and provide a detailed system design that will meet the coverage and capacity requirements of the UNCW.
- K Remote Management. The ERRAS shall provide for remote configuration, control, and monitoring of active components.

- L An automatic monitoring system with a dedicated panel in the emergency command center of the building is required.
- M Network Management System (NMS): The ERRAS shall have a NMS capable of alarm, monitor, configuration, and control of all Active Components.
- N Simple Network Management Protocol (SNMP) Alarm Reporting and SNMP Integration: The ERRAS NMS shall be capable of integration with third party SNMP based NMS products for alarm purposes and provide alarming information.
- O Public Safety Network (PSN) Approval. The Contractor shall design and implement a ERRAS capable of receiving the approval or certification from UNCW Public Safety.
- P Fire stopping shall be installed at all firewall penetrations.

1.2 DEFINITIONS

- A ATTENUATION: The reduction in signal power, expressed in decibels, as a result of coupling, heat loss, or transmission distance in a cable or in air.
- B BDA: Bi-directional amplifier in-building radio communication system that brings wireless signals into a structure from outside, amplifies those signals with a signal booster, and then evenly distributes the amplified signals throughout a structure via an Emergency Responder Radio Antenna System (ERRAS). The system also amplifies signals originating inside the building and transmits them outside.
- C BIM: Building Information Modeling.
- D CABLE ASSEMBLY (JUMPER): Short length of flexible coaxial cable used to attach antennas or other components to the main coaxial cable distribution system.
- E ERRAS: (Distributed Antenna System): A network of service antennas connected at intervals along shielded coaxial transmission lines and all connected to head-end electronics amplifying the signals to be distributed. Often refers to a system that includes both the passive distribution system and the active amplifying electronics.
- F DIRECTIONAL COUPLER: A component which directs a small portion of downstream RF energy to a port which can be connected to an antenna or another branch of distribution cabling, and also serves as a combiner of upstream energy between the tap port and the through connection.
- G DONOR ANTENNA: The antenna, usually mounted on the outside of a structure where a ERRAS is installed, which picks up signals over-the-air from a donor source.
- H DONOR SOURCE: The repeater, transceiver, cell site or other radio site that produces signals which a ERRAS will relay and distribute.
- I REFLECTED POWER: Power which is reflected back along a transmission line as a result of discontinuities in line impedance caused at connectors or close proximity of metallic objects.
- J RF (RADIO FREQUENCY): Energy from electromagnetic waves, or alternating currents that produce electromagnetic waves, in the spectrum of radio frequencies (30 kHz to 300GHz).
- K SPLITTER: A passive component that has a single input port and two or more output ports, effectively splitting the signal equally amongst the output ports. It also serves to combine upstream signals from the "output" ports into composite signals at the "input" port.
- L TERMINATION: A device that is installed on the end of a transmission line to provide a pure resistive 50-ohm load.

1.3 REFERENCES

- A Codes and orders: The design of all equipment and materials shall conform to the following codes and orders:
 - 1. NFPA 1 – current edition.
 - 2. NFPA 72 – current edition Chapter 24.
 - 3. IFC – current edition Section 510.
- B Rules, Regulations and Plans:
 - 1. FCC Rules and Regulations 47 CFR
- C Standards: The following standards shall apply to the design work, and are hereby made a part of these Specifications to the extent referenced:

1. Telecommunications Industry Association (TIA) Technical Systems Bulletin TSB 88-A

1.4 CONTRACTOR QUALIFICATIONS AND WORKMANSHIP

- A The Contractor shall provide documentation demonstrating five (5) years of experience designing, installing, and commissioning ERRAS solutions of a similar scope and complexity.
- B The Contractor shall provide documentation demonstrating certification from the manufacturer of the active components of the ERRAS.
- C The Contractor shall comply with the latest editions of the National Electrical Code, National Electrical Safety Code, National Contractor's Association Standard of Installation, relevant local regulations, and manufacturer's instructions during the design, installation, and commissioning of the ERRAS.

1.5 PRE-COMMISSIONING ACTIVATION AND OPTIMIZATION

- A The installer posts the Provisional Retransmission Authorization at the headend location. The installer notifies UNCW Public Safety and UNCW Technical Security when ready to activate for the initial time. If required by the UNCW and/or UNCW, an initial desense test is coordinated for the first activation of the system. The installer conducts system activation and optimization.

1.6 FIRE ALARM/TWO-WAY RADIO COMMUNICATIONS ENHANCEMENT SYSTEM TESTING

- A The installer coordinates scheduling of the system testing with the fire alarm contractor at the site with the Architect, Owner, and UNCW Technical Security. Testing shall include the following:
 - 1. Installer.
 - 2. Fire alarm contractor.
 - 3. Electrical Contractor.
 - 4. UNCW Public Safety staff.
 - 5. UNCW Technical Security staff.

1.7 ERRAS PERFORMANCE SPECIFICATIONS

- A The primary requirement is to provide in-building signal booster systems that must receive and re-transmit to support UNCW Sheriff and Fire and Rescue Radio Systems. This is a P25 800 MHz system. This system must be state-of-the-art, operating bi-directionally and in full-duplex. The system shall be fully compatible with and shall function on the UNCW Public Safety Radio System.
- B Public Safety Network Approval. The contractor shall design and implement a ERRAS capable of receiving the approval or certification from the local operator(s) of a respective band.
- C Active Distribution. Plenum cable shall be installed between runs.
- D Remote Management. The ERRAS shall provide for remote configuration, control, and monitoring of active components.
- E PERFORMANCE
 - 1. The ERRAS shall meet or exceed the Minimum Downlink Receive Signal Level (RSL) as described in Table 2.
- F Completed installations (including cabling) must comply with all applicable codes and standards, including County Building and Electrical Codes, NFPA, ANSI, NEC, OSHA, EIA, IEEE, R-56 etc., as well as, the FCC Rules and Regulations, as applicable. Equipment manufacturer shall be Comba RXxxxV2 PS 700/800 MHz Class A DC powered. The system shall use fiber optic cable to minimize any cable losses. Equipment provided must be UL listed and the FCC type accepted for this specific application. Compliance to codes and standards must extend to include proper grounding, bonding and surge protection. Conduct a signal coverage test at 75% of construction completion to determine the extent of the system location of the repeaters. A coverage Acceptance Test shall be executed prior to final acceptance of an installed system. Coverage acceptance testing shall be based on audio quality performance in evenly spaced test grids (minimum of 20 grid cells per floor area) in the defined service areas. A minimum of 20 (twenty) tests will be taken per floor/level.

1. Refer to the 2012 International Fire Code (IFC) 2012 Section 510 EMERGENCY RESPONDER RADIO COVERAGE. All new buildings shall have approved radio coverage for emergency responders within the building based upon the existing coverage levels of the public safety communication systems of the jurisdiction at the exterior of the building.
- G The system will provide digital signal strength coverage over 99 percent floor area radio coverage area on each floor/level of the equipped building, or in specific areas defined by the County in a Scope of Work document for a particular building or site. Systems must provide a minimum digital and analog coverage of Circuit Merit (CM) 3, with a reliability factor of 100 per cent. A Coverage Acceptance Test must be executed prior to final acceptance of an installed system. Coverage acceptance testing must be based on audio quality performance in evenly spaced test grids in the defined service areas. A minimum of twenty tests will be taken per floor/level. Total number of test grid cells will be determined by the County AHJ, based on the size of the space per floor/level.
- H System design shall take into account:
 1. Potential sources of interference.
 2. Actual building construction materials.
 3. Extended traffic in every area and density shall be provided to accommodate a 30 percent increase in capacity.
- I The ERRAS system shall be powered by the building's electrical distribution system. A transient voltage surge suppressor shall be provided as part of the bidirectional amplifier design, and protect the incoming power line from transients.
- J Provide uninterruptable power source(s) (UPS) capable of maintaining the system operational for a period of at least 24 hours per IFC Section 510 (appendix J) J103.1.3 secondary power.
- K In-building antenna system: The in-building antenna system shall consist of a sufficient number of antennas and/or radiating cable distribute with the building to meet the -90 dBm, or 10 dB above noise floor, design criteria throughout the building. Coaxial power dividers shall distribute and balance the radio signals into appropriate branch circuits connecting back to the ERRAS.
 1. Each splitter shall be mounted in a separate junction box located so as to be easily accessible for maintenance while maintaining security from tampering. Each junction box shall be labeled externally. Also, provide label below grid indicating junction box location above.
 2. Antenna Isolation: Provide an antenna isolation of a minimum 15 dB higher than the signal booster gain of the amplifier per NFPA requirements under all operating conditions.
- L Degraded performance in emergencies:
 1. The signal booster shall be designed to allow degraded performance in adverse conditions, such as high temperatures in the event heat from a nearby fire, voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, high VSWR, etc.) are not acceptable. It is the purpose of this specification to assure the maximum possible level of communications to public safety personnel depending upon the signal booster even to the extent of damaging the signal booster as long as some communications benefit can be provided during the emergency.
- M During initial installation, each system must be optimized to perform in accordance with the specifications set forth in the system design, manufacturer's specifications and FCC regulations. The contractor must ensure that uplink and downlink levels are properly set and consistent with design expectations. The contractor must further ensure that noise and spurious products are held within limits set forth in the system design, manufacturer's specifications and FCC regulations. Prior to system acceptance, for each active ERRAS, booster amplifier, etc., the contractor must submit a Proof of Performance certification, that lists the design expectations, actual measurements, and, if applicable, FCC specifications for the following parameters:
 1. Worst case ERRAS uplink input level, in dBm.
 2. Worst case ERRAS uplink output level, in dBm.

3. ERRAS downlink input level, in dBm.
 4. ERRAS downlink output level, in dBm.
 5. Noise and spurious products, ERRAS uplink output, in dBc.
 6. Noise and spurious products, ERRAS downlink output, in dBc.
- N The original Proof of Performance report must be submitted to UNCW project manager, and a copy of the Proof of Performance report must be affixed to its associated equipment.
- O The system is designated for in-building use and must be designed and quoted as follows:
- P Design and appearance will be of "finished" construction, etc. must be concealed and/or unobtrusive in the administrative areas. Flush-mount ceiling antennae may be acceptable on a case-by-case basis. "Wiremold" type installations will not be acceptable unless approved by the UNCW Public Schools in advance.

1.8 SUBMITTALS

- A Comply with Division 01 section "Submittals Procedures" and Division 27 section "Common Work Results for Communications".
- B Provide Product data. For each type of product indicated, submit application, technical, and installation data. Include dimensions and manufacturers' technical data on features, performance, accessories, and finishes. All product data sheets, etc. are to be labeled to indicate ERRAS.
1. Bill of Materials (BOM)
 2. Component data sheets
 - a. Donor and in-building antennae
 - b. Coaxial cable, connectors, splitters, combiners, and couplers
 - c. Class A channelized bi-directional amplifier(s) (BDA)
 3. Design documents
 - a. RF link budget
 - b. Overlay of system components on floor plans
 - c. Donor antenna and grounding drawings
 - d. Bill of Materials (BOM)
 - e. Maintenance Service Contract
 - f. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
 - g. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.
- C Shop Drawings: For ERRAS head-end and distribution system. In accordance with Division 27 section "Common Work Results for Communications".
1. All shop drawings, etc. are to be labeled to indicate ERRAS or school campus radio system.
 2. Include dimensioned plans, floor plans with cable routing, antenna locations (roof) and interior, equipment locations with elevations including panel, rack, and cabinet layouts, sections, details, and attachments to other work, including required clearances and service space around equipment.
 3. Provide a riser diagram.
 4. Show fabrication and installation details of tower, tower base, and tower top. Designate components and accessories, including clamps, brackets, fittings, etc.
 5. Detail fabrication, including anchorages and attachments to structure and to tower.
 6. Donor antenna lightning suppression and grounding details.
 7. Dimensional Plan and Elevations of Head-end Equipment: Show access and workspace requirements.
 8. Wiring Diagrams: For power, signal, and control wiring and transmission cable, include cross connects, taps, equipment interconnection diagrams, and other connections, cords.
 9. RF link budget.
 10. Show locations of bonding connections.
 11. Signal to Noise Interference Ration (SNIR) map.

- D Design Calculations: Calculate signal attenuation budget and show calculated line and equipment losses for the system based on the functional block diagram, to show that system layout can be expected to perform up to the specification. Calculate signal strength from sources to endpoints. Allowable losses between components and user interface shall be used to determine size and type of cable.
- E Equipment List: Include each piece of equipment and include model number, manufacturer, serial number, location, and date of original installation. Insert testing record of each piece of adjustable equipment, listing name of person testing, date of test, and description of as-left set points.
- F Field quality-control test reports. Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- G Field quality-control reports.
- H Conduct a signal coverage test at 75% of construction completion to determine the extent of the system location of the repeaters.
 - 1. Provide test results to Owner and Owner's engineer of record.
- I Submittal Requirements at Close Out
 - 1. Drawings: Submit BIM as-built drawings indicating:
 - a. Donor antenna, grounding and lighting protection details
 - b. Cable routing, splitters, couplers and coverage antenna locations
 - c. Active component locations, layout and configuration
 - 2. Test Reports
 - a. PSN: Submit Accepted ATP reports confirming the requirements of Section 1.07 B have been met.
 - 3. Field Reports: Submit sweep-testing results for all cable runs.
 - 4. Field Reports: Submit OTDR test results for all fiber runs.
 - 5. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
 - 6. Warranty Documents:
 - a. Submit for all manufactured components specified in this Section.
 - b. Submit Contractor's System Warranty.
 - c. Submit Manufacturer's Extended Warranty
- J Operation and Maintenance Data: For head-end and distribution system to include in emergency, operation, and maintenance manuals:
 - 1. Refer to Division 01 Section "Operation and Maintenance Data".
 - 2. All product data sheets, drop drawings, etc. are to be labeled to indicate ERRAS.
 - 3. Instructions for periodic testing and inspection.
 - 4. Provide signal strength propagation modeling in 3D.
 - 5. Tests shall be to determine if impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not. Include recommended testing intervals.
 - 6. Service Manuals:
 - a. Service manuals shall be supplied for each signal booster. The minimum contents of each manual shall include:
 - 1) Operating and installation detail.
 - 2) Block (sub assembly) overall circuit diagram with assembly number detail.
 - 3) Mechanical assembly drawing with part number detail.
 - 4) Detailed schematic circuit diagrams listing all components and locations.
 - 5) Detailed parts list.
 - b. NOTE: Equipment provided without detailed schematics and parts lists are unacceptable.

- K BIM Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
- L Qualification Data:
 - 1. Certification of in-building system training issued by a nationally recognized organization or school.
 - 2. For factory trained technician/installer.
- M Copy of valid FCC issued General Radio Operators License for:
 - 1. System designer
 - 2. Tester
 - 3. Lead installation personnel
- N Resumes for:
 - 1. System designer
 - 2. Project manager
 - 3. Lead installation supervisor
- O Provide four references for prior Public Safety in-building reinforcement systems.
- P Provide training/education certificate issued by equipment manufacturer of equipment being installed.
- Q
- R Provide documentation demonstrating certification from the manufacturer of the active components of the ERRAS.
- S Warranty Documents
 - 1. Contractor's system warranty
 - 2. Manufacturer's extended warranty

1.9 COORDINATION

- A BIM Coordination Drawings: Coordinate layout and installation of ceiling-mounted antenna system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.10 QUALITY ASSURANCE

- A Conditions for Consideration of "comparable product" products: Where products are specified by name and accompanied by the term "comparable product", the proposed "comparable product" will be considered when the following conditions are satisfied. Refer to Division 01 section "Product Requirements". If all the following conditions are not satisfied, the Engineer will return requests without action, except to record noncompliance with these requirements:
 - 1. Proposed product does not require extensive revisions to the Contract Documents.
 - 2. With the exception of the product name or number and manufacturer's name, proposed product conforms with requirements indicated on the Drawings and in the Specifications in every aspect and will produce indicated results.
 - 3. Proposed product is fully documented and properly submitted.
 - 4. Proposed product has received necessary approvals of Authorities Having Jurisdiction (AHJ).
 - 5. Proposed product provided specified warranty.
 - 6. If proposed product involves more than one contractor, proposed product 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.
 - 7. Submission is accompanied with detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - 8. Submission is accompanied with a list of similar installations for completed projects with project names and addresses and addresses of design consultants and authorities.

9. Submission is accompanied with proposed product's Manufacturer signed written statement on Manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents.
- B The minimum qualifications of the system designer, tester, and lead installation personnel shall include:
 1. A valid FCC issued General Radio Operators License
 2. Certification of in-building system training issued by a nationally recognized organization or school.
 3. Provide training/education certificate issued by equipment manufacturer of equipment being installed.
- C Installer Qualifications: Factory trained technician who is trained and approved for installation of units required for this Project.
- D Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
- E Source Quality Control: Materials and equipment shall be new, unused and UL listed (UL Standard 1459).
- F NFPA 72-2010
 1. 24.5.2 Two-way Radio Communications Enhancement Systems.
 2. 10.5.1 System Designer.
 3. 10.5.2 System Installer.
 4. 10.5.3 Inspection, Testing, and Service Personnel.
 5. 10.6.7 / 10.6.7.3.1 Secondary Power Supply.
 6. 14.4.10 In-Building Emergency Radio Communications Systems (testing).
 7. A.14.4.10 In-Building Emergency Radio Communications Systems (testing annex).
 8. IBC Section 915.
 9. NFPA 70 National Electrical Code Articles 810 and 820.
 10. IEEE Standard No: 205 – current edition.
 11. ANSI/TIA – 568C Telecommunications Standards for Pathways.
- G The system and components shall be supplied by one manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least ten (10) years and who shall be able to refer to similar installations rendering satisfactory service.
- H The ERRAS System shall be installed by the manufacturer's authorized distributor and factory trained installation contractor with full manufacturer's warranty privileges for the specified system, hereinafter known as the "ERRAS System Trade". The installation shall include wiring, components, connections, adjustment, testing, and certification. The Electrical Trade shall provide j-hooks, conduit, junction boxes and pull boxes as indicated and required by the ERRAS System manufacturer's drawings or Trade instructions. The ERRAS System Trade shall furnish any special boxes, cabinets, enclosures, and similar items to the Electrical Trade for installation by the Electrical Trade in accordance with the manufacturer's drawings, Trade instructions, and as indicated. All repeater, transmitter, receiver, and signal booster components shall be contained in a NEMA 4 or NEMA 4X type enclosure(s) per NFPA72-2010 24.5.2.5.4.
- I BICSI Telecommunications Distribution Methods Manual (TDMM), latest edition.
- J The ERRAS Trade shall furnish a list of similar or equal installations (a minimum of ten) and show at least five (5) years of company experience in this type of work.
- K Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.
- L The ERRAS shall comply with the latest edition of NFPA 1.
- M The ERRAS shall transmit the requested frequency bands simultaneously over one passive component installation.
- N Non-Interference: Per NFPA 72-2010 24.5.2.1.1. No amplification system capable of operating on frequencies or causing interference on frequencies assigned to the jurisdiction by the FCC shall be assigned to the jurisdiction by the FCC shall be installed without prior coordination and approval of UNCW Public Safety.

- O System wiring shall be in accordance with good design practices as established by the EIA and NEC. Wiring shall meet all established State and Local electrical codes. All wiring shall test free from grounds and shorts.
- P In addition, this system shall be approved, inspected, and tested by the UNCW Public Safety.

1.11 ON-SITE PRE-CONSTRUCTION MEETING

- A A pre-construction conference shall be conducted prior to the start of the access controls installation. It is the General Contractor's responsibility to schedule this meeting. Attendees shall include the General Contractor, Project Architect, Project Engineer, electrical contractor, cabling system contractor, UNCW Senior Project Manager, UNCW Project Manager, UNCW Electrician, UNCW Technical Security, and UNCW Safety and Security representative. The meeting shall be initiated by the General Contractor. This meeting should be held no later than thirty (30) days after NTP has been issued.
 - 1. An initial planning meeting will be held with the Contractor to clarify all requirements (submittal submission, systems, services, distribution methods, etc.), identify responsibilities, and schedule the events that will transpire during the implementation of the project.

1.12 DELIVERY, STORAGE, AND HANDLING

- A Deliver all materials in good condition, store in a dry place, off ground, and keep dry at all times.
- B Materials shall be clearly marked with project name, state contract number, and Contractor's name.
- C Any equipment dropped or damaged, is to be replaced at the Contractor's expense.

1.13 COMMISSIONING

- A Authority reserves the right to determine the final approval of the system at the time of scheduled job completion. Failure to meet the installation schedule or provide the "precise functional equivalent" shall result in the removal of the system at the Contractor's expense

1.14 WARRANTY

- A Refer to Division 01 section "Warranties".
- B The ERRAS System Trade shall warrant this system for a minimum of five (5) year against defective parts and/or workmanship and shall provide parts and labor to fulfill this warranty at no cost to Owner.
- C Five (5) year limited warranty from the date of system acceptance on splitters, couplers, and in-building antennae
- D Twenty year limited warranty from date of system acceptance on coaxial cable, fiber optic cable and connectors
- E All tests are to be performed by a factory certified technician.
- F The ERRAS System must provide a full five (5)-year warranty, from date of acceptance by Owner, to cover installation and all equipment, software, and components; the warranty must commence upon the County's final acceptance of the facility
- G Under warranty coverage, the successful contractor must provide same business day response time for system malfunctions.
- H The contractor must perform optimization of each system during the initial warranty period, sixty (60) to ninety (90) days prior to warranty expiration. This optimization task is separate from the initial optimization performed during system installation. The contractor must include pricing for annual system optimization to be included as part of post-warranty maintenance.
- I Actual scope of work for annual optimization and maintenance will vary on a case by case basis, but will typically consist of the following:
- J Optimize the system to perform in accordance with the specifications set forth in the system design, manufacturer's specifications and FCC regulations.
- K Ensure that uplink and downlink levels are properly set and are consistent with design specifications.

- L Ensure that noise and spurious products are held within limits set forth in the system design, manufacturer's specifications and FCC regulations.
- M Update the Proof of Performance records for the system, listing the design expectations, actual measurements, and, if applicable, FCC specifications for the following parameters:
 - 1. Worst case ERRAS uplink input level, in dBm.
 - 2. Worst case ERRAS uplink output level, in dBm.
 - 3. ERRAS downlink input level, in dBm.
 - 4. ERRAS downlink output level, in dBm.
 - 5. Noise and spurious products, ERRAS uplink output, in dBc.
 - 6. Noise and spurious products, ERRAS downlink output, in dBc.
- N The updated Proof of Performance report must be submitted to the UNCW Senior Project Manager, and a copy of the updated Proof of Performance report must be affixed to its associated equipment.
- O Visually inspect outside antenna installation. Correct any issues found with the antenna mounting hardware, grounding system, or outside cabling.
- P Visually inspect inside ERRAS or booster amplifier equipment installation. Correct any issues found with RF cabling, electrical connection, or equipment mounting.
- Q Clean equipment fans, filters and other ventilation system components.
- R Inspect and replace any defective indicator lights.
- S Test UPS system performance for proper fallback to battery power and the duration of battery operation.
- T Test fault reporting system for proper operation and reporting of system faults.
- U Submit one (1) written Preventive Maintenance Report and one (1) flash drive to UNCW Project Manager for delivery to UNCW Technical Security, listing the results of the optimization and preventive maintenance effort. The report must include the Proof of Performance report for active RF components, and details of any other discrepancies found and corrective actions taken.

1.15 AS-BUILT DRAWINGS

- A BIM as-builts will be submitted to UNCW Public Safety and UNCW Public Schools upon completion. To include antenna system layout and all associated hardware, along with specification sheets. Include RF measurements taken.
 - 1. Provide riser drawings of the complete system including all device locations and cabling.
 - 2. Provide 1/8-inch scale drawings in hardcopy and electronic format including all device locations and cabling.
 - 3. As-builts by the Contractor shall include parts lists and wiring diagrams that clearly indicate all equipment, locations, wiring, and connections.

1.16 MANUFACTURER'S EXTENDED WARRANTY

- A The Manufacturer shall administer a follow-on program through the Contractor to provide support and service to the County. The program shall cover a certified system, defined as a ERRAS installation performed by a certified contractor using certified components while following all the Manufacturer's installation instructions, recommendations, and best practices. The program shall include:
 - 1. A twenty-five (25) year warranty, provided by the Manufacturer and the Contractor, on all coaxial cable, fiber optic cable, and connectors
 - 2. An assurance that, during the twenty-five (25) -year warranty, the ERRAS shall support current and future modulation formats in the frequency bands for which it is designed per NFPA 72.
- B Diagrams: The Contractor shall furnish three complete sets of operating instructions, including cable diagrams, and other information necessary for proper installation, operation and maintenance of the system components. As-built drawings of the system shall be supplied. These drawings shall include signal levels measured throughout the system as they were at the acceptance date of the system.

- C The Manufacturer and Contractor, using a schedule agreed upon by the County, shall remediate any failure of the ERRAS whether during ATP, normal use, or the upgrade of the ERRAS to support additional frequency bands.
- D The Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacturer any component of the ERRAS.

1.17 MAINTENANCE

- A The Contractor shall show satisfactory evidence that he maintains a fully equipped service organization, capable of furnishing adequate inspection and service to the system, including standard replacement parts. The Contractor shall be prepared to offer a service contract for the maintenance of the system after the guarantee period.
- B Service Calls: Provide eight (8) hours of service calls on system in school after final acceptance to make any adjustments necessary to keep system at peak operating condition. Service calls performed as requested by the Owner. Warranty work is not included in the service call time.
- C Service Contract: Equipment Supplier: The Contractor shall provide an optional maintenance service contract, covering for a period of one-year: preventative maintenance, system monitoring, spares, fault mitigation, equipment repair, and response time. Accredited by proposed equipment manufacturers and prepared to offer service contract for system maintenance on completion of guarantee period and provide names, locations, and size of 10 recent successful installations in area; 24 hours per day service, with 24 hour non-emergency service response time provided, and including 1 hour emergency call response time on 365-day- per-year, 24 hours per day basis.

PART 2 PRODUCTS

2.1 GENERAL

- A The contractor shall design, furnish, install, and warranty a complete signal booster system for the ERRAS. The installed system shall include all hardware, bi-directional amplifiers, band-pass filters, surge suppressors, lightning protection, UPS, transmission lines, power cabling, antennas, and other components necessary for a complete operational system as specified and as acceptable to the local authorities having jurisdiction.
- B The contractor shall install all antenna, j-hooks, conduits, cables, connectors, lightning protections, junction boxes, all supporting devices, etc. for a complete operation system.

2.2 ROOF COMMUNICATION TOWER (NO SUBSTITUTIONS)

- A The external antenna system shall consist of a Rohm Products, LLC ROHN #45G series antenna, ROHN # 45AG3 top assembly, Rohm flat roof mount base # FR45G, and coaxial lightning surge suppressor. The antenna gain shall be selected to provide the minimum required signal level.
 - 1. Locate tower to avoid signal obstructions and minimize visibility from all directions of grade.
 - 2. 360 degree line of sight. No structure within 20-feet and taller than antenna tower.
 - 3. Mount tower to roof structure, coordinate installation with architect and structural engineer. The use of guywires is prohibited. The use of ballast roof mounts/sleds is prohibited. Coordinate tower base plate installation with structural engineer and architect. Antenna tower to be installed above or as close as possible to second floor data closet where BDA and radio equipment shall be installed. Parts a & b are both required.
 - a. Tower: Rohm # 45G
 - 1) 10-feet section with optional double bracing.
 - b. Tower Top Section: Rohm # 45AG3.
 - 1) Tower height: 10'-0" unless obstruction is taller than the tower, if this conflict occurs, provide an additional 10'-0" for installation.
 - 4. Antenna Flat Roof Mount Base: Rohm # FR45G.

- B Lightning surge suppressor shall be connected to the feed line in-between the antenna and the ERRAS. A copper grounding plate shall be provided with the surge suppressor and bonded to the grounding system. The ERRAS is to be installed in the building, the surge suppressor will be installed in the building at the cable penetration point. Building penetration for the feed line cabling shall be protected with a waterproof/UV stabilized cable boot suitable for the installation, or with an electrical service weather head with a cable drip loop.
- C The antenna system, antenna mast, cable, and surge suppressor shall be grounded by attachment to the building's grounding system. Grounding cable shall be sized according to manufacturer's recommendations.

2.3 LIGHTNING PROTECTION (NO SUBSTITUTIONS)

- A Each cable requires one polyphaser for lightning protection inside the building entry on a grounded buss bar.
 - 1. Polyphaser # IS-50NX-C2: Lighting protector: flange mounted, dc block single transmitter coaxial lighting protection for 125MHz to 1 GHz with N female connectors.
 - 2. Polyphaser # TSX-NFF Bi-Directional Broadband DC Short Filter operating between 698 MHz – 2.7 GHz with N Female Connector.

2.4 IN-BUILDING OMNI-ANTENNA

- A Andrew # CELLMAX-O-43- WI or comparable product: 360° omnidirectional in-building antenna, 680-960 MHz and 1710-2700 MHz; impedance 50 ohm; maximum input power 50W. Color=White, ceiling mount. Provide thru-hole ceiling mount, pigtail cable KSR195, plenum rated, RF Connector: N Female.
 - 1. Provide wire guards where required.
- B Andrew # CELLMAX-D-43- WI or comparable product: Directional in-building antenna, 698-960 MHz, 1710-2700MHz. Color = White. Use Four (4) hole mounting plate and hardware included with antenna.
 - 1. Provide wire guards where required.

2.5 RADIO FREQUENCY (RF) ERRAS-BASED SIGNAL BOOSTER SYSTEMS

- A In-building signal booster systems shall receive and re-transmit the entire uplink/downlink frequency band utilized by the regional emergency service provider(s). The contractor shall confirm with the regional emergency service provider(s) as to the specific frequencies used by the various agencies. This system shall be state-of-the-art, operating bi-directionally and in full duplex.

2.6 HEAD-END RACK (NO SUBSTITUTIONS) IF REQUIRED

- A Racks: Head-end racks, NEMA4 cabinet securely mounted to floor, shall be equipped with a 7-foot high, 19-inch-wide equipment rack for voice and data equipment and terminations and shall consist of enough sliding shelves, cable organizers, hooks, and new switches for a complete and operational system that conforms to NFPA 72-2012. Enclosure cabinets shall protect equipment from water. Provide adequate ventilation to vent excessive gassing released from the batteries. Provide NEMA 4 cabinet with sealed louvers/vents to meet NEMA 4 watertight standards without trapping gasses
 - 1. Aluminum, 7-feet high x 19-inches wide, self-supporting base, boltable to floor with 79-inches of mounting space.
 - 2. Horizontal Cable Management: 19-inches wide filling two (2) rack units.
 - 3. Vertical Cable Management Cage with Cover: Provide two (2) per rack. 3.75-inches x 6.58-inches x 7-feet, single sided. Ortronics Part #OR-SVMS704
 - 4. Cable Rings: Use as needed. Ortronics Part # OR-CR-93S-2B, OR-CR-93S-4B.
 - 5. Guard Rail: One guard per rack. 2.88-inches high x 19.81-inches wide x 4.50-inches Deep. Color = Black. Ortronics Part # OR-GR-19B.

6. Blank panel for use in covering unused space in an ION-B subrack. The quad electrical outlet designated for each rack is to be mounted on the rack, not on the adjacent wall at 36-inches AFF.
7. Racks shall be bolted to the floor.

2.7 RACK-MOUNTED BATTERY BACK-UP UNITS: (BATTERY BACK-UP UNITS)

- A Per NFPA72- 10.5.6.3.1. The secondary power supply shall have sufficient capacity to operate the system under quiescent load (system operating in a non-alarm condition) for a minimum of alarm condition) for a minimum of 24 hours and, at the end of that period, shall be capable of operating all alarm notification capable of operating all alarm notification appliances used for evacuation or to direct aid to the location of an emergency for five (5) minutes. Provide quantity of units as required.
 1. Comba CPBBUV2 Series.

2.8 GROUNDING:

- A Furnish and install #6 wire in 1-inch conduit from the work to the TMGB. Ground all equipment in the respective data rack to the main rack ground point.

2.9 AMPLIFIER BDA & SUPPORTING REPEATER CARDS UNCW PUBLIC SAFETY REQUIREMENT – NO SUBSTITUTIONS)

- A Comba CriticalPoint™ Public Safety Bi-Directional Amplifier RX08V2-A3748-UL PS 700/800MHz BDA (DC Version) UL 2524 Standard Certified
 1. Class A
 2. Complies with UNCW Public Safety specifications
 3. Frequency Range, Uplink: 700/806-824
 1. FCC: FCC type certified

2.10 NODE A 800 SMR 5W AMPLIFIER MODULE

- A Andrew #7577538-00 or comparable product: Node A digital module for 800 MHz band. Gain + 94dB and power = 5 watts.

2.11 CABLES AND CONNECTORS

- A All cables are to be plenum rated. Cabling installed on exterior of building or under slab to be rated for installation type.
- B Splice Wallet Kit
 1. Commscope # KIT-SW-48-SFS-2FD or comparable product.
- C Times Microwave # LMR-400-LL-PL 3/8-inch LMR-400 LL-PL BK Plenum Rated Cable (Radio System) or comparable product.
 1. Provide Times Microwave # LMR-400-LL-PL 3/8-inch LMR-400LL-PL-BK plenum rated low loss coaxial cable with orange CATV-P rated jacket in an in- door, fire-retardant cable. A 50 Ohm coax cable stranded outer conductor and bare copper conductor. Provide a 100 percent coverage foil and 90 percent coverage braided shield or comparable product.

a. Dielectric Insulation:	PTFE,
b. Center Conductor Material:	Copper Clad Aluminum.
c. Center Conductor Diameter:	100-inch.
d. Center Conductor Construction:	Solid,
e. Nominal Core O.D.:	0.285-inch.
f. Nominal O.D.:	0.405-inch.
g. VOP:	76 %.
h. Shield:	100 % foil 90 % braid.
i. Nominal Capacitance: (pF/ft.):	27.0.
j. Loss @ 50 MHz:	1.00 dB.
k. Loss @ 100 MHz:	1.35 dB.
l. Loss @ 400 MHz:	2.74 dB.

- m. Loss @ 900 MHz: 4.2 dB.
 - n. Loss @ 1000 MHz: 4.39 dB.
 - o. Jacket: Orange.
 - p. Warranty: Five (5) years
- D Times Microwave # EZ-400-NMH-X; N male Hex/Knurl Combo No Braid Trim LMR 400. N male advantage connector for LMR-400 cable, gold pin, silver plate body, no braid trim or comparable product.
- 1. ERRAS Network Cable quantity = 1. One cable run required for ERRAS network.
 - a. For Cable: LMR400
 - b. Material (Pin): Gold.
 - c. Insulator Material: PTFE.
 - d. Frequency Range: 0-3 GHz.
 - e. Center Pin Type: Captivated.
 - f. RF Connector Type: Straight.
 - g. RF Impedance: 50 Ohms.
 - h. Max Voltage/Power: 1000 V peak.
 - i. Warranty: Five (5) years.

PART 3 EXECUTION

3.1 INSTALLATION

- A Contractor must be a licensed installer in North Carolina.
- B The ERRAS and backup power housing shall be mounted side by side. An electric circuit breaker with one (1) 30-amp 120 VAC emergency dedicated receptacle shall be provided for the Emergency Responder Radio Antenna System (ERRAS) head-end. Provide one (1) 20 amp emergency branch circuit for each future micro cell or similar equipment. Each remote unit requires one (1) 20 amp 120 VAC receptacle and emergency branch power circuit. Locate remote unit receptacle within 4-feet of the remote unit. Each back up power supply shall have one (1) 20 amp dedicated receptacle and emergency branch circuit. The number of remote units and location shall be determined via calculations and modeling of propagation results during design of the system and shall be shown on the shop drawings and shall be verified in the field at the time of installation. Remote units are wall mounted and require a wall space of 30-inches wide x 36-inches high. Once design of system has been completed, Contractor shall determine emergency circuit(s) to be utilized at the direction of the Engineer.
- C The ERRAS shall have plenum rated LMR400 Cable shall be installed in a complete Rigid/IMC conduit system thru and above the roof. In the building interior, j-hooks may be used except in walls or inaccessible ceilings where conduit is required. An electric circuit breaker panel with one (1) 30-amp 120 VAC emergency dedicated receptacle shall be provided for the Distributed Antenna System head-end. The conduit shall be installed from the roof mounted Communications Tower in a weatherproof head with drip loop to the security room adjacent to the security rack. Both antenna cables shall be terminated through the lightning protection units. All exterior donor antenna must be protected with a polyphaser device at entry point of the building to the ground bar in the building to meet Motorola R56 specifications. The lightning protection would be mounted to a copper ground bar within the room. Provide plenum rated LMR 400 cable from the ground bar to the security rack. Owner will install any required repeater(s) upon completion of all j-hooks and conduits and cables by this contractor.
- D All exterior cable shall be installed in a 2-inch Rigid / IMC conduit.
- E All interior fiber optic and coaxial cabling shall be installed in conduit; 3/4-inch EMT minimum for the ERRAS.
- F Where not provided as part of the electrical work or ERRAS work, the contractor shall furnish and install any necessary j-hooks, conduit, raceways, pull boxes, outlet boxes, and cable to provide a complete system as herein specified. A junction box shall be installed in the equipment room. The roof end of the conduit must extend two (2) feet above the roof deck and be terminated with an electrical weatherhead.

3.2 TESTING

- A Conduct a signal coverage test at 75% of construction completion to determine the extent of the system location of the repeaters.
 - 1. Results to be provided to Owner and Owner's engineer of record.
- B Upon completion of installation, the radio system tested to ensure that two-way coverage on each floor of the building reveals a minimum signal strength of -95 dBm in 99 percent of the building's floor area radio coverage. All wiring shall be tested for continuity and freedom of all grounds and short-circuits. Signal strength measurements should be taken at the center of each grid. In addition, the quality of radio signal shall be no less than Delivered Audio Quality (DAQ) 3.4 as defined by the Telecommunications Industry Association (TIA). The test procedure shall be conducted as follows:
 - 1. Each floor of the building shall be divided into a grid of 20 approximately equal areas.
 - 2. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the UNCW's Public Safety Radio System talking through the agency's radio communications system.
 - 3. A maximum of two nonadjacent areas shall be allowed to fail the test. This cannot be determined until the grids and test results are in.
 - 4. In the event that three of the non-adjacent areas fail the test, in order to be more statistically accurate, the floor may be divided into 40 equal areas. A maximum of four nonadjacent areas shall be allowed to fail the test. If the system fails the 40-area test, the system shall be altered to meet the 99 per cent floor area radio coverage requirement.
 - 5. A test location approximately in the center of each grid area shall be selected for the test, then the radio shall be enabled to verify two-way communications to and from the outside of the building through the public agency's radio communications system. Once the test location has been selected and recorded, that location shall represent the entire area. If the test fails in the selected test location, that grid area shall fail, and prospecting for a better spot within the grid area shall not be allowed.
 - 6. The gain values of all amplifiers shall be measured and the test measurement results shall be kept on file with the building owner so that the measurements can be verified during annual tests. In the event that the measurement results become lost, the building owner shall be required to rerun the acceptance test to reestablish the gain values.
 - 7. As part of the installation a spectrum analyzer or other suitable test equipment shall be utilized to insure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at time of installation and subsequent annual inspections. Provide calibration date of the test equipment.
 - 8. "Alarm reporting" means an SNMP (Simple Network Management Protocol)-based monitoring system that sends notifications of faults or diminished performance.
 - 9. Appropriate tie-ins means physical and/or virtual connections to UNCW's public safety communications system as determined by the County.
 - 10. "Dedicated communications conduit" means conduit assigned to contain only the fiber optic cable used for public safety communications.
 - 11. "Dedicated backup power" means a secondary source of power, whether from battery or emergency generator, supplying automatically when the primary power source is lost, continuously operational for no less than 12 hours and, if from a battery, charging itself automatically in the presence of an external power input;
 - 12. "Donor antenna" means a bi-directional antenna mounted to the roof of a building interconnected to optical signal conversion and distribution equipment;
 - 13. "Fiber distribution remote unit" means one or more modules capable of converting optical signals into radio frequency signals for distribution to all interconnected omni-directional antennas.
 - 14. "Head-end equipment" means one or more modules capable of receiving radio frequency signals from a donor antenna, amplifying the radio frequency signals, and converting the radio frequency signals into optical signals for distribution via fiber optic cable to all fiber distribution remote units throughout the building;

15. "Omni-directional antenna" means an antenna capable of receiving and broadcasting radio frequency signals.
- C The minimum qualifications of the system designer, tester and lead installation personnel shall include:
 1. A valid FCC-issued General Radio Operators License; and
 2. Certification of in-building system training issued by a nationally recognized organization or school or a certificate issued by the manufacturer of the equipment being installed.
 3. Personnel may be exempt from these requirements upon successful demonstration of adequate skills and experience satisfactory to the County Emergency Manager or designee.

3.3 TECHNICAL ASSISTANCE AND TRAINING

- A A factory trained technician for the ERRAS System Trade shall instruct the proper designated authority on the programming and correct operation of the system after the installation is completed. Operating manuals and user guided shall be provided at the time of the training. Provide a two (2) operating manuals two (2) flash drives. This instruction shall be scheduled at the convenience of the staff.
- B Final tests and inspection shall be held in the presence of Architect/Engineer's representatives, UNCW Technical Security Staff and to their satisfaction. The RF-BDA System Trade shall supply personnel and any required auxiliary equipment for this test without additional cost.
- C Instruction and Training:
 1. Provide instruction and training of Owner's personnel to include at a minimum, school general office and cafeteria staffs, UNCW Technical Security personnel, as well as others as required for operation of integrated security and communication system.
 - a. Include six (6) hours of training in two sessions.
 - 1) Session 1 – 3 hours: At Final Acceptance for school staff and UNCW Technical Security Staff.
 - 2) Session 2 – 3 hours: Six months after Final Acceptance for school staff and UNCW Technical Security Staff.
 2. Provide instruction and training by qualified representative of manufacturer.
 3. Video tape training session 1. Provide two complete sets of flash drive media of the training and training documents.
 4. Training shall include a 'walk-through' of the system for device locations and a review the system as-built drawings, a review of the system testing and acceptance documentation. The contractor shall provide, in addition to the factory authorized service representative, personnel who are thoroughly familiar with the installation.
 5. Provide key personnel at the training session, as required and/or requested by the Owner, at no additional cost to the Owner. Key personnel include Electrical Contractor's site supervisor and project manager, and this contractor's site supervisor, project manager, and service manager.
 6. Perform demonstration at final system inspection by qualified representative of manufacturer.

END OF SECTION 27 64 10

SECTION 28 10 00 - ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 26 00 10 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

- A. Description: This specification describes access control devices, cabling, and programming required for installing a complete campus electronic access control system.
- B. Section Includes:
1. Controllers
 2. Card Readers
 3. Cables
 4. Power Supplies and Enclosures
- C. Related Requirements:
1. Refer to Division 08 for hardware groups containing electrically controlled door hardware devices integrated with the Access Control System.
 2. Refer to Section 27 05 28 "Pathways for Communications Systems" for low voltage pathway requirements.
 3. Refer to Section 27 15 00 "Communications Horizontal Cabling" for network cabling requirements.

1.3 REFERENCES

- A. Abbreviations and Acronyms

RAS	Remote access services.
ROM	Read-only memory. ROM data are maintained through losses of power.
TCP/IP	Transport control protocol/Internet protocol.

- B. Definitions

1. Credential: Data assigned to an entity and used to identify that entity.
2. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
3. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
1. National Fire Protection Association (NFPA):
 - a. NFPA 731, "Standard for the Installation of Premises Security Systems"

1.4 PRE-INSTALLATION MEETING

- A. Conduct pre-installation meeting in conformance with requirements of Section 01 31 00. Meeting to verify requirements to do the following with the Work of this Section:
1. Coordination with Division 08 scope to verify locations of all electronic hardware, ensure doors and door frames are properly prepped, and verify power supply needs.
 2. Coordination with Division 26 scope to review pathway requirements, ensure adequate power is provided, ensure fire alarm interfaces are properly addressed.
 3. Coordination with Division 27 scope to verify locations of all LAN connected devices.
 4. Coordinate with Division 28 scope for all fire alarm interface requirements.
 5. Coordinate scheduling and sequencing of work.

1.5 SUBMITTALS

- A. Product Data: for each product type.
1. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Shop Drawings.
- B. Shop Drawings: Provide the following.
1. Floor Plans: Contractor prepared CAD drawings indicating final outlet and device locations, routing of raceways, and cables both inside and outside the building.
 2. System Riser Diagram
 3. Wiring Diagrams. For power, signal, and control wiring. Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. including the following:
 4. Door Elevations for each electrified hardware set.
 5. Enclosure, Controller, and Power Supply layouts.
 6. Component Installation Details.
 7. Battery and charger calculations for controllers and door hardware.
 8. Details of surge-protection devices and their installation.
- C. Qualification Data: For qualified installer.
- D. Sample Warranty.
- E. Test and Inspection reports.
- F. Closeout Submittals
1. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 include the following:
 - a. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on USB media of the hard-copy submittal.
 - b. Copies of software and programming. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware.

- c. System installation and setup guides with data forms to plan and record options and setup decisions.

1.6 MAINTENANCE MATERIAL

- A. Extra Stock Materials: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Five continuous years, minimum, design and manufacture of the materials and equipment specified.
 - 2. Manufacturing facilities certified to ISO 9001 International Quality Standard with third-party certification verifying quality assurance in design/development, production, installation, and service.
 - 3. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, maintenance, emergency repairs to equipment, and response times less than eight hours.
 - 4. Employ trained staff that are available 24/7 to provide scheduling support and assist with reporting needs.
- B. Installer Qualifications:
 - 1. Manufacturer's authorized representative who is trained and certified by the manufacturer for installation of the specified product.
 - 2. Minimum of five years successful installation experience with Projects of similar size and complexity.
 - 3. Upon request, be able to provide a minimum of three reference accounts at which similar work, both in scope and complexity, have been completed by The Contractor within the last three years.
 - 4. Project Personnel Requirements: Installer must have the following certified full-time employees on staff and assigned to the project:
 - a. Lead Technician: certified by the Electronic Security Association.

1.8 WARRANTIES

- A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of sound system and all associated components that fail in materials or workmanship within 2 years of Final Acceptance.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended use.

- B. Source Limitations: Obtain controllers and readers through one source.
- C. Basis of Design: Subject to compliance with requirements, provide product indicated on Drawings.
- D. Preferred Manufacturer: Lenel
- E. All access control equipment must be compatible with the Lenel OnGuard system and provided through a UNCW Certified Lenel VAR. All installation and wiring shall be performed by Lenel Certified Technicians
- F. Equipment must not impair reliability or operational functions of the existing campus system.

2.2 CONTROLLERS

- A. Approved Intelligent System Controllers (ISCs)
 - 1. LNL-X2220 (small/medium)
 - 2. LNL-X3300 (small/medium)
 - 3. LNL-X4420 (large)
- B. Reader Interface Modules
 - 1. LNL-1320
 - 2. LNL-2210
 - 3. LNL-2220
- C. Door Controller: Unit consisting of a reader modules and input/output modules, installed in a power supply/enclosure assembly.
 - 1. Function: Provide local entry-control functions including one- and two-way communications with access-control devices such as card readers, door strikes, magnetic latches, door operators, door alarms, and exit push buttons.
 - a. Operate as a stand-alone portal controller using the downloaded database during periods of communication loss between the controller and the field-device network.
 - b. Accept information generated by the entry-control devices; automatically process this information to determine valid identification of the individual present at the portal:
 - 1) On authentication of the credentials or information presented, check privileges of the identified individual, allowing only those actions granted as privileges.
 - 2) Privileges shall include, but are not limited to, time of day control, day of week control, group control, and visitor escort control.
 - c. Maintain a date-, time-, and Location-stamped record of each transaction. A transaction is defined as any successful or unsuccessful attempt to gain access through a controlled portal by the presentation of credentials or other identifying information.
 - 2. Master Intelligent Controller: contains cardholder database and TCP/IP interface to communicate with the campus host system.
 - 3. Reader Modules: contains inputs and outputs for controlling and monitoring door hardware and card readers.
 - 4. Input/Output Modules: contains inputs and outputs for interfacing with door alarms, door contacts, or other auxiliary devices.
 - 5. Enclosure: provide with integral NFPA 70, Class II power-supply transformer, with 24-V ac secondary and fuses rated to match manufacturer requirements.
 - a. Battery Backup: External sealed, lead acid; sized to provide run time during a power outage of 30 minutes.

- D. Hardware Kit: assorted standoffs, screws, washers, bolts, terminal blocks, and related hardware required to assemble and connect components.

2.3 MULTI TECHNOLOGY CARD READERS

- A. Approved HID Signo Readers
 1. 40KTKS-03-00PVFG (keypad, terminal – standard for keypad installs)
 2. 40TKS-03-00PVFG (terminal – standard for non-keypad installs)
 3. 20KTKS-03-00PVFG (mullion keypad, terminal)
 4. 20TKS-03-00PVFG (mullion terminal)
- B. Comply with UL 294.
- C. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.
- D. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.
- E. Enclosure and mounting plate: Suitable for surface, semi-flush, pedestal, mullion, or weather-proof mounting. Mounting types shall additionally be suitable for ambient operating environment.
- F. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.
- G. Readers must support HID iClass, NXP MIFARE, and Transact encrypted key mobile credentials.
- H. Communication Protocol: Compatible with local Controllers.

2.4 CABLES

- A. Von Duprin PS914-4RL power supplies are required.
- B. Expansion via 90-4RL boards permitted (supports up to 4 QEL or 8 mortise locks).
- C. Power supplies must be mounted in secure rooms, not above doors or ceilings.
- D. 120 VAC service shall be hardwired with individual shutoffs per supply.

2.5 CABLES

- A. General Cable Requirements: Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and as recommended by system manufacturer for integration requirement.
- B. Plenum-Rated RS485 Cables:
 1. Shielded twisted pair
 2. 120-ohm resistance
 - a. Max 1000ft (4000ft with Lenel 8000 multiplexer).

- C. Multiconductor, Plenum-Type, Composite Cables:
1. Color-Coded composite cable assembly with cables for Reader, Door Contact, Lock Power, and Request to Exit under an overall jacket.
 2. Provide cable components as indicated below with stranded conductors, fluorinated-ethylene-propylene insulation, and overall aluminum-foil/polyester-tape shield or as recommended by manufacturer:
 - a. Reader Cable: 3 pair, No. 22 stranded shielded, color-coded (Red-VO, Black-GND, Brown-LED, Blue-BZR, White-Data 1, Green-Data 0)
 - b. Lock Power Cable: 4 conductor, No. 18 AWG minimum.
 - c. Door Contact Cable: 2 conductor, No. 22 AWG minimum.
 - d. Request-to-Exit Cable: 4 conductor, No. 22 AWG minimum, REX wired in parallel, DPS wired in series
 3. NFPA 70, Type CMP.
 4. Flame Resistance: NFPA 262 flame test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01.
- B. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval at the pre-installation meeting.
 1. For each Location, record setup of controller features and access requirements.
 2. Propose start and stop times for time zones and holidays and match up access levels for doors.
 3. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
 4. Assign action message names and compose messages.
 5. Set up alarms. Establish interlocks between alarms and video surveillance features.
 6. Prepare and update alarm graphic maps.
 7. Complete system diagnostics and operation verification.
 8. Prepare a specific plan for system testing, startup, and demonstration.
 9. Develop acceptance test concept and, on approval, develop specifics of the test.
 10. Develop cable and asset-management system details, input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.
- C. In meetings with Owner, present Product Schedules, and review, adjust, and prepare final setup

documents. Use approved, final Product Schedules to set up system software.

- D. Field locate controller and devices in accordance with contract documents, verify and prepare concealed security protected path for wiring. When not located in the contract documents, verify proposed location with Owner's Representative prior to work. Take into consideration:
1. Cardholder safety.
 2. Environmental protection.
 3. Cable routing and distance limitations.
 4. Installation height and location regulations.

3.3 INSTALLATION

- A. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
1. All access control system cabling shall be bundled, wrapped, and tied to isolate it from other wire and cable.
 2. Service loops required at all terminations.
- B. Cable Installation:
1. Splicing of conductors is not permitted.
 2. Lock power connections: solder with heat shrink only.
 3. Other terminations: 3M Scotchlok UY2 connectors acceptable.
 4. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
 5. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.
 6. Card Readers and Keypads:
 - a. Install number of conductor pairs recommended by manufacturer for the functions specified.
 - b. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
 - c. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 - d. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
 7. Install minimum No. 18 AWG cable from controller or power supply to electrically powered locks for distances not to exceed 250 ft. between terminations, and install No. 16 AWG wire for distances up to 500 ft.
- C. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- D. Install controllers, card readers, power supplies, and accessories in accordance with manufacturer's instructions.
- E. Space controllers and power supplies according to manufacturer's requirements. Ensure adequate space is allowed for device heat dissipation.
- F. Provide interface with electric locking mechanics as required by the door hardware.

- G. Provide lock control of electrified locking mechanics through output contacts activated by Door Controller.
- H. Connect door controller to building fire alarm system for fail-safe release upon any fire alarm. Interface with low voltage / low current normally closed dry contact from fire alarm system. Contact shall open on any fire alarm condition.
- I. At vestibule doors, integrate auto door operation functions with access control system.
- J. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.
- K. Provide all initial system information for system setup including, but not limited to following:
 - 1. SMS Card Reader Information
 - a. Coordinate all card reader values and text, including descriptors, alarm messages, map call up and identification with Owner.
 - 2. Input and output points for system. Coordinate all input and output priorities and text, including descriptors, alarm messages, Video Camera call up, and map call up and identification with Owner.
 - 3. Initial system users, including levels of access.

3.4 GROUNDING

- A. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- B. Bond shields and drain conductors to telecommunications bonding busbar at only one point in each circuit.

3.5 IDENTIFICATION

- A. All panels and power supplies must be labeled with UNCW-approved door numbers.
- B. In addition to requirements in this article, comply with applicable requirements in Section 27 05 53 "Identification for Communications Systems" and with TIA 606-C.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, as-built drawings shall reflect as-built conditions.

3.6 FIELD QUALITY CONTROL

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

- B. Provide written 7-day advance notice of any testing to allow The Engineer and Owner's Representative the option to witness the tests.
- C. Visual and Mechanical Inspections:
 - 1. Verify that units and controls are properly labeled, and interconnecting wires and terminals are identified.
 - 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
- D. System Pre-Testing: After installation of cables and connectors, demonstrate product capability and compliance with requirements.
 - 1. Complete system diagnostics and operation verification.
 - 2. Prepare specific plan for system testing, start-up, and demonstration.
 - 3. Test each circuit and component of each system. System components with battery back up to operate on battery power for not less than 10 percent of calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
 - 4. Complete installation and start-up checks in accordance with manufacturers written instructions.
- E. Acceptance Tests: Perform acceptance test procedures in accordance with manufacturer's requirements and NFPA 731.
- F. Test and Inspection Reports: Prepare a written report to certify compliance with test parameters and record the following:
 - 1. Test 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.
- G. Products will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, "Documentation and User Training."

END OF SECTION 28 10 00

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SECTION 28 20 00 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 26 00 10 "General Requirements for Electrical Systems" apply to this Section.

1.2 SUMMARY

- A. Description: This section of the specification includes the furnishing, installation, connection, and testing of a digital video surveillance system required to form a complete, fully operational, and coordinated system.
- B. Section Includes:
1. Video Management Software
 2. Network Video Storage Server
 3. IP Cameras
 4. Accessories
- C. Related Requirements:
1. Refer to Section 27 15 00, "Communications Horizontal Cabling" for requirements related to Network Cabling.

1.3 REFERENCES

- A. Abbreviations and Acronyms

FPS	Frames per Second
PoE	Power over Ethernet
VMS	Video Management System
WDR	Wide Dynamic Range

- B. Definitions

- C. Reference Standards: The following publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest version as of the date of the Contract Documents, unless otherwise specified.
1. National Electrical Contractors Association (NECA):
 - a. NECA 303, "Standard for Installing Closed-Circuit Television Systems".
 2. National Fire Protection Association (NFPA):
 - a. NFPA 731, "Standard for the Installation of Premises Security Systems".
 3. Underwriters Laboratories (UL):

- D. UL 60950, "Information Technology Equipment"

1.4 COORDINATION

- A. Coordinate system scope and layout requirements, attachment methods, and envelope penetrations with architectural and MEP ceiling plans, elevations, and sections.

1.5 PRE-INSTALLATION MEETING

- A. Schedule preinstallation meeting with Architect, Engineer, Owner, and all affected trades. Agenda topics should include, but are not limited to, the following:
 - 1. System installation schedule and sequencing.
 - 2. Site readiness requirements.
 - 3. Review of all device locations, conductor routing, and pathway coordination.
 - 4. Equipment delivery and site security.
 - 5. System programming and owner's requirements for camera views, user permission groups, analytics and system naming nomenclature.
 - 6. Assignment of IP addresses.
 - 7. Interface requirements for connection to other building systems.

1.6 SUBMITTALS

- A. Product Data: Submit for each type of product.
- B. Shop Drawings: For video surveillance system and related equipment.
 - 1. Include floor plans, elevations, and sections drawn to scale which show locations of all devices, outlets, and equipment. Indicate electrical power connections, approximate location and size of conduit/wiring runs, and other information required to clearly describe the proposed system.
 - 2. Detail equipment assemblies and indicate critical dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control, and interface with other building systems. Show cable types and sizes.
 - 4. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 - 5. Include calculations for all network bandwidth and system server storage requirements.
- C. Qualification Data: For qualified designer and technicians assigned to the project.
- D. Sample Warranty.
- E. Test and inspection reports.
- F. Closeout Submittals
 - 1. Operation and Maintenance Data: In addition to items specified in Division 01 and Section 26 00 10 "General Requirements for Electrical Systems", include the following:
 - a. Software and Firmware Operational Documentation: Provide operating manuals and backups of software, camera configurations, camera model numbers, IP addresses, and MAC addresses, and other system settings on USB media. The backups provided shall be useable by any authorized and certified distributor of the product line and shall include all applicable passwords necessary for total and unrestricted use and modification of the system.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Minimum five continuous years design and manufacture of the materials and equipment specified.
 - 2. Manufacturing facilities certified to ISO 9001 International Quality Standard with third-party certification verifying quality assurance in design/development, production, installation, and service.
 - 3. Employ trained staff that are available 24/7 to provide scheduling support and assist with reporting needs.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for design, installation, and programming of units required for this Project:
 - 1. Maintain a fully staffed and equipped service office within 100 miles of the project site that regularly offers maintenance and service for systems of similar design and size.
 - 2. Be in business a minimum of 5 continuous years with documented experience installing systems similar in size and scope.
 - 3. Upon request, be able to provide a minimum of three reference accounts at which similar work, both in scope and complexity, have been completed by The Contractor within the last three years.
 - 4. Project Personnel Requirements: Installer must have the following certified full-time employees on staff and assigned to the project.
 - a. All personnel must be trained and certified by the manufacturer for installation of units required for this Project.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements: Comply with manufacturer instructions for storage of electrical and electronic equipment to prevent damage from condensation or other environmental conditions.

1.9 WARRANTIES

- A. Manufacturer Warranty: Manufacturer agrees to repair or replace intercommunication system equipment and components that fail in materials or workmanship for a period of 5 years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 GENERAL 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 the requirements of the National Defense Authorization Act (NDAA) which addresses the prohibited use of certain video surveillance telecommunications services, equipment and components manufactured by specific vendors.
- C. All video surveillance cameras and equipment shall be ONVIF profile S compliant.

- D. Source Limitations: All cameras and hardware must be provided by an authorized Axis dealer with full manufacturer warranty and support.
- E. Existing Equipment: Components must be compatible with and operate as extension of the existing video management system. Equipment must not impair reliability or operational functions of the existing system. Provide system manufacturer's certification that components provided have been tested as, and will operate as, a complete and fully functional system.
- F. Licensing:
 - 1. Cameras should be free of any licenses for all feature sets including but not limited to embedded video analytics, web browser and onboard storage.

2.2 VIDEO MANAGEMENT SOFTWARE

- A. Provide all programming and components necessary to integrate new devices into existing district wide video management system.
- B. Existing VMS: Genetec Video Management Software
- C. Client Workstation: Setup interfaces for system operators which can display video images from select system cameras and allow for complete programming of the VMS servers within system.

2.3 NETWORK VIDEO STORAGE SERVER

- A. Provide a standard server/storage solution for the recording and retention of security video for use in both real-time and forensically for investigative purposes.
- B. Description: The NVR server shall record video and audio at a minimum of 470 Mbps and send data from video cameras to a hard disk array of 1 -12 HDDs within a rack mountable format and enable playback of video and audio from the hard disk array.
- C. Cameras are to record a continuous low-resolution stream at provided FPS and switch to high-resolution stream at provided FPS upon motion detection.
- D. Storage: Up to 12 HDDs in JBOD configuration with RAID support. Include USB connection for memory/storage device for video clip backup and settings export.

2.4 IP CAMERAS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following: Axis is the preferred manufacturer.
 - 1. Axis
- B. General Characteristics:
 - 1. Comply with UL 60950
 - 2. Housing:
 - a. Indoor Cameras: IK10 impact resistance with IP67 rating
 - b. Outdoor Cameras: IK10 impact-resistance with IP67 rating
 - 3. Operating Temperatures:
 - a. Indoor Cameras: -10° C to 55° C.
 - b. Outdoor Cameras: -30° C to 55° C.

4. Video Compression and Transmission: Capable of H.265, H.264, and MJPEG, with each derived from dedicated encoders.
 5. Frame Rate: Capable of frame rates up to 30 fps with WDR enabled.
 6. WDR: minimum 120dB.
 7. Integral IR illuminator.
 8. Connectivity: 10/100 Base-T Ethernet via RJ-45 connector.
 9. Communication Protocol: TCP/IP v4 and v6.
 10. Power: POE capable
- C. Mounting Hardware: Provide products matched to items supported and mounting conditions.
1. Designed to provide rigid support for electrical and optical systems so that unintentional changes in alignment do not occur during operation, movement, or lens adjustments.
- D. FIRMWARE & SECURITY
1. Cameras must run the latest firmware approved for Genetec. Contractor to confirm version with UNCW.
 2. Integrators must be manufacturer-certified installers.

2.5 ELEVATOR CAMERAS

- A. Cabling: Elevator cab cameras require special plenum CAT6 cable.
1. Commscope – 874049304/10
- B. Cabling method: Attach to cab travel cable, terminate in elevator control panel, and protect with Ditek MRJPOE surge protector.
- C. Variance letter to NCDOT Elevator Bureau required for cabling installation.

2.6 ACCESSORIES

- A. Surge Protection:
1. Provide Ditek MRJPOE surge protector within 6ft of each camera.
 2. Provide rack-mounted Ditek DTK-VM2W4, VM2W8, or VM2R24 surge suppression patch panels.
 3. Provide grounding bars and bond per UNCW standards:
 - a. #6 AWG from TMGB to ground bar
 - b. #12 AWG from ground bar to each surge protector

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.
- B. Examine raceway rough-in and electrical connections to verify actual locations of connections before installation.

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

3.2 PREPARATION

- A. Verify network design and configuration for system compatibility and performance.
- B. Test and qualify camera network configurations prior to installation.
- C. Cybersecurity:
 - 1. Update all product firmware, system software, and operating systems to the latest and most up-to-date version provided by the manufacturer. Ensure system compatibility.
 - 2. Configure all equipment requiring a user log on with a user/site-specific password. Default passwords are not allowed.

3.3 INSTALLATION

- A. Install all equipment and accessories in accordance with NECA 303, NFPA 731, and manufacturer's instructions.
- B. Wiring Methods: Install all cabling in raceways, in accordance with Section 26 05 33, "Raceways and Boxes for Electrical Systems", Section 27 05 28, "Pathways for Communication Systems", and manufacturer's recommendations. Conceal raceway, except in unfinished spaces.
 - 1. Unenclosed wiring methods may be used in accessible ceiling spaces.
 - 2. Install plenum rated cable.
 - 3. Provide cable listed for wet locations where cabling is routed outdoors or in/under concrete slabs on grade.
- C. Camera Installation:
 - 1. Install cameras to minimize the effect of environmental conditions such as icing, sunlight angles, temperature extremes, wind loading, and rain.
 - 2. Ensure that all cameras are accessible for maintenance without the use of special lifts.
 - 3. Ensure that proposed camera locations afford the necessary field of view of the areas to be monitored without obstruction. If conflicts exist, notify Architect and Engineer prior to installation.
- D. Integrate all system components with software for a fully functional video surveillance system.

3.4 GROUNDING AND BONDING

- A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" and Section 27 05 26 "Grounding and Bonding for Communications Systems".

3.5 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53, "Identification for Electrical Systems" and Section 27 05 53, "Identification for Communications Systems".
 - 1. Identify all system enclosures, components, wiring, cabling, and terminals.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
- B. Provide written 7-day advance notice of any testing to allow The Engineer and Owner's Representative the option to witness the tests.
- C. Visual and Mechanical Inspections
 - 1. Verify that units and controls are properly installed, connected, and labeled, and that all interconnecting wires and terminals are identified.
- D. Preliminary System Testing:
 - 1. Test systems, equipment, and components in accordance with manufacturer requirements and NFPA 731.
 - 2. Field of View Test: Review the aim and focus of all cameras to verify the field of view satisfies the intended coverage requirements. Ensure video does not include significant dead space such as ceilings.
 - 3. Video Quality Test: Under daytime conditions, direct a test subject to enter the field of view. Verify the video image is clear and the subjects movement is smooth and not choppy. Verify the image is in focus, stable, and without pixilation, rolling, flickering, discoloration, and glare from light sources. Simulate nighttime conditions, and repeat test, ensuring the camera has shifted to the correct day/night mode.
 - 4. Video Validation Test: Verify the camera frame rates and recording resolutions are set in accordance with the system performance requirements.
 - 5. Video Loss Detection Test: Disconnect the camera from the system and verify the proper system alarm response. Reconnect camera and verify alarms are no longer present.
 - 6. Visually inspect monitors to ensure system monitors are working properly and that cameras are properly aimed and focused.
 - 7. Verify proper operation of recording devices.
- E. Acceptance Tests
 - 1. Perform operational system tests to verify that system complies with system performance criteria. Test equipment for proper operation in all functional modes.
 - 2. Demonstrate all recording is properly configured, including retention length, images per second, drive fault tolerance, etc.
- F. Test and Inspection Reports: Prepare a written report to certify compliance with test parameters and record the following:
 - 1. Test 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.
- G. Products will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

3.7 ADJUSTING

- A. Post-Occupancy Adjustments: When requested within 12 months of date of Completion, provide on-site assistance in adjusting cameras to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, "Documentation and User Training."

END OF SECTION 28 20 00

SECTION 28 31 00 – ADDRESSABLE FIRE ALARM SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Notification appliances.
 - 6. Magnetic door holders.
 - 7. Remote annunciator.
 - 8. Digital alarm communicator transmitter.

1.3 DEFINITIONS

- A EMT: Electrical Metallic Tubing.
- B FACP: Fire Alarm Control Panel.
- C NICET: National Institute for Certification in Engineering Technologies.

1.4 ACTION SUBMITTALS

- A 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.
- B Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and 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. Detail assembly and support requirements.
 - 5. Include voltage drop calculations for notification-appliance circuits.
 - 6. Include battery-size calculations.
 - 7. Include input/output matrix.
 - 8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 - 9. Include performance parameters and installation details for each detector.
 - 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; 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 required for HVAC unit shutdown on alarm.
 - 12. 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.
- C General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.
 - c. Licensed or certified by authorities having jurisdiction.
- 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 signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
 2. Design Calculations: Calculate requirements for selecting the 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.

1.5 INFORMATIONAL SUBMITTALS

- A Qualification Data: For Installer.
- B Seismic Qualification Data: Certificates, for fire-alarm control unit, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C Field quality-control reports.
- D Sample Warranty: For special warranty.

1.6 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," include the following:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72. Coordinate Fire alarm document cabinet location with owner per NFPA 7.7.2.1.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall 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" according to the "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 fire-alarm control unit and each annunciator unit.
 - B Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
- 1.7 MAINTENANCE MATERIAL SUBMITTAL
- A Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Smoke & Heat Detectors: 1 or 6% of total installation
 - 2. Detector Bases: 1 or 2% of total installation
 - 3. Keys and Tools: One extra set for access to locked or tamper proofed components.
 - 4. Audible and Visual Notification Appliances: 1 or 4% of total installation
 - 5. Fuses: 1 or 4% of total installation
 - 6. Pull Stations: 1 or 2% of total installation
 - 7. Relay/Monitor/Isolation Modules: 1 or 4% of total installation
- 1.8 QUALITY ASSURANCE
- A Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
 - B Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- 1.9 WARRANTY
- A Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 - 2. Warranty Period: One year from date of Final Acceptance.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- A Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice evacuation.
- B Automatic sensitivity control of certain smoke detectors.
- C Evacuation Alarm: Entire Building.
- D All components provided shall be listed for use with the selected system.
- E Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A Fire-alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors.
 - 5. Automatic sprinkler system water flow.
- B Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances.

2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Release fire and smoke doors held open by magnetic door holders.
 5. Close fire/smoke dampers in air ducts of designated air-conditioning duct systems.
- C Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Duct smoke detectors.
 3. Elevator shunt trip.
 4. BDA
 5. Low temperature
- D System trouble signal initiation shall be by one or more of the following devices and actions:
1. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 2. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in internal circuits of fire-alarm control unit.
 5. Abnormal ac voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
- E System Supervisory Signal Actions:
1. Initiate notification appliances.
 2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
 3. Record the event on system printer.
 4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 PERFORMANCE REQUIREMENTS

- A Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.4 FIRE-ALARM CONTROL UNIT

- A Subject to compliance with the specifications, the following are approved for bid:
1. Notifier
 2. Edwards System Technologies
 3. Siemens
 4. Fire Control Instruments
 5. ABB
- B General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.

- e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
- 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
- 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- D Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- E Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1. Pathway Class Designations: NFPA 72, Class A.
 - 2. Pathway Survivability: Level 0.
 - 3. Install no more than 50 addressable devices on each signaling-line circuit.
 - 4. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - 5. Alarm notification appliance (NAC) circuits shall be NFPA 72 Class A. The load connected to each circuit must not exceed 80% of rated module output and the coverage of each circuit shall not exceed 3 floors (to limit the effect of faults, and to facilitate trouble shooting). The NAC voltage drop during alarm shall not exceed 14% of the voltage measured across the batteries at that time. To achieve this, the design must consider wire size, length of circuit, device load, inherent voltage loss within the FACU's power supply, etc. The contractor shall use power outage testing to verify that the NAC circuit was designed and installed properly.

- F Notification-Appliance Circuit:
 - 1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 - 2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- G Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.
- H Remote Smoke-Detector Sensitivity Adjustment: Controls shall 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 the final adjusted values on system printer.
- I Provide supervised by-pass switches labeled and accessible on the display panel for elevator recall. For air handling unit shutdown, an alarm signal shall directly activate.
- J The system must be equipped with the protective devices to prevent damage or nuisance alarms by nearby lightning strikes, stray currents, or voltage transients. Use Transtector ACP100BWN3, Ditek DTK-120HW or DTK-120/240CM or Leviton OEM-120EFI. Install at circuit origination using knockout or supplied "L" bracket, and trim excess lead lengths. Provide coil of six turns in branch conductor to panel at point of connection of surge suppressor and secure with "tie-wrap".
- K Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- L 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 all other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.
- M Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- N Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch. 60-hour battery backup is required.
 - 1. Batteries: Sealed lead calcium.
- O Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

- A Subject to compliance with the specifications, the following are approved for bid:
 - 1. Notifier
 - 2. Siemens
 - 3. Wheelock
 - 4. Gamewell
 - 5. ABB
- B General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall 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 an alarm, pull-lever type; with attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Station Reset: Key operated switch.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.6 SYSTEM SMOKE DETECTORS

A Subject to compliance with the specifications, the following are approved for bid:

1. Notifier
2. Siemens
3. Gamewell
4. ABB
5. Gentex

B General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 Fper minute.
 - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 deg F.
 - c. Multiple levels of detection sensitivity for each sensor.
 - d. Sensitivity levels based on time of day.

C Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall 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.).

D Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall 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.).
- E Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 - 2. An operator at fire-alarm control unit, having the designated access level, shall 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.).
 - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
 - 4. Each sensor shall have multiple levels of detection sensitivity.
 - 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
 - 7. All air duct/plenum detectors shall have a Remote Alarm Indicator Lamp (RAIL) with a test switch (which shall be mounted 8'-0" AFF) installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. Duct smoke detectors are permitted to be installed only inside an air duct. Duct detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration.

2.7 HEAT DETECTORS

- A Subject to compliance with the specifications, the following are approved for bid:
 - 1. Notifier
 - 2. Siemens
 - 3. Gamewell
 - 4. ABB
 - 5. Gentex
- B General Requirements for Heat Detectors: Comply with UL 521.
 - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- C Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.8 NOTIFICATION APPLIANCES

- A Subject to compliance with the specifications, the following are approved for bid:
 - 1. ABB
 - 2. Siemens
 - 3. Wheelock
 - 4. Gentex
- B General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C Alarm Voice/Tone Speakers: Provide alarm voice/tone speakers, as applicable, to satisfy current NC State Building Code, NFPA 72 and ADA requirements for building. Speakers shall be electronic and suitable for flush mounting. Speakers shall operate a 24 VDC and shall have a rated output as required to meet both DOI and ADA requirements. Speakers shall be provided

in quantity and intensity as required to provide 15 dBA of alarm sound over the normal ambient sound level in all occupiable areas of the building.

- D Visible Notification Appliances: LED strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, white.

2.9 MAGNETIC DOOR HOLDERS (IF ANY)

- A Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
 4. Rating: 120-V ac.
- B Material and Finish: Match door hardware.

2.10 REMOTE ANNUNCIATOR

- A Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, 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 shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.11 ADDRESSABLE INTERFACE DEVICE

- A General:
1. Include address-setting means on the module.
 2. Store an internal identifying code for control panel use to identify the module type.
 3. Listed for controlling HVAC fan motor controllers.
- B Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C Control Module:
1. Operate notification devices.
 2. Operate solenoids for use in sprinkler service.

2.12 ISOLATOR MODULE:

- A Provide so that not more than 20 initiating devices are grouped together in between isolation modules or between loop interface board and isolator module. No matter how many devices are placed between isolators, under no circumstances shall 80% capacity of the manufacturer's requirements be exceeded between isolators. Isolators shall be mounted at same height above floor as audible/visual appliances, in a flush-in-wall box. (Box may be surface mounted in equipment rooms.)

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

- B Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C Local functions and display at the digital alarm communicator transmitter shall 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 the central station or fire-alarm control unit.
- D Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the 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

3.1 EXAMINATION

- A Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A Comply with **2013** NFPA 72, The International Mechanical Code - 2015, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all 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 all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
- C Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 - 2. Mount manual fire-alarm box on a background of a contrasting color.

3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D Smoke- or Heat-Detector Spacing:
 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed 30 feet
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F Duct Smoke Detectors: Comply with NFPA 72 and The International Mechanical Code - 2015. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall 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 Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

- A Pathways shall be installed in EMT. All junction boxes shall be Red.

3.4 SYSTEM CONFIGURATION AND INSTALLATION

- A Wiring must be in metal conduit.
- B Initiation or notification circuits shall not be included in raceways containing AC power or AC control wiring.
- C Within the FACP, any AC control wiring must be properly separated, per NEC 760, from other circuits and the enclosure must have an appropriate warning label to alert service personnel to the hazard.
- D Conductors shall be copper same as specified for electrical system. Initiation circuits shall be number 14 AWG stranded, type THHN or XHHW shall be used.
- E Addressable loop controller circuits are to be wired with FPL/FPLR/FPLP solid copper, AWG 18 minimum, low capacitance, twisted pair, installed in conduit in lieu of the 14 AWG noted above.
- F Alarm appliances shall be connected with 14 AWG noted above.
- G For other circuits the following color code shall apply
 1. Initiating circuits – red and white
 2. Signal line circuit cable – Red Jacket with red and black
 3. Alarm indicating device circuits – blue and black
 4. Air handling shut-down circuits – yellow
 5. Door control circuits – orange
 6. Other (smoke shutters, dampers) – verify
- H Permanent wire markers shall be used to identify all and terminations for each circuit.
- I Use terminal blocks for all splices. Twist on splices are not allowed.
- J For terminations, indicate which conductor leads to the control panel.
- K All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

3.5 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 "Door Hardware." 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.

3.6 IDENTIFICATION

- A Identify system components, wiring, cabling, and terminals.
- B Install framed instructions in a location visible from fire-alarm control unit.
- C EOL notification devices shall be labeled EOL.
- D Initiating devices shall be labeled with an address.

3.7 GROUNDING

- A Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B Ground shielded cables at the control panel location only. Insulate shield at device location.

3.8 FIELD QUALITY CONTROL

- A Field tests shall be witnessed by North Carolina SCO, UNCW, and Engineer of Record for the project.
- B Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C Perform tests and inspections.
- D Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Re-acceptance" column and list only the installed components.
 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72. UNCW and Engineer of Record shall witness 100% of testing and sign NFPA 72.
 7. SCO Fire Alarm System Check List (2020).
- E Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G Prepare test and inspection reports.
- H Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I Annual Test and Inspection: One year after date of Final Acceptance, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.9 MAINTENANCE SERVICE

- A Initial Maintenance Service: Beginning at Final Acceptance, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.10 SOFTWARE SERVICE AGREEMENT

- A Comply with UL 864.
- B Technical Support: Beginning at Final Acceptance, service agreement shall include software support for one year.
- C Upgrade Service: At Final Acceptance, update software to latest version. Install and program software upgrades that become available within two years from date of Final Acceptance. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.11 DEMONSTRATION

- A Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 31 00

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SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes provisions for hot-mixed asphalt paving over prepared subbase.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements of NCDOT "Standard Specifications for Roads and Structures".
- C. Job Mix Formula: Provide Geotechnical consultant with two copies of the proposed job mix formula at least ten days prior to beginning work. This formula shall be approved by NCDOT for the type of pavement specified.
- D. Recycled Content: As approved by NCDOT.

1.4 SITE CONDITIONS

- A. Weather Limitations for Tack Coats: Apply tack coats only when the surface to be treated is dry and when the atmospheric temperature measured at the location of paving operations away from artificial heat are in compliance with current NCDOT Standard Specifications for Roads and Structures. Do not apply tack coat when weather is foggy or rainy.
- B. Weather Limitations for Asphalt Courses: Apply hot-mixed asphalt surface, intermediate and base courses when surface and air temperatures are in compliance with current NCDOT Standard Specifications for Roads and Structures and when base is dry.
- C. Grade Control: Establish and maintain required lines and elevations.
- D. Traffic Control: Provide traffic control devices, lane closures, positive protection and/or any other warning or positive protection devices necessary for the safety of road users and pedestrians during construction.
 - 1. Traffic control shall be performed in conformance with the latest NCDOT Roadway Standard Drawings and Standard Specifications for Roads and Structures and the Manual on Uniform Traffic Control Devices for Streets and Highways.
 - 2. Sidewalk closures shall be installed as necessary. Pedestrian traffic shall be detoured around these closures and shall be signed appropriately and in accordance with ADA guidelines.
 - 3. Two-way traffic shall be maintained at all times through use of flagmen when necessary.
 - 4. Maintain access for fire-fighting equipment and access to fire hydrants.

1.5 QUALITY ASSURANCE

- A. All materials, construction methods and testing shall comply with the requirements of the latest editions of the North Carolina Department of Transportation (NCDOT) "Standard Specifications for Roads and Structures" and the Asphalt Handbook Manual Series No. 4 (MS-4).
- B. All work within any NCDOT right-of-way shall conform to the provisions and conditions of the NCDOT encroachment agreement(s) and driveway permit(s) and other applicable NCDOT standards and policies. The encroachment agreement(s) and driveway permit(s) are considered part of the project specifications by reference. Copies of the agreement(s) and permit(s) will be provided upon request from the Architect.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Use locally available materials and gradations that comply with the requirements of the NCDOT "Standard Specifications for Roads and Structures" and exhibit a satisfactory record of previous installations.
- B. Aggregate Base Course (ABC): Type A aggregate base course meeting the requirements of the latest version of NCDOT "Standard Specifications for Roads and Structures."
- C. Superpave Asphalt Paving Mix: Superpave base, intermediate and surface asphalt paving mix meeting the requirements of the latest version of NCDOT "Standard Specifications for Roads and Structures." Types as indicated on the drawings.
- D. Tack Coat: Asphalt material meeting the requirement of the latest version of NCDOT "Standard Specifications for Roads and Structures."
- E. Parking Lot Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
 - 1. Color: White for parking and bus lot striping.
 - 2. Color: Yellow for fire lanes and service area striping.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. General: Remove loose material from compacted subbase surface immediately before applying base courses of asphalt.
- B. Proof-roll prepared subgrade surface as described in Section "Earth Moving" to check for unstable areas and areas requiring additional compaction.
- C. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving. Ensure subgrade is graded for proper drainage. Repair as needed to avoid ponding on final pavement surfaces.
- D. Cold mill surfaces of existing pavements in locations and to depths as indicated on the drawings and as follows.
 - 1. At edges of existing pavement to be overlaid: Cold mill surfaces of existing pavements to a minimum depth of 1.5-inches at longitudinal terminus of asphalt overlays for a minimum

width of 10 feet (extend terminus milling width to 100-ft on public roads) and at horizontal terminus (including along gutter line of existing curbs adjacent to asphalt overlays) for a minimum width of 6 feet to allow a smooth transition from full-depth thickness of overlay course to existing pavement or gutter surface. Thoroughly remove all loose material from milled surface before placing tack coat.

2. At pavement to be wedge overlaid: Cold mill surfaces of existing pavements to required depths at edges of asphalt wedge sections on public roads for widths needed to allow minimum depth thickness of wedge course. Thoroughly remove all loose material from milled surface before placing tack coat.
3. At butt joint of new asphalt to existing asphalt: Cold mill surfaces of existing pavements to a minimum depth of 1.5-inches for a minimum width of 18-inches along length of new joint to allow new asphalt surface to be keyed-in to the existing pavement. Thoroughly remove all loose material from milled surface before placing tack coat.

- E. Thoroughly remove all dust and loose material from surfaces of that which the tack coat is to be applied along with adjacent surfaces before placing tack coat.

3.2 REPAIRS

- A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new subgrade. Install hot-mix asphalt pavement per the requirements of this section.
- B. Crack Filling: Remove debris from cracks or joints to a depth of 1/4 inch.
1. Clean cracks and joints in existing hot-mix asphalt pavement.
 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

3.3 PLACING MIX

- A. Limitations: Do not produce or place asphalt mixtures during rainy weather, when the subgrade or base course is frozen, or when the moisture on the surface to be paved would prevent proper bond. Comply with all NCDOT weather and temperature limitations.
- B. General: Place hot-mixed asphalt mixture on prepared surface, spread, and strike off. Spread mixture at minimum temperature of 225 deg F. Place areas inaccessible to equipment by hand. Place each course to required grade, cross-section, and compacted thickness.
- C. Paver Placing: Place in strips not less than 10 feet wide, unless otherwise acceptable to Architect. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.
- D. Immediately correct surface irregularities in finish course behind paver. Remove excess material forming high spots with shovel or lute.
- E. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of hot-mixed asphalt course. Clean contact surfaces and apply tack coat.

3.4 ROLLING

- A. General: Begin rolling when mixture will bear roller weight without excessive displacement.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling, if required, with hot material.
- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been evenly compacted.
- E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained required density. Compact the asphalt to at least the minimum percentage of the maximum specific gravity listed below unless otherwise allowed by NCDOT.
 - 1. Standard Vehicular Area Pavement:
 - a. S-9.5B/C, I-19.0B/C, B-25.0B/C: 92.0% of Maximum Specific Gravity.
- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 TRAFFIC MARKINGS

- A. Cleaning: Sweep and clean surface to eliminate loose material and dust.
- B. Materials: Use thermoplastic marking for permanent markings on public streets and stop bars and crosswalks on private drives and parking lots. Use marking paint for parking and fire lane striping and other markings on private drives and parking lots.
- C. Apply traffic paint with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates to provide minimum 12 to 15 mils dry thickness.
- D. Apply thermoplastic markings using application equipment constructed to assure continuous uniformity in the thickness and width of the thermoplastic pavement marking. Use equipment that provides multiple width settings ranging from 4 inches to 12 inches and multiple thickness settings to achieve the pavement marking thickness ranging from 0.090 inch to 0.120 inch. Comply with all applicable NCDOT standards.
- E. Remove existing markings as indicated by water blasting.

3.6 FIELD QUALITY CONTROL

- A. General: Testing of asphalt concrete mix and in-place hot-mixed asphalt courses for compliance with requirements for thickness and surface smoothness will be done by Owner's testing laboratory in accordance with Division 1 Section "Quality Control." Repair or remove and replace unacceptable paving as directed by Architect.
 - 1. Owner's Independent Testing Agency will conduct and interpret tests and state in each report whether tested work complies with or deviates from the specified requirements.
- B. Thickness: In-place compacted thickness of each layer of asphalt shall be tested in accordance with ASTM D 3549. Results shall be considered unacceptable if the compacted thickness of any one core sample is greater than 1/2-inch below the thickness specified on the drawings or if the average thickness of all core samples is less than the thickness specified on the drawings.
- C. Surface Smoothness: Test finished surface of each hot-mixed asphalt course for smoothness, using 10 feet straightedge applied parallel with and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness:
 - 1. Base Course Surface: 1/4 inch.
 - 2. Wearing Course Surface: 3/16 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
- F. Contractor shall repair all test core holes with full depth asphalt patch.
- G. Perform ponding water tests. Repair areas of pavement that pond water.
- H. Check surface areas at intervals as directed by Architect.

END OF SECTION 32 12 16

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SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Light Duty Concrete Paving Walks.
 - 2. Heavy Duty Concrete Paving Walks.
 - 3. Detectable warnings
 - 4. Curbs and gutters.
- B. Related Sections:
 - 1. Division 03 Section "Cast-in-Place Concrete Miscellaneous Cast-in-Place Concrete" for general building applications of concrete.
 - 2. Division 32 Section "Decorative Concrete Paving" for stamped concrete
 - 3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
- C. Action Submittals:
 - 1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer.

- B. Material Certificates: For the following, from manufacturer:
1. Cementitious materials.
 2. Steel reinforcement and reinforcement accessories.
 3. Admixtures.
 4. Curing compounds.
 5. Applied finish materials.
- C. Material Test Reports: For each of the following:
1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- D. Field quality-control reports.
- E. Product Submittals: Submit cut sheets of detectable warning paver selection. Include paver choice and color.

1.6 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- C. Slip Resistance: The project shall conform to the Occupational Safety and Health Administration recommendations for walking surfaces have a static coefficient of friction of 0.5. A static coefficient of friction of 0.6 is required for accessible routes and 0.8 for ramps.
- D. Concrete Testing Service: Owner will engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- E. ACI Publications: Comply with ACI 301 unless otherwise indicated.
- F. Preinstallation Conference: Conduct conference at [Project site] <Insert location>.
1. Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a. Concrete mixture design.
 - b. Quality control of concrete materials and concrete paving construction practices.
 - c. Sub base and base preparation
 - d. Form work layout
 - e. Finish, finish tools and finishing process

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Concrete paving subcontractor.

1.7 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces. Use material appropriate to obtain the correct quality and alignments.
 1. Use 2" thick wood forms or formed steel forms for straight lines and rectangular applications
 2. Use flexible forms capable of delivering smoothly curved formwork free of kinks, bulges, or flats. Forms can be steel, plastic or wood, but must have adequate joining methods to allow the smooth flow of curved lines through the union of form sections.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.
- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 ; deformed.
- D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars galvanized after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, gray Portland cement Type I. The following are allowed supplements:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.
 1. Maximum Coarse-Aggregate Size: 1 inches nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
 3. For Provide Grey Aggregate –For exposed aggregate concrete surfaces. Provide #78 dark grey aggregate from the Butner Quarry.
- C. Water: Potable and complying with ASTM C 94/C 94M.
- D. Air-Entraining Admixture: ASTM C 260.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
 7. Surface Retarder for Exposed Aggregate Finish:
 - a. Formula Type S for horizontal applications.

2.4 CURING MATERIALS

- A. Water: Potable.
- B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anti-Hydro International, Inc.; A-H Curing Compound #2 DR WB.
 - b. ChemMasters; Safe-Cure Clear.
 - c. Conspec by Dayton Superior;
 - d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
 - e. Edoco by Dayton Superior;
 - f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; AQUA KURE - CLEAR.
 - i. L&M Construction Chemicals, Inc.; L&M CURE R.
 - j. Meadows, W. R., Inc.; 1100-CLEAR SERIES.
 - k. Nox-Crete Products Group; Resin Cure E.
 - l. SpecChem, LLC; PaveCure Rez.

- m. Symons by Dayton Superior; Resi-Chem Clear.
- n. Tamms Industries, Inc., Euclid Chemical Company (The); TAMMSCURE WB 30C.
- o. TK Products, Division of Sierra Corporation;.
- p. Vexcon Chemicals Inc.; Certi-Vex Enviocure 100.

2.5 DETECTABLE WARNING MATERIALS

- A. Detectable Warning Paver: Precast, designed to meet current ADA guidelines, made from Portland cement, fine and coarse aggregates, hydraulically pressed under 1000 pounds per square inch. Nominal size to be 12" by 12" by 1 1/4" or as shown on the drawings.
 - 1. Color – Dark Gray [charcoal]
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hanover Architectural Products
 - b. Pavestone Company.
 - c. Wausau Tile, Inc.
 - d. Tile Tech Pavers.

2.6 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.
 - 2. Color: [Gray]
 - 3. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

2.7 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 , for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 - 2. When automatic curb and gutter machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 3500 psi
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 - 3. Slump Limit: 5 inches, plus or minus 1 inch .

- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 5-1/2 percent plus or minus 1.5 percent.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture or plasticizing and retarding admixture in concrete as required for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - 1. Fly Ash or Pozzolan: 25 percent.
 - 2. Ground Granulated Blast-Furnace Slag: 50 percent.
 - 3. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F , reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F , reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances. Grades should be compacted, smooth and free of dips, ridges or other potential snags that could cause less predictable cracking.
- B. Proof-roll prepared base surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll base in one direction [for pedestrian applications] and repeat in perpendicular direction [for vehicular applications]. Limit vehicle speed to 3 mph .
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons .
 - 3. Correct base with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Division 31 Section "Earth Moving." Do not fill with concrete.

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

3.2 PREPARATION

- A. Remove loose material from compacted base surface immediately before placing concrete.
- B. Place and compact base materials according to "Hot Mixed Asphalt Paving" specifications for ABC gravel.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- 3.5 General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

- 3.6 Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

- 3.7 Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.8 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

- C. Expansion Joints: Form isolation joints of preformed joint-filler strips abutting buildings, columns, footings, concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
1. Locate expansion joints at intervals shown in the drawings but not more than 40'.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
 7. [EDIT] Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows[, to match jointing of existing adjacent concrete paving]:
1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. [Eliminate edging-tool marks on concrete surfaces.]

3.9 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface, steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into.
- G. Consolidate concrete according to ACI 301 by hand spading, rodding, or tamping.

- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F , uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface by hand floating. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3.11 DETECTABLE WARNINGS

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Division 32 Section "Unit Paving".
 - 1. Tolerance for Opening Size: Plus 1/4 inch , no minus
 - 2. Match paver depth plus sand setting bed.

3.12 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by curing compound as follows:
 - 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.13 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch .
 - 2. Thickness: Plus 3/8 inch , minus 1/4 inch .
 - 3. Surface: Gap below 10-foot- long, unlevelled straightedge not to exceed 3/8 inch .
 - 4. Lateral Alignment and Spacing of Dowels: 1 inch .
 - 5. Vertical Alignment of Dowels: 1/4 inch .
 - 6. Contraction Joint Depth: Plus 1/4 inch , no minus.
 - 7. Joint Width: Plus 1/8 inch , no minus.
 - 8. Joint Spacing: as shown on the drawing
 - 9. Joint alignment: when aligned with plan identified site element, 1/4".
 - 10. Edge alignment – no more than 1/2" out of alignment over 20'
 - 11. Joint straightness – no more than 1/2" out of alignment over 20'

3.14 WHEEL STOPS

- A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
- B. Securely attach wheel stops to paving with not less than two [galvanized-]steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for the first 20 yards and one each 100 cu. yd. thereafter or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi .
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- H. Prepare test and inspection reports.

3.16 CONCRETE REJECTION AND REPLACEMENT

- A. Concrete paving will be considered defective if it:
 - 1. Does not pass tests and inspections.
 - 2. Does not meet layout and alignments,
 - 3. Does not have a consistent color and texture
 - 4. Shows spalling, alligator cracking or cracking due to base failures.
 - 5. Jointing is installed after contraction cracking has occurred,
 - 6. Jointing and edges are not smooth curves or in straight lines as indicated by the drawings,
 - 7. Exceeds the gradients indicated on the plans,
 - 8. Does not adequately drain water away as shown on the drawings.
- B. Defective concrete shall be removed immediately and replaced with acceptable concrete work at the Contractor's expense.

3.17 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Final Acceptance inspections.

END OF SECTION 32 13 13

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cold-applied, fuel-resistant joint sealants.
 - 2. Joint-sealant backer materials.
 - 3. Primers.
- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants 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. Paving-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of joint sealant and accessory.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

1.7 FIELD CONDITIONS

- A. 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 joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been 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.

2.2 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

- A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems; MasterSeal NP1 or equal.
 - b. Provide separate colors selected from manufacturers full range for the following applications:

2.3 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints 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: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- 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. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

- C. Install joint-sealant backings to support joint 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 joint-sealant backings.
 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
1. Place joint sealants so they fully contact joint substrates.
 2. Completely fill recesses in 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 Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements 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 joint sealant from surfaces adjacent to joints.
 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.

3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. 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 Final Acceptance. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within concrete paving.
1. Joint Location:
 - a. Expansion and isolation joints in concrete paving.
 2. Joint Sealant: Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric
 3. Joint-Sealant Color: Selected from manufacturers full range.

- B. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving.
1. Joint Location:
 - a. Joints between concrete and asphalt paving.
 2. Joint Sealant: Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant
 3. Joint-Sealant Color: Selected from manufacturers full range.

END OF SECTION 32 13 73

January 15, 2026

University of North Carolina at Wilmington
Housing Village Phase 3
Complete Package - Construction Documents

5142301800
SCO 24-29053-02D

SECTION 32 14 00 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick pavers.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete base under unit pavers.
2. Section 321443 "Porous Unit Paving" for unit paving using grid pavers or pavers with openings between them.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:

- a. Pavers.
- b. Edge restraints.

B. Sustainable Design Submittals:

1. Third-Party Certifications: For each product.
2. Third-Party Certified Life Cycle Assessment: For each product.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

D. Samples for Initial Selection: For each type of unit paver indicated and the following:

1. Joint materials involving color selection.
2. Exposed edge restraints involving color selection.

E. Samples for Verification: For full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints. Include Samples of the following:

1. Joint materials.
2. Exposed edge restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.
- C. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
 - 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified unit paving installer. Installer's field supervisor must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with both of the following designations:
 - 1. Residential Paver Technician Designation.
 - 2. Commercial Paver Technician Designation.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.
 - 1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquids in tightly closed containers protected from freezing.
- E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.8 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Bituminous Setting Bed:
 - 1. Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.
 - 2. Apply asphalt adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.
- C. Weather Limitations for Mortar and Grout:
 - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.
 - a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 BRICK PAVERS

Brick Pavers, Light-Traffic Paving Brick: ASTM C902, Class SX, Type I, Application PS. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

- 1. Products: Subject to compliance with requirements, Solid interlocking paving units

complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates. Product shall comply with all Americans with Disabilities Act architectural guidelines, and provided from the following manufacturer or approved equal.

- a. Pine Hall Pathway Full Range
 2. Thickness: As indicated by manufacturer
 3. Face Size and Shape: Rectangular – Campus Standard
 4. Chamfered edge – As indicated by manufacturer
 5. Pattern: Herringbone
 6. Color: Pine Hall Pathway Full Range
 7. Face Size: Campus Standard.
- B. Efflorescence: Brick to be rated "not effloresced" when tested according to ASTM C67.
- C. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

2.3 CURBS AND EDGE RESTRAINTS

- A. Steel Edge Restraints: Manufacturer's standard painted steel edging 1/4 inch thick by 5 inches high with loops pressed from or welded to face to receive stakes at 36 inches o.c. and steel stakes 15 inches long for each loop.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Border Concepts, Inc
 - b. J. D. Russell Company (The)
 - c. Sure-loc Edging Corporation.
 2. Color: As selected by Architect from manufacturer's full range.
 3. Regional Materials: Concrete curbs shall be manufactured within 500 miles of Project site.
 4. Regional Materials: Concrete curbs shall be manufactured within 100 miles of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.
 5. Indigenous Materials: Concrete curbs shall be manufactured within 500 miles of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.
 6. Regional Materials: Concrete curbs shall be manufactured within 500 miles of Project site

from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

7. Color and Texture: Campus Standard.

2.4 ACCESSORIES

- A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.
- B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.5 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D448 for Size No. 57 ASTM D2940/D2940M, subbase material requirements in Section 312000 "Earth Moving" for subbase material.
- B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- C. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D448 for Size No. 10.
- D. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
 1. Provide sand of color needed to produce required joint color.
- E. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2, AASHTO M 288.
 2. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
 3. Permittivity: 0.02 per second, minimum; ASTM D4491.
 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.
- F. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 1. Survivability: Class 2, AASHTO M 288.
 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
 3. Permittivity: 0.5 per second, minimum; ASTM D4491.
 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.
- G. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.6 BITUMINOUS SETTING-BED MATERIALS

- A. Primer for Base: ASTM D2028/D2028M, cutback asphalt, grade as recommended by unit paver manufacturer.
- B. Fine Aggregate for Setting Bed: ASTM D1073, No. 2 or No. 3.
- C. Asphalt Cement: ASTM D3381/D3381M, Viscosity Grade AC-10 or Grade AC-20.
- D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.
- E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
 - 1. Provide sand of color needed to produce required joint color.
- F. Water: Potable.
- G. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062 inch in diameter; comply with ASTM A1064/A1064M except for minimum wire size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
- C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
 - 1. For concrete pavers, a block splitter may be used.
- D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
- E. Joint Pattern: As indicated.
- F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
 - 1. Provide joint filler at waterproofing that is turned up on vertical surfaces unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
- G. Tolerances:
 - 1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
- H. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
 - 1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
 - 2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.

3.4 AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D698 laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.

- D. Place aggregate subbase and base, compact by tamping with plate vibrator, and screed to depth indicated.
- E. Place aggregate subbase and base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.
- F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.
- G. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- H. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- I. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
 - 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
- J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
 - 1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
 - 2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
 - 3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
 - 4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- L. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- M. Repeat joint-filling process 30 days later.

3.5 BITUMINOUS SETTING-BED APPLICATIONS

- A. Apply primer to concrete slab or binder course immediately before placing setting bed.
- B. Prepare for setting-bed placement by locating 3/4-inch-deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

- C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F. Strike setting bed smooth, firm, even, and not less than 3/4 inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.
 - 1. Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F.
- D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.
- E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.
- F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.6 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.
- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately 1/2 inch.
- E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- G. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

- H. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch-thick bond coat to mortar bed or to back of each paver with a flat trowel.
- I. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
- J. Spaced Joint Widths: Provide hand tight joints. Match Campus Standard.
- K. Grouted Joints: Grout paver joints complying with ANSI A108.10.
- L. Grout joints as soon as possible after initial set of setting bed.
 - 1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
 - 2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
 - 3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
 - 4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
- M. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.7 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
 - 1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
 - 2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 32 14 00

SECTION 32 14 43 - POROUS UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid concrete pavers with openings between pavers filled with aggregate.
 - 2. Crushed stone bedding material.
 - 3. Open-graded subbase aggregate and base aggregate.
 - 4. Aggregate setting bed for pavers.
 - 5. Bedding and joint/opening filler materials.
 - 6. Edge restraints.
- B. Related Requirements:
 - 1. Section 01 23 00 Alternates.
 - 2. Division 31 Section "Earth Moving" for excavation and compacted subgrade.
 - 3. Division 03 Section "Cast in Place Concrete" for cast-in-place concrete curbs that serve as edge restraints for porous paving.
 - 4. Division 33 Section "Storm Utility Drainage Piping" for sub surface drainage.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site or as directed by Owner.

1.4 ACTION SUBMITTALS

- A. Product Data: For materials other than aggregates.
- B. Product Data: For the following:
 - 1. Pavers.
 - 2. Edge restraints.
 - 3. Geotextiles.
- C. Product Data: Buy America Requirements dated March 7, 2013
- D. Sustainable Design Requirements: Refer to LEED Division 1 Specifications.
- E. Sieve Analyses: For aggregate materials, according to ASTM C 136.
- F. Samples:

1. Full-size units of each type of unit paver indicated.
2. Exposed edge restraints.
3. Aggregate fill.
4. Aggregate setting bed materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.

1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Final Acceptance.
 3. Mock-Ups:
 - a. Install a 10 ft x 10 ft paver area.
 - b. Use this area to determine surcharge of the bedding layer, joint sizes, lines, laying pattern, color and texture of the job.
 - c. Subject to acceptance by owner, mock-up may be retained as part of finished work.
 - d. If mock-up is not retained, remove and properly dispose of mock-up.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. Store materials in a protected area such that they are kept free from mud, dirt, and other foreign materials.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install in rain or snow.
- B. Do not install frozen materials.

1.9 MAINTENANCE

- A. Provide 5% additional material for use by owner for maintenance and repair.
- B. Pavers shall be from the same production run as installed materials.

PART 2 - PRODUCTS

2.1 UNIT PAVERS

- A. Source Limitations: Obtain each type of paver from single source that has resources to provide materials and products of consistent quality in appearance and physical properties.
- B. Solid Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested according to ASTM C 67.
 - 1. Products: Subject to compliance with requirements, Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates. Product shall comply with all Americans with Disabilities Act architectural guidelines, and provided from the following manufacturer or approved equal.
 - a. Pine Hall Stormpave
 - 2. Thickness: As indicated by manufacturer.
 - 3. Face Size and Shape: Rectangular – Campus Standard
 - 4. Spacer bars: provided on each side of paver for uniform spacing.
 - 5. Chamfered edge – As indicated by manufacturer.
 - 6. Pattern: Herringbone
 - 7. Color: Finish A – Full Range, Finish B – Cocoa; Refer to plans for locations.

ACCESSORIES

- C. Refer to Concrete Paving Section 321313 for Cast In Place Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 4000 psi and water absorption not more than 5 percent, in shapes and sizes indicated.

2.2 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 2.
- B. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57.
- C. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- D. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
 2. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
 3. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- E. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:
1. Survivability: Class 2; AASHTO M 288.
 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 FILL MATERIALS

- A. Graded Aggregate for Porous Paving Fill: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 or No. 9.
1. Color: Match Architect's sample.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for porous paving.

3.2 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Tolerances:
1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch unit-to-unit offset from flush.
 2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches and 1/4 inch in 10 feet or a maximum of 1/2 inch.
- E. Provide curbs as indicated. Install curbs before placing unit pavers.

1. Install cast in place concrete curbs on a bedding of compacted base-course material over compacted subgrade. Install curbs before placing base course for pavers. Set curbs at elevations indicated, accurately aligned, and place and compact base-course material behind curbs as indicated.
2. Install concrete curbs on aggregate base course after placing and compacting base course for pavers. Set curbs with top edge 1 inch below top of pavers. Anchor curbs with metal stakes driven through holes in curbs into base-course material.
3. Install concrete curbs on aggregate-base course after placing and compacting base course for pavers. Set curbs with top surface $\frac{1}{4}$ " maximum above top of pavers. Anchor curbs with metal stakes driven behind curbs into base-course material.

3.3 SETTING-BED INSTALLATION

- A. Compact soil subgrade uniformly to 98 percent of ASTM D 1557 laboratory density.
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.
- D. Place aggregate subbase and base, compact by tamping with plate vibrator, and screed to depth indicated.
- E. Place aggregate subbase and base, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.
- F. Place drainage geotextile over compacted subbase, overlapping ends and edges at least 12 inches.
- G. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.
- H. Place leveling course and screed to a thickness of 1-1/2 – 2 inches, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

3.4 PAVER INSTALLATION

- A. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- minimum and 1/8-inch- maximum joint width. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size pavers.
 1. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
- B. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
 2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
 3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
 4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- C. After filling pavers with soil, sow seed to comply with requirements in Division 32 Section "Turf and Grasses," except sow seed at half the rate specified for seeding lawns. Sweep seed from surfaces of pavers into voids and water with fine spray.
1. Within 24 hours after sowing seed, spread an additional 3/16 inch of soil fill over seed and soak with water.
- D. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
1. Before ending each day's work, place aggregate fill in installed porous paving except for 42-inch width of unfilled paving adjacent to temporary edges (laying faces).
 2. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within 42 inches of laying face.
 3. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
- E. As work progresses, remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 32 14 43

SECTION 32 84 00 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

- 1. 22113 – Facility Water Distribution Piping

1.2 SUMMARY

- A. The Drawings and Specifications herein apply to the Point of Connection and down stream.

- B. Section Includes:

- 1. Piping.
 - 2. Encasement for piping.
 - 3. Manual valves.
 - 4. Pressure-reducing valves.
 - 5. Automatic control valves.
 - 6. Automatic drain valves.
 - 7. Transition fittings.
 - 8. Dielectric fittings.
 - 9. Miscellaneous piping specialties.
 - 10. Quick couplers.
 - 11. Sprinklers
 - 12. Drip irrigation specialties.
 - 13. Controllers.
 - 14. Boxes for automatic control valves.
 - 15. Decoder modules – support for two wire system.

DEFINITIONS

- C. Irrigation Supply: Upstream of the Point of Connection, the irrigation supply includes the back flow preventer, the meter, feeds and taps.
- D. Point of Connection: Defined as the below ground discharge from the backflow preventer.
- E. Irrigation System: Defined as components of the system that are located immediately down stream of the point of connection. See Engineering drawings and specifications for upstream portions of the system
- F. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.
- G. System Main Feed – The piping and fittings required to move water from the Point of Connection to 5' beyond the Main Isolation Valve

- H. Main Isolation Valve – A master valve capable of shutting off the entire system before the system main splits - as located on the plan.
- I. Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.
- J. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 PERFORMANCE REQUIREMENTS

- A. This Section describes work down stream of the Irrigation Supply (backflow device). See Division 22 Section "Facility Water Distribution Piping" for taps, meter, and backflow device.
 - 1. Follow NC General Statute 143-355.4 for separate meters and taps for irrigation systems.
- B. The design must meet the following design guidelines:
 - 1. Requirements supplied by the Town of Morrisville;
- C. Irrigation zone control shall be automatic operation with controller and automatic control valves.
- D. System must be a two-wire system with sufficient grounding installed per manufacturer recommendations. Decoder modules for two-wire system must be installed according to manufacturer requirements.
- E. High rate delivery systems such as flood bubblers are not allowed.
- F. Provide only high efficiency equipment capable of providing water accurately and efficiently. The system shall use drip irrigation for plants and spray for turf.
- G. Provide an irrigation system that completely separates lawn irrigation from shrub irrigation. Maintain 100 percent head to head coverage of areas indicated.
- H. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and lights.
- I. No valves, fittings, or joints are to be placed under paved surfaces, curbs or sidewalks. Where possible, crossing shall be uninterrupted stretches of pipe within sleeves sized according to the drawings.
- J. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
 - 1. Irrigation System Feed: 400 psig.
 - 2. Irrigation Main Piping and Circuit Piping: 200 psig.
- K. The following are soil conditions found at the site:
 - a. Structure: The soil structure of the site is compacted due to working and construction activity. This compaction will reduce standard infiltration rates.
 - b. Infiltration Rate:
 - 1) Clay: .2-.3 in/hr.

- L. Drip Emitters Per Plant – use the following guide to set the number of emitters per plant, based upon a 2 hour watering window [WW] and delivering matched water delivery per zone.

TABLE 1 – DRIP SYSTEM PERFORMANCE REQUIREMENTS

Type of plant	Plant Size at installation	Gal. Per week [X]	Gal/ WW	Minimum # emitters per plant	# emitters per plant at 1.5 gph	# emitters per plant at 2.0 gph	# emitters per plant at 2.5 gph	# emitters per plant at 3.0 gph	# emitters per plant at 3.5 gph
Tree	5-7" caliper tree	100	7.1	6	14	7	5	4	2
	2.5" to 4" caliper	60	4.3	4	9	4	3	2	1
Shrub	8-10' BB shrub	40	2.9	4	6	3	2	1	1
	5-7' BB shrub	20	1.4	3	3	2	1	1	N/A
	3-6' container shrub	10	0.7	2	2	2	N/A	N/A	N/A
	8" – 30" shrub or groundcover	7	0.5	1	1	1	N/A	N/A	N/A
Grasses and Perennials	Quart size plant	5	0.4	1	1	N/A	N/A	N/A	N/A
Plugs	4" pot and less	3		Grid of drip. See below					
- Minimum emitters per plant equals what is required to fully wet the root ball perimeter, not just one side - Emitters should be placed 4-6" inside the root ball - N/A – less than one emitter which is not possible - Grid of drip should be the same rate as the plant spacing - The Contractor shall use this table as a guide. Provide refinement of the system for different plant types and VARYING soil conditions.									

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Equipment Numbering System
- C. Use a coordinated numbering system for shop drawings, as-builts and field labeling as follows:

1. Turf Valve – Use 1-50
2. Drip Valves – Use 51-99
3. Valves, Pressure Regulators & Other Equipment - Use 100 and above

D. Delegated-Design Submittal [Shop Drawings]: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional designer responsible for their preparation. Submittal should include irrigation systems, drawn to scale in a CAD software (contact the Landscape Architect for CAD backgrounds), showing the following:

1. Main piping
2. Circuit piping
3. Stream and Spray Rotors – with graphic indicated
4. Automatic control valves
5. Point of Connection location
6. Time clock and rain sensor location
7. Blow-off valves, isolation valves, quick coupler connections,
8. Numbered valves with GPM calculated for each
9. Coordination with site elements and utilities.
10. Required Pressure at Point of Connection – The irrigation designer shall state the pressure required of irrigation system in PSI.
11. System Pressure Loss – The designer shall state the calculated pressure loss from the Point of Connection to the furthest automated valve in PSI on the drawing.
12. Flow sensor locations.
13. Field satellite locations (as required for Toro Sentinel system).
14. Decoder module locations (for two-wire systems).

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. System Manual: A hard cover, 3 ring bound, exterior project titled, with table of contents for sprinklers, controllers, pumps, quick couplers, rain sensors, and automatic control valves to include the following:
 1. Product cut sheets designating exact model number(s)
 2. Written schedule of operation including a winterization date, start up date, and controller timing schedule suggestions for spring, summer, and fall.
 3. Operation and Maintenance information of the provided equipment including a schedule of routine maintenance for cleaning and adjusting equipment.
 4. Reduced as-built plans with color and numeric coding for zone separation bound within the manual or in plastic sleeves.
 5. Reduced as-built zone diagram with color and numeric coding for zone separation, to be housed within interior of controller box (or locations as requested by the Owner) and provided within closeout manual to Owner.
 - 6.

- B. Prepare an as-built CAD drawing of the installed system. The drawings shall be legible with no overlapping or hidden graphics. Provide enlargements of crowded or obscured areas. Take field measurements and indicate on the drawings the dimensions of key elements from known site points such as the buildings and roadways to showing installed conditions of the following equipment:
1. Irrigation heads.
 2. Main lines and lateral lines
 3. Automatic valves, manual valves, blow-offs and quick couplers
 4. Tap, meter, backflow, time clock and rain sensor
 5. Circuit and sensor wires
 6. Valve numbers corresponding to the time clock labeling, zone designation, and GPM for each zone.
- C. Provide the following equipment to the Owner at time of closeout:
1. Provide minimum of 1 remote controller for Owner to remote operate the system.
 2. Provide minimum of 3 keys necessary for head adjustments.

1.7 MATERIALS MAINTENANCE SUBMITTALS [ATTIC STOCK]

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Stream Rotors: Equal to 5% percent of amount installed for each type and size indicated; but no fewer than 5 units with filters and a selection of matching nozzles.
 2. Spray Sprinklers: Equal to 5% percent of amount installed for each type and size indicated; but no fewer than 5 units with filters and a selection of matching nozzles.
 3. Drip-Tube System Tubing: Equal to 2% percent of total length installed for each type and size indicated, but not less than 100 feet.
 4. Drip emitters – provide 10 of each type.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Must be a licensed irrigation contractor in the State of North Carolina according to NC Irrigation Licensing Board.
- 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.10 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
1. Notify Architect and Owner no fewer than two days, or longer advance notice if required by the advance of proposed interruption of water service.
 2. Do not proceed with interruption of water service without Owner's written permission.
 3. Do not proceed with irrigation work until rough grade approval is given by the Landscape Architect.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes. Supply components having pressure rating equal to or greater than system operating pressure.
- B. Underground irrigation System Main Feed shall be the following:
1. Schedule 80, PVC socket fittings; and solvent-cemented joints.
- C. Underground irrigation Main Piping shall be the following:
1. SDR 200, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.
- D. Circuit piping shall be the following:
1. SDR 200, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.
- E. Risers to Aboveground drip lines: Schedule 80, PVC pipe and socket fittings; and solvent-cemented joints.

2.2 PIPING JOINING MATERIALS

- A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656. Use a color tinted material.

2.3 MANUAL VALVES

- A. Plastic Ball Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Valve, Inc.
 - b. Asahi/America, Inc.
 - c. Colonial Engineering, Inc.
 - d. Fischer, George Inc.
 - e. Hayward Flow Control Systems; Hayward Industrial Products, Inc.

- f. IPEX Inc.
- g. Jomar International, LTD.
- h. KBI (King Bros. Industries).
- i. Legend Valve.
- j. NIBCO INC.
- k. Sloane, George Fischer, Inc.
- l. Spears Manufacturing Company.
- m. Thermoplastic Valves Inc.
- n. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-122.
- b. Pressure Rating: 200 psig.
- c. Body Material: PVC.
- d. Type: Union.
- e. End Connections: Socket or threaded.
- f. Port: Full.

2.4 PRESSURE-REDUCING VALVES

A. Water Pressure Regulators:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cash Acme; a division of The Reliance Worldwide Corporation.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Honeywell International Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group; Wilkins Water Control Products.
- 2. Description:
 - a. Standard: ASSE 1003.
 - b. Body Material: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved.
 - c. Pressure Rating: Initial pressure of 150 psig.
 - d. End Connections: Threaded for NPS 2 and smaller.

2.5 AUTOMATIC CONTROL VALVES

A. High Flow Drip Control Valves:

- 1. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid. For flow ranges from 5 to 100 gpm.
- 2. Manufacturers: Provide products by the following:
 - a. Toro Company (The); Irrigation Division or equal.

B. Low Flow Drip Control Valves:

1. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid. For flow ranges below 5 gpm.
2. Manufacturers: Provide Products by the following:
 - a. Toro Company (The); Irrigation Division or equal.

2.6 DECODER MODULE

A. TDC Decoder Module:

1. Description: Molded-plastic body, with integrated power surge protection.
2. Manufacturers: Provide products by the following:
 - a. Toro Company (The); Irrigation Division or equal.
 - 1) Compatible with Sentinel system and controller.

2.7 AUTOMATIC DRAIN VALVES

- A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig.

2.8 TRANSITION FITTINGS

- A. General Requirements: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

B. Transition Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; DMD Division.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Smith-Blair, Inc; a Sensus company.
 - f. Viking Johnson.
2. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

C. Metal to Plastic Transition Fittings at Point of Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Harvel Plastics, Inc.
 - b. Spears Manufacturing Company.

2. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-socket or threaded end.

2.9 MISCELLANEOUS PIPING SPECIALTIES

- A. Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.
- B. Pressure Gages: ASME B40.1. Include 4-1/2-inch- diameter dial, dial range of two times system operating pressure, and bottom outlet.
- C. Detectable Warning Tape: Provide detectable warning tape with "IRRIGATION LINE" clearly marked and a unique color.

2.10 SPRINKLERS

- A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.
- B. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:
 1. Manufacturers: Provide products by the following:
 - a. Toro Company (The); Irrigation Division or equal.
 2. Description:
 - a. Body Material: ABS.
 - b. Nozzle: ABS.
 - c. Retraction Spring: Stainless steel.
 - d. Internal Parts: Corrosion resistant.
 3. Capacities and Characteristics:
 - a. Flow: see plan – fit with nozzles to provide matched precipitation.
 - b. Pop-up Height: 4" aboveground to nozzle.
 - c. Spray Shapes: radial - full, three quarter, half, one quarter or adjustable], rectangle, strips.
 - d. Radius: see plan
 - e. Inlet: NPS 1/2.
- C. Plastic, Pop-up Spray Sprinklers:
 1. Manufacturers: Provide products by the following:
 - a. Toro Company (The); Irrigation Division or equal.
 2. Description:
 - a. Body Material: ABS.
 - b. Nozzle: ABS.
 - c. Retraction Spring: Stainless steel.

- d. Internal Parts: Corrosion resistant.
- e. Pattern: Fixed, with flow adjustment.

3. Capacities and Characteristics:

- a. Nozzle: ABS.
- b. Flow: See plan
- c. Pop-up Height: minimum 6" for lawns.
- d. Arc: [full, three quarter, half, one quarter or adjustable], rectangle, strips.
- e. Radius: see plan
- f. Inlet: NPS 1/2.

2.11 QUICK COUPLERS

A. Manufacturers: Provide products by the following:

- 1. Toro Company (The); Irrigation Division or equal.

B. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap;

C. Key – Provide factory-fabricated brass one piece swiveling connector with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet. Provide one key per installed quick coupler with a minimum number of two.

2.12 RAIN SENSOR

A. Manufacturers: Provide products by the following:

- 1. Toro Company (The); Irrigation Division or equal.

B. Description: UL listed, UV stabilized plastic housing rain sensor with the following properties:

- 1. Hardwire installation
- 2. 2-5 minute time duration to system shut down
- 3. Time to reset should be less than 4 hours
- 4. Operating temperature range 32 – 130 degrees
- 5. 24 volt, 3amp
- 6. Matched to controller station
- 7. Selectable rain shut off indexes at 1/8", 1/4", 1/2", 3/4" of rainfall

2.13 DRIP IRRIGATION SPECIALTIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1. Toro Company (The); Irrigation Division.

B. On-line [on pipe] Emitter Systems:

1. Tubing: Black PE tubing UV resistant.
2. Emitter: Attached to pipe drip device.
 - a. Body Material: UV Resistant PE or Vinyl
 - b. Design Flow: .5 to 2.0 gph.
 - c. Pressure compensating from 7-50 psi
 - d. Minimum operation pressure if 15 psi
 - e. Minimum filtration 120 mesh
 - f. Self flushing design
 - g. Includes an internal low pressure 1.5 psi check valve
- C. Application Pressure Regulators: Brass or plastic housing, NPS 3/4 , with corrosion-resistant internal parts; capable of controlling outlet pressure to approximately 20 psig .
- D. Filter Units: Plastic housing with corrosion-resistant internal parts; of size and capacity required for devices downstream from unit.
 1. Provide screening to 120 mesh size.
 2. Minimum size 3/4"
 3. Flow Range 1-12 gpm
 4. maximum pressure 140 psi
 5. Polyamide staking ring type filter
- E. Air Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.
- F. Vacuum Relief Valves: Brass or plastic housing, with corrosion-resistant internal parts.

2.14 CONTROLLERS

- A. Manufacturers:, Provide controller unit by the following:
 1. Toro Company (The); Irrigation Division.
- B. Basis of Design:
 1. Manufacturer: Toro Company (The)
 2. Model/ System Compatibility: Sentinel Global System
 3. Field Satellites: Compatible with Sentinel Global System
- C. Description:
 1. General: Controllers/ field satellites/ systems must provide the following features:
 - a. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily
 - b. A minimum of programming three fully independent programs with four start times per program.
 - c. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation
 - d. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 120 minutes. Include switch for manual or automatic operation of each station
 - e. Quantity of stations equal to the zones required plus 4 empty zones as a minimum.
 - f. Rain Sensor: Adjustable from one to seven days, to shut off water flow during rain
 - g. Non-volatile memory for holding programs during power outages
 - h. Power Requirements: 120 volt input, 24 VAC output
 - i. Control Transformer: 24-V secondary, with primary fuse

- j. Surge Protection: Metal-oxide-varistor type on each station and primary power
 - k. With a cistern, pump start capability
 - l. Hand held remote included with system
 - m. Lockable cabinet with two matching keys.
 - n. Communication: Ethernet or Wireless to match existing Campus system.
 - o. Compatible with a two-wire system.
2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof and provision for grounding.
- a. Body Material: Enameled-steel sheet metal or Stainless-steel sheet metal
 - b. Mounting: Freestanding type for concrete base.
3. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
- a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
 - b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
 - c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.
4. Concrete Base: Reinforced precast concrete not less than [36 by 24 by 4] inches thick. Include opening for wiring.

2.15 BOXES FOR AUTOMATIC CONTROL VALVES

A. Plastic Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Nationwide Plastics, Inc.
 - d. NewBasis.
 - e. Oldcastle, Inc.
 - f. Orbit Irrigation Products, Inc.
 - g. USFilter/Plymouth Products, Inc.
2. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
- a. Size: As required for valves and service.
 - b. Shape: Round and rectangular
 - c. Sidewall Material: Structural foam plastic.
 - d. Cover Material: Structural foam plastic
 - e. UV resistant
 - f. Stainless steel screw lock
 - g. Color: black.

- B. Drainage Backfill: #57 stone.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."
- B. Install detectable warning tape directly above Main Line piping only at 12" below finished grade.
- C. Provide minimum cover over top of underground piping according to the following:
1. System Main Feed: Minimum depth of 30 inches below finished grade.
 2. Main Line Piping: Minimum depth of 18 inches below finished grade
 3. Circuit Piping: Minimum of 12 inches below finished grade
 4. Sleeves: 24 inches or 12" below finished grade or pavement gravel sub-bases, whichever is deeper
 - a. Extend sleeves 30" beyond edge of pavement.

3.2 PREPARATION

- A. Carefully mark out the extent of lawn versus planting beds to avoid spray overlap. Spray irrigation of areas other than lawns is not allowed.
- B. Confirm that the rough grades have been established prior to topsoil spreading.
- C. Examine the site compared to the system design and notify the Architect of changes.
 1. Submit design changes to the Architect if revisions to the design are warranted
- D. Verify existence of required sleeving.
- E. Store pipe and fitting for project in an area that will not introduce dirt and debris into the interior.

3.3 PIPING INSTALLATION

- A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
- B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.
- C. Install piping free of sags and bends.
- D. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- E. Install fittings for changes in direction and branch connections.
- F. Install unions adjacent to valves and to final connections to other components with NPS 2 or smaller pipe connection.
- G. Install expansion loops in control-valve boxes for plastic piping.

- H. Lay piping on solid subbase, uniformly sloped without humps or depressions.
- I. Install PVC piping in dry weather when temperature is above 40 deg F. Allow joints to cure at least 24 hours at temperatures above 40 deg F before testing.
- J. Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install below ground in control-valve boxes.
- K. Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.
- L. Install sleeves made of Schedule 80 PVC pipe and socket fittings, and solvent-cemented joints. Extend 30" beyond pavement or curb edges.
- M. Install piping in sleeves under parking lots, roadways, and sidewalks. Avoid fittings within sleeves.
- N. Install transition fittings for plastic-to-metal pipe connections according to the following:
 - 1. Underground Piping:
 - a. NPS 1-1/2 and Smaller: Plastic-to-metal transition fittings.
 - b. NPS 2 and Larger: AWWA transition couplings.

3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.
- E. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.5 VALVE INSTALLATION

- A. Isolation valves: Install isolation valves with handles oriented to surface.
- B. Pressure-Reducing Valves: Install in boxes for automatic control valves. Install full-size valved bypass.
- C. Automatic Control Valves: install according to manufacturer's recommendations with manual adjustment handles oriented to the surface.
- D. Drain Valves: Install in underground piping in boxes for automatic control valves.

3.6 DECODER MODULE (TWO-WIRE SYSTEM) INSTALLATION

- A. Decoder Modules: Install according to manufacturer's recommendations in boxes for underground control valves.

3.7 SPRINKLER INSTALLATION

- A. Install sprinklers after hydrostatic test is completed.
- B. Install sprinklers in final grades at manufacturer's recommended heights.
- C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches from walls and 2 inches from other boundaries such as curbs and walks unless otherwise indicated.

3.8 QUICK COUPLER INSTALLATION

- A. Install quick coupler as per manufacturers' recommendations at a height below mower damage level.
- B. Install approximately 6" by 6" by 6" concrete collar underground, covered by 1" of soil.
- C. Paint exposed plastic parts black.

3.9 RAIN SENSOR INSTALLATION

- A. Hardwire connection from time clock to sensor.
- B. Place in an open area with no overhang as approved by the landscape architect or as shown on the plan.
- C. Installation should be neat with organized wiring.

3.10 DRIP IRRIGATION SPECIALTY INSTALLATION

- A. Install area connection tubes with 3" of cover and with galvanized stakes as needed.
 - 1. For each zone provide loop back to within 10' of the first emitter.

- B. Install the number of drip emitter per plant according to TABLE 1 – DRIP SYSTEM PERFORMANCE REQUIREMENTS
- C. For Trees, large shrubs, use drip line with internal emitters on “T” loops from main line.
- D. For container shrubs choose drip line with internal emitters for regularly spaced shrubs and drip line with external emitter for irregularly spaced shrubs.
- E. For mass plantings of small containers or plugs, use a grid of drip tube with internal emitters.
- F. Install drip tubes as follows:
 - 1. Install on ground. Stake with galvanized stakes as needed to maintain contact.
 - 2. Drip tubing should be placed on the root ball, 3” from the edge and exposed.
 - 3. External emitters should be exposed to view.
 - 4. For container shrubs place beneath the mulch on the root ball.
 - 5. For grid layout, use a matching spacing to the planting.
- G. Install application pressure regulators and filter units in piping near zone valves below ground in boxes. Orient the regulators to assist with maintenance.

3.11 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

- A. Equipment Mounting: Install exterior freestanding controllers on precast concrete bases.
 - 1. Place and secure anchorage devices. Use 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.
- B. Install control cable in same trench as irrigation piping and at least 2 inches beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas. Install warning tape during backfill operation.

3.12 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.
- C. Connect wiring between controllers and automatic control valves.

3.13 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Equipment Nameplates and Signs: Brand each valve box where isolation valve, automatic control valves, pressure regulator valve, or filter is housed with a unique name that appears on the time clock and the as-built drawings.

1. Text: Minimum ½' letters branded into plastic valve box housing.
 - a. Turf Valves – Use 1-50
 - b. Drip Valves – Use 51-99
 - c. Valves, Pressure Regulators & Other Equipment - Use 100 and above
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Division 31 Section "Earth Moving" for warning tapes.

3.14 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. System Main Feed & Main Line Leak Test: After installation, charge system and test for leaks with a pressure indicator over a 24 hour period. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Test spray heads for too little or too much pressure. Make adjustments in the system, including installing pressure compensation devices or boosting overall system pressure to provide a functioning system.

B. Any irrigation system or product will be considered defective if it:

1. Does not pass tests and inspections.
2. Does not provide manufacturer's recommended pressures throughout the system
3. Does not provide complete separation of grass and planting areas [individual trees may be over sprayed]
4. Does not provide matched precipitation rates throughout the lawn
5. Does not provide drip system delivery target rates for plant types.
6. Sprays water onto pavements, buildings, or signage.
7. Does not provide for easy maintenance as follows:
 - a. Ball valves, filters, regulators are poorly oriented for hand access
 - b. Automatic Valves are poorly oriented for access
 - c. Irrigation equipment is installed at a grade that would encourage damage from mowers

C. Defective irrigation systems or components shall be repaired at no cost to the Owner.

3.15 FLUSH OUT CLEANING

- A. Flush dirt and debris from piping before installing sprinklers and other devices.
- B. Clean or replace all filters.

3.16 STARTUP SERVICE

- A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that controllers are installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal.

3.17 ADJUSTING

- A. Provide at least three programmed time schedules.
 - a. One is for immediate post planting where the system is run at high rates for a short duration.
 - b. Second is for a longer term establishment period, where distribution rates are reduced but still higher for plant establishment.
 - c. Third is a long term summer schedule distributing about 1" of precipitation to lawn areas per week and 70 gallons per week to shrubs.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
- C. Adjust sprinklers and devices so they will be flush with finish grade or as recommended by the manufacturer.
- D. Adjust drip system to provide gallons per week delivery targets by adding and subtracting emitters.

3.18 DEMONSTRATION

- A. Train Owner's maintenance personnel by providing the following instruction:
 1. Review the as-built materials with the owner
 2. Demonstrate how to program the clock.
 3. Demonstrate how to adjust heads
 4. Demonstrate how to clean filters and pressure regulation
 5. Review the site components of the system, identify valve boxes

END OF SECTION 32 84 00

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sodding.
 - 2. Grass paving.
- B. Related Sections:
 - 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
 - 3. Division 32 Section "Plants" for border edgings.
 - 4. Division 33 Section "Subdrainage" for subsurface drainage.

1.3 DEFINITIONS

- A. Final Acceptance: The proper installation of sod, and meadow with final grades, mulch and irrigation functioning (if provided) with no indication of widespread plant death. It is possible to grant Final Acceptance to portions of the site without total project completion however all construction activities must be completed in the requested area.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- D. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- E. Planting Soil: The prepared earth [existing or imported as specified herein] used to backfill lawn or sod areas.
- F. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

- H. Turf: A groundcover established from either lawn lawn type sod.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit at time of Final Acceptance.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of the Professional Landcare Network, the NC Landscape Contractors Association, or the American Nursery and Landscape Association.
 - 2. Experience: Three years' experience in turf installation in addition to requirements in Division 01 Section "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: All personnel who handle herbicides and herbicides shall be State licensed, for commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Test native in- place surface soil and soil components of Planting Soils Type A, B, C, and D. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. Test shall include mechanical analysis of sand, silt and clay components.
3. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
4. Soil tests shall include the following information:
 - a. Percentage of sand, silt and clay.
 - b. Cation exchange capacity.
 - c. Percent of organic matter.
 - d. Stated recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - e. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C. Bulk Materials:
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.8 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Final Acceptance.
Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

Grass Type:	Variety:	Dates:
Warm Season	Hybrid Tiftuf Bermuda	March - October

1.9 Construction Water: During the construction period, water will be provided by the Owner.

1.10 The Contractor shall supply watering labor as follows:

- a. The construction period until Final Acceptance for the last phase of work.
- b. Final Acceptance for the last phase of work through the maintenance period

1.11 Construction Maintenance Water: Water will be provided by the Owner.

- A. Initial Maintenance Service for Lawns (sod). Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after lawns are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
 1. Construction Maintenance Period: 12 months. The Maintenance Period will begin from the date of Final Acceptance for the last phase of work. Partial substantially completed areas will require continued maintenance until the completion date set by the final phase of work.
- B. Continuing Maintenance Proposal: Any agreement of an Owner with the Contractor for annual landscape services would begin after the maintenance period elapses.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

- A. Turfgrass Sod: Number 1 Quality/Premium, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Tall Fescue Sod

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 1. Provide lime in form of ground dolomitic limestone or calcitic limestone depending on soil test.

2.3 ORGANIC SOIL AMENDMENTS

- A. Soil Conditioner: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 70 percent of dry weight.
 2. Sources: Agricultural, bark, biosolids; municipal compost; or source-separated or compostable mixed solid waste.
 - a. Free of toxic materials to plant growth
 - b. Free of weed seeds.

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.5 PLANTING SOILS

- A. Planting Soil Type A-2: Imported sandy loam topsoil formed under natural conditions blended with organic matter. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
1. Depth of soil conditioner to mix in Planting Soil: 3/8" to 4".
 2. Weight of Slow-Release Fertilizer as per soil test
 3. Weight of dolomitic limestone as per soil test.
- B. Planting Soil Type E: Stalite Structural Soil mix for firelanes. Imported manufactured structural soil containing components of expanded slate and organic matter.
1. Ratio:
 - a. 5/16" Expanded Slate: 75%
 - b. USGA Root Zone Mix: 20%
 - c. Certified Compost*: 5%

*Percentages may vary to meet testing requirements.
Saturated Drained Weight: 66 pounds per Cubic Foot

2.6 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.7 GRASS-PAVING MATERIALS

- A. Grass Paving: Cellular, made from recycled plastic, non-biodegradable mats, designed to contain small areas of soil and allow an 80,000 lbs fire truck loading and general service traffic. Include manufacturer's recommended anchorage system for slope conditions.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Invisible Structures, Inc.; Grasspave2.
(<http://www.invisiblestructures.com/grasspave2.html>)
- B. Base Course: As indicated on drawings.
- C. Sand:
 - 1. 1.Coarse, well draining sand, such as washed concrete sand conforming to AASHTO M6 or ASTM C 33
 - 2. United States Golf Association (USGA) greens, section sand mix "The Root Zone Mixture".
- D. Proprietary Growing Mix: As required by manufacturer.
- E. Sandy Loam Soil Mix: Naturally occurring sandy loam topsoil containing 60% sand, 35% silt and 5% clay, 5% by volume organic matter and free of weed seed and deleterious materials to plant growth.
- F. Soil for Paving Fill: As indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance. Notify the Architect immediately and do not start landscape construction operations if:
 - 1. Grades or site features do not match the design.
 - 2. There is ponding or areas that do not appear to drain
 - 3. The subsoil contains foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

4. If the soils are frozen or moist beyond that required to produce optimal working conditions.
5. Excessively dry soil that is not workable and which is too dusty.
6. If the subsoil is over compacted.
7. If irrigation main and lateral lines have not been installed.
8. If irrigation main or lateral line trenches have not been compacted.

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

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect grade stakes set by others until directed to remove them.
 2. Protect areas that should not receive seed such as planting beds.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.

- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches.

1. General

- a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, trash, and other extraneous matter.
 - c. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
 - d. Reduce elevation of planting soil to allow for soil thickness of sod.
2. Spread planting soil to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 3. Thoroughly blend planting soil with organic amendments off-site before spreading
 4. Apply lime and fertilizers on surface, and thoroughly blend planting soil.

- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Note any areas on the plan that indicate tree root zones. These areas may require the use of hand tools.

- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR GRASS-PAVING MATERIALS

- A. Reduce subgrade elevation soil to allow for thickness of grass-paving system. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade so that installed paving is within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions, compact subgrade as specified in paving-material manufacturer's written instructions..
- B. Install base course and/or sand course as recommended by paving-material manufacturer for site conditions; comply with details shown on Drawings. Compact according to paving-material manufacturer's written instructions.
- C. Install paving mat and fasten according to paving-material manufacturer's written instructions.
- D. Before planting, fill cells of paving mat with soil mix indicated by manufacturer and compact according to manufacturer's written instructions.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across angle of slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 or in the bottom of swales with steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.6 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and

replant bare or eroded areas to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Repair turf as necessary because of settling, erosion or settlement or other processes.
 2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain irrigation systems, temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow turf-type tall fescue to a height of 3 inches.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.7 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.8 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.9 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Plants.
- 2. Planting soils.
- 3. Landscape edgings.

B. Related Sections:

- 1. Division 01 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
- 2. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
- 3. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
- 4. Division 32 Section "Turf and Grasses" for turf (lawn).
- 5. Division 33 Section "Subdrainage" for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

1.3 DEFINITIONS

- A. Final Acceptance: The proper installation of plant material with final grades, mulch and irrigation (if provided) functioning with no indication of widespread plant death. With no indication of widespread plant death, no evidence of plant disease or pests, and no further heavy construction machinery is scheduled to move through the landscaped area, it is possible to grant Final Acceptance to portions of the site without total project completion. However all construction activities must be completed in the requested area.
- B. Backfill: The planting soil used to replace or the act of replacing earth in an excavation.
- C. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during

shipping and be sized according to ANSI Z60.1 for type and size of plant required. Container grown stock should be free of girdling or circling roots.

- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Area: Areas to be planted.
- H. Planting Soil: The prepared earth [existing or imported as specified herein] used to backfill planting areas or to create planting beds.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) or main roots of trees below the soil surface.
- L. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- M. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- N. Environmental Conditions: Physical, chemical, and biotic factors affecting ecological community and ability for plants to survive.
- O. Detrimental Conditions: Environmental conditions harmful to the health of proposed plants that can be corrected through supplemental site improvements. Harmful conditions include, but shall not be limited to the following: poor soil, poor drainage, or contaminated soil.

1.4 ACTION SUBMITTALS

- A. Samples for Verification: For each of the following:
 - 1. Mulch: A 1-quart volume of each mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
 - 2. Mineral Mulch: 1 quart volume of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.
 - 3. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
 - 4. Tree Grates, Frames, and Accessories: Manufacturer's standard cut sheets and model numbers

- B. Soil Analysis: For each un-amended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Test native in place surface soil [and soil components of Planting Soils Type A, B, and C, ~~and D~~.
 2. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 3. Test shall include mechanical analysis of sand, silt and clay components.
 4. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 5. Soil tests shall include the following information:
 - a. Percentage of sand, silt and clay.
 - b. Cation exchange capacity.
 - c. Percent of organic matter.
 - d. Stated recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - e. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
 - f. Provide post construction compaction evaluation for areas where trees are planted. Compaction testing shall be performed to a depth that reveals soils with the appropriate compaction levels for plant success. Testing methods shall include ASTM D-698-80, AASHTO T-99.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Substitutions: The Contractor shall provide the products specified. Changes must be made by written submittal with reason and alternate suggestion.
- C. Environmental Conditions: Prior to contract acceptance by Contractor, submit written description of environmental conditions preventing compliance with warranty.
1. As applicable, submit detrimental conditions and/or substitutions submittals.
- D. Detrimental Conditions: Per encounter, submit written description of detrimental conditions with recommendation for correcting condition. Include cost estimate.

1.6 QUALITY ASSURANCE

- A. **Installer Qualifications:** A qualified landscape Installer whose work has resulted in successful establishment of plants.
1. **Professional Membership:** Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. **Experience:** Five years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
 3. **Installer's Field Supervision:** Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 4. **Personnel Certifications:** Installer's field supervisor shall have certification in one of the following categories from the following:
 - a. Professional Landcare Network Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
 - b. Or Certified Ornamental Landscape Professional, designated COLP.
 - c. Or actively certified by the North Carolina Landscape Contractors Association
 - d. Four year degree in horticulture, landscape architecture or agronomy
 5. **Selection of plants purchased under allowances** will be made by Architect, who will tag plants at their place of growth before they are prepared for transplanting.
- B. **Measurements:** Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
1. **Trees and Shrubs:** Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
 2. **Other Plants:** Measure with stems, petioles, and foliage in their normal position.
- C. **Plant Pre-Approvals:** Utilize the following methods for plant selection.
1. **Container Plant Photographs:** Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
 2. **Select Plant Tagging:** The Architect will accompany the Contractor for a scheduled trip to nurseries to tag large shrubs and trees as required by the Architect.
 - a. The Architect shall notify the Contractor of the plants requiring tagging.
 - b. The Contractor will pre-tag plant materials and submit photos prior to nursery tagging to confirm the nursery has acceptable material for consideration.
 - c. The Contractor shall provide the cost of travel, meals and accommodations for the trip. He shall provide 3 weeks notice of the trip to the Architect.
 - d. The Architect will provide the time free of charge to the Contractor.
- D. **Additional Plant Material Observation:** Architect may observe plant material either at site before planting or once installed for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected

trees or shrubs immediately from Project site. Rejected materials shall be replaced at no cost to the owner.

- E. Substitutions: Substitutions will be permitted only upon submission of proof that a specified plant is not obtainable and with written approval of proposed substitution by Landscape Architect.
 - 1. Contractor shall propose the use of the nearest obtainable variety of the plant having the same essential characteristics that is equal to or greater in size to original specified plant.
- F. Detrimental Conditions: The contractor shall notify the Owner and Landscape Architect in writing of all conditions considered detrimental to growth of plant material. State condition and submit proposal including costs for correcting condition.
- G. Preinstallation Conference: Conduct conference at Project site.
 - 1. The following individuals must be present:
 - a. GC Contractor's site representative responsible for the Landscape Contractor's work
 - b. The Landscape Contractor's branch manager [or Owner] and job estimator.
 - c. The Project supervisor who will be directly responsible for field work and/or paperwork.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. All storage of materials must comply with all applicable federal, state, and local laws. All materials shall be stored in a designated space for material storage. No stored materials should show evidence of leakage, or accidental movement out of the immediate location of storage. Once used, any access materials shall be promptly returned to designated areas.
- B. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacture
- C. r, and indication of conformance with state and federal laws if applicable.
- D. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates. Provide a copy of all certificates shall be provided to the owners representative.
- E. Do not prune trees and shrubs before delivery.
- F. Protect bark, branches, and root systems from sunscald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

- G. Handle planting stock by root ball or container.
- H. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
- I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist. Plants shall be marked with a white dot on the trunk to show the north orientation in the field.
- J. If plants are stored for over 24 hours provide the following:
 - 1. Set balled stock upright on ground and cover ball with soil, peat moss, sawdust, or other acceptable material to prevent wind, cold, or heat damage to the roots.
 - 2. Provide shade to shade requiring trees and shrubs.
 - 3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work. Verify compaction of soils prior to proceeding with planting work.
- B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
 - 1. Notify Owner and Architect no fewer than two days in advance of proposed interruption of each service or utility.
 - 2. Do not proceed with interruption of services or utilities without Architect's written permission.
- C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Final Acceptance.
 - 1. Spring Planting: Feb 1 to May15
 - 2. Fall Planting: Sept. 1 to Dec. 24.
 - 3. Tree Planting: October 1 to April 1.
- D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements. Do not plant when soil conditions are such that the movement of machinery will cause detrimental compaction or other detrimental conditions.
- E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated or acceptable to Landscape Architect.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

- F. Under no circumstances should work proceed prior to establishment of appropriate grades.
- G. The Owner shall provide water for:
 - 1. The construction period until final acceptance. Contractor shall maintain the temporary water system and provide watering labor until the project is accepted by Architect and Owner.
- H. Unusual Field Conditions: It is the Contractor's responsibility to communicate to the Architect unusual field conditions found at the project site before and during construction. The presence of unusual field conditions such as wind, wetness, soil issues, invasive weeds, will require the Contractor take note and advise the Architect on how best to remedy the discovery.

1.9 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death, disease, pest, or other unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, incidents that are beyond Contractor's control or neglect by Owner as documented in writing submitted to owner in a timely manner. For instances of neglect by Owner, contractor must show documentation that the Owner has failed to act and provide recommended maintenance in a timely manner once receiving the Contractor's letter of notification.
 - b. Structural failures including plantings falling, blowing over or settling out of plumb.
 - c. Faulty performance of tree stabilization, edgings, tree grates, or subdrainage.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Periods from Date of Final Acceptance:
 - a. Trees, Shrubs, Vines, Ornamental Grasses, Ground Covers, Biennials, Perennials, and Other Plants, metal edges, decorative mulches, landscape drainage features, landscape grading: 12 months.
 - b. Annuals: 3 months.
 - 3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
 - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. There will be no limitation on replacements of each plant except for losses or replacements due to species intolerance of environmental conditions.
 - 1) Contractor shall notify Landscape Architect in writing of any concerns related to species intolerance of environmental conditions prior to purchase of plant material; otherwise, purchased plant material will be accepted by Contractor as tolerant of environmental conditions. Detrimental conditions shall be corrected prior to installation of plant material and sh

- 2) all not be considered grounds for warranty exclusion.
- d. Provide extended warranty for period equal to original warranty period, for replaced plant material. As required, continue extended warranty until leaf out to ensure health of replaced material. Plants shall be deemed dead if leaf out does not occur prior to end of spring.
4. All replacements shall be plants of the same kind as originally planted and shall be of size equal to that attained by adjacent plants of the same kind at the time replacement is made. They shall be furnished and planted as specified
5. herein.
6. Removal and replacement shall be at no cost to the Owner.

1.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service for all plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.
 1. Maintenance Period: 12 months. Maintenance shall begin immediately upon installation and continue until written acceptance of landscape by owner. The maintenance period of 12 months shall begin immediately after written acceptance. Partial Final Acceptance s will require continued maintenance until the entire landscape project is deemed substantially complete.
- B. For Mechanized Tree Spade Trees: Provide 6 months of watering by refilling slow release water bags from the date of installation.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. ent.
 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
 3. Provide trees from active, consistently aged specimens.

4. Unless directly specified, provide only trees that are genetic clones of the requested variety.
- C. Select Balled and Burlapped material from nurseries who utilize root pruning practices and have a systematic approach to hardening off newly dug material.
- D. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- E. Provide small trees and shade trees that are grown on their own roots, not utilizing grafting or budding techniques (unless directed in the plant list).
- F. Provide container plant material that is free from circling roots or pot bound conditions.
- G. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- H. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.
- I. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.2 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 1. Provide lime in form of ground dolomitic limestone.

2.3 ORGANIC SOIL AMENDMENTS

- A. Soil Conditioner: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Pine bark soil conditioner: finely ground, well composted, pine bark mulch with a maximum particle size of 1/4".
 2. Organic Matter Content: 70 percent of dry weight.
 3. Sources: Agricultural, bark, biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
 - a. Free of toxic materials to plant growth
 - b. Free of weed seeds.

2.4 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory. Several different blends may be necessary to meet the requirements.

2.5 PLANTING SOILS

- A. Planting Soil Type A-2: Imported sandy loam topsoil formed under natural conditions blended with organic matter. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 1. Depth of soil conditioner to mix in Planting Soil: 3/8" to 4" pending soil analysis.
 - 2. Weight of Slow-Release Fertilizer as per soil test
 - 3. Weight of dolomitic limestone as per soil test.
- B. Planting Soil Type E: Stalite Structural Soil mix for firelanes. Imported manufactured structural soil containing components of expanded slate and organic matter.
 - 1. Ratio:
 - a. 5/16" Expanded Slate: 75%
 - b. USGA Root Zone Mix: 20%
 - c. Certified Compost*: 5%

*Percentages may vary to meet testing requirements.
Saturated Drained Weight: 66 pounds per Cubic Foot

2.6 MULCH

- A. Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 2 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and suitable as a top dressing of trees and shrubs, consisting of one of the following:
 - 1. Type: Pine Straw Mulch – Campus Standard

Color: Natural. METAL EDGING
- B. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
 - 1. Edging Size: 1/4 inch wide by 5 inches deep.
 - 2. Stakes: Tapered steel, a minimum of 15 inches long.
 - 3. Accessories: Standard tapered ends, corners, and splicers.

4. Finish: Standard paint
5. Paint Color: Black

2.7 SUB DRAINAGE

- A. Drainage pipe: 4" black corrugated slotted PE pipe pre-wrapped in a geo-textile fabric capable of filtering clay soil from migrating into the pipe.
- B. Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D448.

2.8 HERBICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.9 PESTICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

1. Use pesticides on an as-needed basis.

2.10 TREE STABILIZATION MATERIALS

- A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood Stakes and Guys:
 1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
 2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
 3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
 4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
- B. Below Grade Root-Ball Stabilization Materials:
 1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated; stakes pointed at one end.
 2. Wood Screws: ASME B18.6.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that subgrades are correct prior to spreading topsoil or spreading amendments.
 - 2. Conduct water percolation tests to verify that planting depths and drainage will meet the needs of the plants that have been selected. Inform the Architect of any drainage issues.
 - 3. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 4. Remove gravel and asphalt from all landscape beds.
 - 5. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 6. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 7. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
 - 1. For gridded layouts, provide surveyed offset stakes. Use field strings to aid in layout.
 - 2. For grade sensitive layouts, set up level lines and grade stakes to insure proper planting depths.

3.3 GENERAL REQUIREMENTS FOR ALL PLANTING TYPES

- A. Before planting, verify that the complete root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Remove all girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

- C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- E. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. S
- F. Clarify sides of planting pit smeared or smoothed during excavation.
 - 1. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 - 2. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 - 3. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 - 4. Maintain supervision of excavations during working hours.
 - 5. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
 - 6. If subdrainage is shown on Drawings or required under planting areas, insure contact between the root ball and subdrain pipe.
- G. After excavation examine the area for potential drainage difficulties matched to plant varieties and inform the Architect of potential poorly drained areas. Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits. Discuss variations in the depth of planting with the Architect prior to planting.
- H. Fill excavations with water and allow it to percolate away before positioning trees and shrubs.
- I. Set out and space plants according to the planting plans and notes in even rows with triangular spacing unless otherwise indicated.
- J. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- K. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- L. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- M. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- N. Backfill plants with the materials and methods indicated in the Tables below and with the following instructions:
 - 1. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if

- root ball is cracked or broken before or during planting operation. Remove all burlap, tags, wire materials from top 2/3rds of root ball and from site.
2. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 3. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.4 MASS PLANTING AREA REQUIREMENTS

- A. Preparation - Loosen subgrade of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 2

PLANT TYPE	TREATMENT AREA	SUBSOIL TREATMENT	EXCAVATION BACKFILL	PLANTING SOIL* DEPTH
Shrub and Groundcover masses	entire planting area	Loosen deep 24"	Use Planting Soil*	6"
Mass perennials	entire planting area	Loosen deep 12"	Use Planting Soil*	6"
Mass annuals	entire planting area	Loosen deep 12"	Use Planting Soil*	8"
Planting Soil Type A				

1. Spread planting soil to a depth indicated in Table 2 but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet. Mix planting soil with the subsoil to form an uneven soil horizon line.
2. Subsoil removed from excavations may not be used as planting soil.

3.5 SOLITARY TREES AND SHRUBS PLANTING REQUIREMENTS

- A. Preparation - Loosen area of planting areas to a minimum depth indicated in the table below. Remove stones larger than 1/2 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

Table 3

	Treatment area	Subsoil treatment	Backfill from excavation	Planting Soil * depth in treatment area
Solitary Trees	10 wider than the root ball	Loosen deep 24"	Use Planting Soil*	8"
Solitary Shrubs	10 wider than the root ball	Loosen deep 24"	Use Planting Soil*	6"
Planting Soil Type A				

- B. Subsoil removed from excavations may not be used as planting soil.

3.6 MECHANIZED TREE SPADE PLANTING

- A. Supply trees as indicated in the plant list as harvested local trees.
- B. The Architect shall tag all trees to be locally harvested with tree spade techniques.
- C. Trees shall be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
- D. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- E. Cut exposed roots cleanly during transplanting operations.
- F. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.
- G. Plant trees as shown on Drawings, with the following procedures :
 - 1. Lower trees without damaging trunk or major branches
 - 2. Fit the root ball into the hole leaving a minimum of gap between the root ball and hole.
 - 3. Fill the remaining gap with a 70% sandy loam topsoil, 30% organic matter and fertilizer blend. Use water to carry mixture to the bottom of the excavation to insure the gap is full. Allow to drain and return the next day and repeat as necessary until all gaps are filled.
 - 4. Stake the tree with appropriate cabling systems and insure the tree is plumb.
 - 5. Mulch the tree planting area.
- H. Where possible, orient the tree in the same direction as in its original location.
- I. Supply one slow release watering bag per tree. Use campus standard watering bag.

3.7 PLANTING IN TREE PITS

- A. Excavate tree pits according to the details, discard the excavated material.
- B. Install drainage and gravel sumps as shown in the details
- C. Contact the Architect for and inspection of results prior to proceeding.
- D. Once approved, back fill the planter pits with Planter Soil as indicated on the drawings
- E. Plant the plant material as indicated on the drawings. Set the crown so it is a maximum of 1" below the bottom of the tree grate. Install root stabilization.
- F. Install material to appropriate depths, leaving room for the final application of mulch.
 - 1. Root crown shall be exposed after completion.

3.8 PLANT STABILIZATION

- A. Install plant stabilization as follows unless otherwise indicated:

PLANT SIZE	STABILIZATION METHOD
6" in Caliper and Greater	Anchor 4 guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle and compression spring for each guy wire and tighten securely. Allow enough slack to avoid rigid restraint of tree. Provide soft flexible protection of the trunk from the guy wires. Attach flags to each guy wire, 30 inches above finish grade.
3" to 6" in Caliper	Anchor 3 guys to 30" wood stakes. Install guy wires allowing enough slack to avoid rigid restraint of tree. Provide soft flexible protection of the trunk from the guy wires. Attach flags to each guy wire, 30 inches above finish grade.
Less than 12' tall	Provide two 6' tall hardwood stakes driven into the ground at the edge of the root ball 2' deep. Fasten the tree to the stakes with flexible bands capable of holding the plant steady but not binding.

- B. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball only as needed to address extraordinary site circumstances.
1. Refer to planting plan for location of plants to be receiving underground stabilization.
 2. Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.9 PLANT PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Do not apply pruning paint to wounds.

3.10 EDGING INSTALLATION

- A. Chiseled Edging: Construct chiseled edge separating mulch areas from lawn as shown in the drawings.
- B. Steel Edging: Install steel edging where indicated in the drawings according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

3.11 PLANTING AREA MULCHING

- A. Layout mulch beds carefully with smooth lines and as indicated on the drawings. Mulch backfilled surfaces of planting areas and other areas indicated.
- B. Organic Mulch in Planting Areas: Apply over whole surface of mass planting areas or on isolated plantings as follows:
1. 2" minimum depth for trees and shrubs.
 2. 1 ½" minimum depth for groundcovers, perennials, and annual beds.

- C. Do not place mulch within 3 inches of tree or large shrub trunks.

3.12 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of weeds, insects and disease.
- B. Until final acceptance fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Include the following required action at 12 months from Final Acceptance:
 - 1. Remove tree staking systems, above and below grade.
 - 2. Remove tree saucers.
 - 3. Expose root crowns of all trees planted on the job.

3.13 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. After installation and before Final Acceptance remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.14 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 32 93 00

January 15, 2026

University of North Carolina at Wilmington
Housing Village Phase 3
Complete Package - Construction Documents

5142301800
SCO 24-29053-02D

SECTION 33 10 00 - SITE WATER SYSTEMS

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.
- B. Cape Fear Public Utility Authority (CFPUA) Material Specification Manual.

1.2 SUMMARY

- A. This Section includes water systems piping for potable water service and fire protection service outside the building.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 21 Sections for fire protection systems inside building.
 - 2. Division 22 Sections for water distribution systems inside building.
 - 3. Section 02660 - Cape Fear Public Utility Authority (CFPUA) Technical Specification sections:
When project Water Systems specifications conflict with the above listed Cape Fear Public Utility Authority (CFPUA) specifications, the Cape Fear Public Utility Authority (CFPUA) specifications will take precedence, with the exception of the hydrant and valve openings that need to follow National Standards and open left.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure Ratings: Except where otherwise indicated, the following are minimum pressure requirements for water system piping.
 - 1. Underground Piping: 150 psi.

1.4 SUBMITTALS

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data, including pressure rating, rated capacity, and settings of selected models for the following:
 - 1. Meter boxes.
 - 2. Backflow preventers.
 - 3. Valves and boxes.
 - 4. Fire hydrants.
 - 5. Fire department connections.
 - 6. Yard hydrants.
 - 7. Identification materials and devices.
 - 8. Pipe and Fittings.
- C. Shop drawings for precast concrete pits. Include frames and covers. Include drains when indicated.

- D. Shop drawings for cast-in-place concrete valve and meter pits. Include frames and covers. Include drains when indicated.
- E. Wiring diagrams for alarm devices, if applicable.
- F. Coordination drawings showing pipe sizes and valves, meter and specialty locations and elevations, if applicable. Include details of underground structures, connections, anchors, and reaction backing. Show other piping in same trench and clearances from water system piping. Indicate interface and spatial relationship between piping and proximate structures.
- G. Record drawings at Project closeout of installed water system piping and products according to Division 1.
- H. Test reports specified in "Field Quality Control" Article in Part 3.

1.5 QUALITY ASSURANCE

- A. All materials, construction methods and testing shall comply with the requirements of the Cape Fear Public Utility Authority (CFPUA) standard specifications and details. Payment of all fees and permits shall be included in the base bid.
- B. Provide listing/approval stamp, label, or other marking on equipment made to specified standards.
- C. Listing and Labeling: Provide equipment and accessories that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Product Options: Water systems specialties and accessories are based on specific types, manufacturers, and models indicated. Components by other manufacturers but having equal performance characteristics may be considered, provided deviations in dimensions, operation, and other characteristics do not change design concept or intended performance as judged by Architect and the Cape Fear Public Utility Authority (CFPUA). The burden of proof of equality and approval by the Cape Fear Public Utility Authority (CFPUA) of products is on the Contractor. Refer to Division 1 sections.
- E. All work within any NCDOT right-of-way shall conform to the requirements of the current version of the NCDOT's Policies and Procedures for Accommodating Utilities on Highway Rights of Way, the provisions and conditions of the encroachment agreement(s), and other applicable NCDOT standards and policies. The encroachment agreement(s) are considered part of the project specifications by reference. Copies of the agreement(s) will be provided upon request from the Architect.
- F. As-Built Survey / Record drawings at Project closeout of installed water system piping and products meeting all requirements of the Cape Fear Public Utility Authority (CFPUA) Water & Sewer District As-Built Checklist. As-built survey shall be signed and seal by a NC Professional Land Surveyor and shall include the following:
 - 1. Name of project and owners, date, north arrow, scale.
 - 2. Surveyor's seal.
 - 3. As-built plans shall be provided on mylar sheets. A CD disk (DXF format or Auto Cad 2000 equivalent) must be provided to the County. All lettering shall be at least 0.10 inches in height. All drawings shall become the property of New Hanover County.

4. All fire hydrant water valve sizes and locations with no less than two primary reference dimensions from permanent above grade features.
5. Locations of bacteriological sampling points.
6. Pipe materials and sizes.
7. Other water system components such as meters, backflow preventers, etc.
8. Location of air release valves, gate valves and fittings along water main.
9. Sheet numbers and number of total sheets.
10. Accurate location map and index planning map at a scale of 1 inch = 200 feet.
11. Clearly indexed cover sheet with location of plan - profile sheets on cover sheet, by sheet number.
12. C/O shown open circle, water meters open box.
13. List total linear feet on cover sheet: Water lines____, Gravity sewer____, Forcemain ____.
14. Water & sewer layers to be bolder line type than drainage, streets, etc.
15. Make contour lines very light or turnoff.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, for shipping as follows:
 1. Ensure that valves are dry and internally protected against rust and corrosion.
 2. Protect valves against damage to threaded ends, flange faces, and weld ends.
 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. Storage: Use the following precautions for valves, including fire hydrants, during storage:
 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 2. Protect valves from weather. Store valves indoors and maintain temperature higher than ambient dew point temperature. Support valves off ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and piping specialties from moisture and dirt.
- G. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Verify that water system piping may be installed in compliance with original design and referenced standards.
- C. Site Information: Reports on subsurface condition investigations made during the design of the Project are available for informational purposes only; data in reports are not intended as

representations or warranties of accuracy or continuity of conditions (between soil borings). Owner assumes no responsibility for interpretations or conclusions drawn from this information.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate connection to water main with utility company. Obtain all necessary permits for pavement cuts, line taps, etc. from the authorities having jurisdiction. Payment of all fees and permits shall be included in the base bid.
- B. Coordinate with pipe materials, sizes, entry locations, and pressure requirements of building fire protection and building water distribution systems piping.
- C. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work are specified herein. Products by other manufacturers having equal performance characteristics may be considered, however approval must be acquired by the Contractor from the Cape Fear Public Utility Authority (CFPUA).

2.2 PIPES AND TUBES

- A. PVC Pipe, 2-in through 3-in: SDR 21 Polyvinyl Chloride, PVC, Pipe shall meet or exceed the following:
 - 1. ASTM D2241 or latest revision thereof.
 - 2. ASTM D1784, manufactured from compounds with cell classification 12454B.
 - 3. Shall comply with and be labeled as approved by the National Sanitation Foundation (NSF) for use in potable water lines meeting NSF 14, 61 or "NSF-pw".
 - 4. Push-on integral bell type supplied with elastomeric gaskets installed.
 - 5. Joints per ASTM D3139 testing requirements.
 - 6. Gaskets per ASTM F477.
 - 7. Pipe shall be clean and ends shall be tarped during shipment.
 - 8. Standard Dimension Ratio (SDR) 21.
 - 9. No solvent-cement weld pipe or fittings will be accepted.
 - 10. 200-psi pressure rating.
 - 11. Color: Blue.
 - 12. Iron Pipe Size (IPS) in 20' or 21' standard joint length.
 - 10. Refer to the CFPUA Material Specification Manual for additional information.
- B. PVC Pipe, 4-in through 12-in: AWWA C-900 Polyvinyl Chloride, PVC, Pipe shall meet or exceed the following:
 - 1. ASTM D1784, manufactured from compounds with cell classification 12454A or 12454B.
 - 2. Push-on integral bell type joints per ASTM D3139 testing requirements, supplied with elastomeric gaskets installed.
 - 3. Gaskets per ASTM F477.
 - 4. Shall comply with and be labeled as approved by the National Sanitation Foundation (NSF) for use in potable water lines meeting NSF 14, 61 or "NSF-pw".
 - 5. Pipe shall be clean and ends shall be tarped during shipment.
 - 6. No solvent-cement weld pipe or fittings will be accepted.
 - 7. Color: Blue.

8. DR-14, Pressure Class 200.
 9. Factory Mutual Approved (FM) and Underwriter Laboratory Listed (UL) as noted by (UL/FM) required on DR 14 pipe.
 10. Ductile iron pipe size in 20' standard joint length.
 11. Refer to the CFPUA Material Specification Manual for additional information.
- C. Ductile Iron Pipe: AWWA C150 and C151, Pressure Class 350 with polyethylene encasement. All ductile-iron pipe shall be listed by ANSI/NSF Standard 61 for potable water contact. Pipe shall have ISO 9001 or later certification, or poured in a foundry located in USA. Pipe shall be Factory Mutual Approved (FM) and Underwriter Laboratory Listed (UL) as noted by (UL/FM) for sizes four (4") thru twelve (12") inch.
1. Lining: AWWA C104, cement mortar, seal coated.
 2. Gaskets, Glands, and Bolts and Nuts: AWWA C111.
 3. Push-On-Joint-Type Pipe: AWWA C111, rubber gaskets.
 4. Mechanical-Joint-Type Pipe: AWWA C111, rubber gaskets, ductile- or cast-iron glands, and steel bolts and nuts.
 5. Restrained-Joint Pipe: TR Flex as manufactured by McWane, HDSS as manufactured by US Pipe, or Flex-Ring as manufactured by American Pipe.
 6. Coating: AWWA C151, bituminous coating.
 7. Polyethylene Encasement: ANSI/ AWWA C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems. Shall have minimum thickness of 0.008" or 8-mil. Shall be linear low-density polyethylene film. Shall be supplied in rolled tube form, suitable for installation method "A" as outlined in reference standard. The tube shall be sized according to the pipe being protected. Film shall be color coded BLUE.

2.3 PIPE AND TUBE FITTINGS

- A. Refer to Cape Fear Public Utility Authority (CFPUA) Specifications.

2.4 VALVES

- A. Refer to Cape Fear Public Utility Authority (CFPUA) Specifications.

2.5 VAULTS

- A. Water meter vaults shall be constructed of pre-cast concrete and sized to provide sufficient access for maintenance and protection of the meter and enclosed valves. The pre-cast box shall be installed on 6 inch thick, 12 inch wide concrete footings. The floor of the valve box shall consist of a 1 foot thick layer of #57 stone. The top of the meter vault shall be set 6 inches above grade.
- B. Access Hatch: Aluminum with flush top handle, stainless steel hinges, bolts and slam lock, automatic hold open arm, and compression springs to allow for easy opening. The meter vault lid shall be able to be fully opened for access to the vault, lockable with matching eye and padlock, rain-tight aluminum, hatch of size and dimension as shown on drawings. At a minimum, the lid must be sized to allow unrestricted maintenance access for meter retrieval and reset. Hatches shall be manufactured by Halliday Products, Inc., or approved equal. The remote read head shall be mounted flush to the aluminum top and adjacent to the hinge so that the meter can be read with District equipment without opening the vault. Electronic wiring between the meter and the door mounted electronic remote read head shall have proper slack, be in a protective sheath, secured, and installed adjacent to the hinge to minimize entanglement and interference with door opening and maintenance access.
- C. Ladder: ASTM A 36, steel or polyethylene-encased steel steps.

- D. Drain: Positive drainage with rodent proofing shall be provided for all below ground vaults.
- E. Valves and meters within the vault shall be bolted to supports adequate to counteract their weight and all imposed dynamic loads.

2.6 FIRE HYDRANTS

- A. Refer to Cape Fear Public Utility Authority (CFPUA) Specifications.

2.7 FIRE DEPARTMENT CONNECTIONS

- A. Exposed, Sidewalk Fire Department Connections: UL 405, cast-brass body, with thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded NPS bottom outlet. Include lugged cap, gasket, and chain; lugged swivel connection and drop clapper for each hose connection inlet; 18-inch high brass sleeve; and round sidewalk escutcheon plate marked "STANDPIPE". Connections shall be two 2 ½ inch inlets and 4 inch outlet.
- B. Wafer Check Valve: UL Listed/FM Approved, ductile iron body, bronze clapper and seat ring, 'O' ring seals, stainless spring closure, with ½" ball drip valve below seat to allow valve to drain water from FDC. Valves shall be Empire Wafer Silent Check Valve or ITT Kennedy Wafer Check Valve.
- C. Signage: 18"x12", .080 aluminum, 1.5-in rounded corners, red background with min. 6" white lettering, marked FDC. Sign field and lettering shall be retro-reflective and have UV protection. Sign shall be mounted on a galvanized steel pole with concrete footing. Mounting height to bottom of sign: 7-ft. min. or per local fire official.

2.8 ANCHORAGES

- A. Refer to Cape Fear Public Utility Authority (CFPUA) Specifications.

2.9 MECHANICAL JOINT RETRAINT

- A. Refer to Cape Fear Public Utility Authority (CFPUA) Specifications.

2.10 IDENTIFICATION

- A. Metallic-Lined Plastic Underground Warning Tapes: Polyethylene plastic tape with metallic core, 6 inches wide by 4 mils thick, solid blue in color with continuously printed caption in black letters "CAUTION - WATER LINE BURIED BELOW."
- B. Copper Tracer Wire: #12 gauge solid (bare) copper and continuous to the greatest extent possible. The tracer wire shall be securely bonded together at all wire joints with an approved industrial crimp connector to provide electrical continuity and extended to the top of all water line valve boxes.

PART 3 - EXECUTION

3.1 GENERAL

- A. All construction shall conform to the Standard Specifications and Details of the Cape Fear Public Utility Authority (CFPUA) and the NCDOT as applicable in addition to the requirements state herein.

- B. Install pipe in strict conformance with AWWA C600. Minimum depth of bury above the top of pipe shall be 36 inches. Maximum joint deflection shall meet requirements of AWWA C600 or AWWA Manual of Practice M23.

3.2 UTILITY TRENCH EXCAVATION

- A. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe, unless otherwise indicated.
 - 1. Clearance: As indicated
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, and fittings. Remove stones and sharp objects to avoid point loading.
 - 1. Where encountering rock or another unyielding bearing surface, carry trench excavation 6 inches (150 mm) below invert elevation to receive bedding course.
- D. Soil excavated from trenches that is to be used as backfill or fill shall be moisture conditioned as needed prior to placement and compaction as backfill or fill.

3.3 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Pipe sleeves and concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches (450 mm) of footings. Place concrete to level of bottom of footings. Contact the Architect or the Owner's independent testing agency to coordinate details, procedures and possible alternatives.
- C. Install copper tracer wire attached directly to pipes.
- D. Place and compact initial backfill of satisfactory soil material or base course material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.
 - 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
 - 2. Moisture condition soil materials as needed prior to placement as backfill.
- E. Coordinate backfilling with utilities testing.
- F. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.
- G. Place and compact final backfill of satisfactory soil material to final subgrade.
 - 1. Moisture condition soil materials as needed prior to placement as backfill.
- H. Install detectable warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.4 SERVICE ENTRANCE PIPING

- A. Extend water system piping and connect to water supply source and building water distribution and fire protection systems at 5-feet outside face of the building wall in locations and pipe sizes indicated.
 - 1. Terminate water system piping at 5-feet outside building wall until building water systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building water systems when those systems are installed.
- B. Install restrained joints for buried piping within 60 inches of building. Use restrained-joint pipe and fittings, thrust blocks, anchors, tie-rods and clamps, and other supports at vertical and horizontal offsets.

3.5 JOINT CONSTRUCTION

- A. Ductile-Iron Piping Gasketed Joints: Construct joints according to AWWA C600.
- B. Flanged Joints: Align flanges and install gaskets. Assemble joints by sequencing bolt tightening. Use lubricant on bolt threads.

3.6 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General Locations and Arrangements: Drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated except where deviations to layout are approved on coordination drawings.
- B. Install piping at indicated slope.
- C. Install components having pressure rating equal to or greater than system operating pressure.
- D. Install piping free of sags and bends.
- E. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- F. Install fittings for changes in direction and branch connections.
- G. Piping Connections: Except as otherwise indicated, make piping connections as specified below.
 - 1. Install unions, in piping 2 inches and smaller, adjacent to each valve and at final connection to each piece of equipment having 2-inch or smaller threaded pipe connection.
 - 2. Install flanges, in piping 2-1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - 3. Install dielectric fittings to connect piping of dissimilar metals.
- H. Lateral Separation of Sewers and Water Mains: Water mains shall be laid at least 10 feet laterally from existing or proposed sewers, unless local conditions or barriers prevent a 10 foot separation. In which case:
 - 1. The water main is laid in a separate trench, with the elevation of the bottom of the water main at least 18 inches above the top of the sewer; or.

2. The water main is laid in the same trench as the sewer with the water main located at one side on a bench of undisturbed earth, and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.
- I. Crossing a Water Main Over a Sewer: Wherever it is necessary for a water main to cross over a sewer, the water main shall be laid at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer, unless local conditions or barriers prevent an 18 inch separation, in which case both the water main and the sewer shall be constructed of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.
- J. Crossing a Water Main Under a Sewer: Wherever it is necessary for a water main to cross under a sewer, both the water main and the sewer shall be constructed of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water pipe shall be centered at the point of crossing.

3.7 PIPING INSTALLATION

- A. Water Main Connection: Tap water main with size and in location as indicated according to requirements of water utility.
 1. Install tapping sleeve and tapping valve according to manufacturer's installation instructions.
 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 3. Install gate valve onto tapping sleeve. Comply with AWWA C600. Install valve with stem pointing up and with cast-iron valve box.
 4. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water service piping.
 5. Install service clamps and corporation stops in size, quantity, and arrangement required by utility company standards and according to manufacturer's installation instructions.
 6. Install service clamps on pipe to be tapped. Position outlet for corporation stop.
 7. Install corporation stops into service clamps. Install valve with stem pointing up and with cast-iron valve box.
 8. Install curb stop in service piping with head pointing up and with cast-iron service box.
 9. Install manifold for multiple taps in water main.
 10. Use drilling machine compatible with service clamp and corporate stop. Drill hole in main. Remove drilling machine and connect water service piping.
- B. Comply with requirements of NFPA 24 for materials and installation.
- C. Install ductile-iron pipe and ductile-iron and cast-iron fittings according to AWWA C600.
- D. Install copper tube and wrought-copper fittings according to CDA No. 404/0 "Copper Tube Handbook."
- E. Bury piping at minimum depth of 3 feet below finished subgrade and not less than 18 inches below average local frost depth.
- F. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- G. Shoring or bracing of pits, trenches and other excavations shall be in accordance with the requirements of NCDOT and OSHA.

- H. The subgrade at the bottom of the trench shall be shaped to secure uniform support throughout the length of the pipe. A space shall be excavated under the bell of each pipe to provide space to relieve bearing pressure on the bell and provide room to adequately make the joint.
- I. Open ends of pipe shall be plugged with a standard plug or cap at all times when pipe laying is not in progress. Trench water shall not be permitted to enter pipe.
- J. Backfill material shall be free from stones greater than 4-inches in diameter, construction material debris, frozen material, organic matter, or unstable material. Backfill materials shall be placed in loose lifts of 8-inches or less in depth. All backfill shall be compacted to not less than 95% of the standard Proctor maximum dry density except the final foot beneath pavement or slab areas where this requirement shall be increased to 98% of the standard Proctor maximum dry density.
- K. Install and test fire protection piping and appurtenances in accordance with the specific requirements of the Cape Fear Public Utility Authority (CFPUA) and applicable NFPA requirements.

3.8 ANCHORAGE INSTALLATION

- A. Anchorages: The plugs, caps, tees and bends deflecting 22-1/2 degrees or more either vertically or horizontally on water lines 6 inches in diameter or larger shall be provided with thrust blocking or "Megalug" retainer gland at each joint, installed per manufacturer's requirements. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown on the plans or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps shall be stainless steel.

3.9 FIRE HYDRANT INSTALLATION

- A. Locate and install as shown on the drawings. Each hydrant shall be connected to the main with a 6-inch branch line buried at least 30 inches. Hydrants shall be set plumb with the pumper nozzle facing the roadway and with the center of the lowest outlet not less than 18 inches above the finished surrounding grade and the operating nut not more than 48 inches above the finished surrounding grade. The hydrant shall be set in a bed of crushed rock which shall surround the barrel at least 12 inches in all directions. Hydrants shall be restrained with stainless steel tie rods extending from the main line tee to the hydrant, or by combination of tie rods and blocking or by "Megalug" retainer glands at each joint per manufacturer's requirements.

3.10 PIT CONSTRUCTION AND INSTALLATION

- A. Provide precast concrete pits of dimensions indicated, with access frame and cover, ladder, and drain. Include sleeves with waterproof mechanical sleeve seals for pipe entry and exit.
- B. Connect vault drain outlet to storm drain

3.11 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install fire department connections in locations indicated in accordance with NFPA 14 and 24.
- A. Install wafer check valve with ball drip valve at each fire department connection. Install concrete or cast iron vault set on #57 washed stone at wafer check valve.

- C. Install signage out of pedestrian and vehicle travelways near FDC. Front of sign to face primary vehicle travelway.

3.12 IDENTIFICATION INSTALLATION

- A. Install continuous plastic underground warning tape during back-filling of trench for underground water service piping. Locate 6 inches to 8 inches below finished grade, directly over piping.
- B. Install copper tracer wire during back-filling of trench for all underground water lines in such a manner as to be able to properly trace all mains and service laterals without loss or deterioration of signal or without the transmitted signal migrating off the trace wire. Tracer wire shall be securely bonded together at all wire joints with an approved industrial crimp connector to provide electrical continuity. A valve box shall serve as the test port with the tracing wire brought up into the valve. The loop wire inside the valve box shall be a minimum of three (3) feet. The wire shall be protected from damage during the execution of the work. No breaks or cuts in the tracer wire shall be permitted. Industrial crimps shall be used to provide electrical continuity and the crimps shall be similar metal to eliminate galvanic corrosion. Contractor shall perform a continuity test on all tracer wire in the presence of the Owner or Owner's representative. If the tracer wire is found to be not continuous after testing, Contractor shall repair or replace the failed segment of wire at their own expense.
 - 1. For new water lines where no tracer is installed on the existing main, provide an anode (one (1) pound minimum) for the tracing wire termination at the point of the new tap on the main.
 - 2. For installations less than eight (8) feet in depth, the tracing wire shall be attached to the pipe. Tracer wire shall be laid flat and securely affixed to the pipe at ten (10) foot intervals.
 - 3. For installations deeper than eight (8) feet, the tracing wire shall be installed at a depth of seven (7) to eight (8) feet directly above the pipe.
 - 4. For lines installed in encasement pipe, the tracing wire shall be routed through the encasement pipe.

3.13 FIELD QUALITY CONTROL

- A. General: All materials shall be inspected by the Cape Fear Public Utility Authority (CFPUA) inspector prior to installation. The Contractor shall furnish all materials, labor and equipment to perform all testing and inspections.
- B. Where any section of a water line is provided with concrete thrust blocking, the hydrostatic test shall not be made until at least 5 days after installation of the concrete thrust blocking unless otherwise approved. The method proposed for disposal of wastewater from hydrostatic tests and disinfection shall be submitted to the Owner's representative prior to performing hydrostatic tests. Use clean potable water for all testing of lines.
- C. Pressure Test: Pressure test in strict conformance with AWWA C600, Section 4.1. For purposes of testing, working pressure shall be 100 psi and test pressure shall be 150 psi. Contractor shall also coordinate with local fire marshal for testing pressure on fire service piping, as it may be required to be a higher pressure (ex. 200 psi).
- D. Leakage Test: Test for leakage concurrent with the pressure test and in strict conformance with AWWA C600, Section 4.2, Table 6 Allowable Leakage per 1000 ft (305 m) of Pipeline. Remedy all visible leaks and locate and repair leakage in lines which exceed the specified amounts..
 - 1. Failure of the water main to comply with the above acceptable leakage rate, shall require the contractor to replace any defective materials to insure a watertight installation. After

any inadequacies have been corrected, the leakage rate shall again be tested. The test shall be repeated until that portion of the main is brought into compliance with the permissible leakage rate. All visible leaks shall be repaired regardless of amount of leakage.

- E. Private Fire Service System Flushing & Testing: Perform flushing and all tests as required by NFPA 14 and NFPA 24.
1. Complete and submit "Contractor's Material and Test Certificate for Underground Piping" (NFPA 14) upon satisfactory completion of system flushing and all tests.
 2. Contractor shall also coordinate with local fire marshal for testing pressure on fire service piping, as it may be required to be a higher pressure (ex. 200 psi).
- F. Disinfection: Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to test the lines. If water is lost during the test procedure and air is admitted to the pipeline, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished. Disinfection procedures shall be in strict conformance with AWWA C601, or latest revision, except as specified herein.
1. Take extra care to prevent contamination during installation, as specified in AWWA C601, Section 4 or latest revision.
 2. Thoroughly flush each segment of the system with clean, potable water, obtaining a minimum velocity of 2.5 fps for a period of 10 minutes, or until the line is free of particulates.
 3. Chlorination: Introduce chlorinated water into the main in such volume and concentration as to achieve a chlorine concentration of 50 ppm throughout the system. Operate all valves. Perform a chlorine residual test at each blow-off or sample tap to verify concentration. Allow the chlorinated water to sit for 24 hours, then flush the mains to achieve a chlorine concentration of not more than 2.0 ppm.
 4. Testing: Upon completion of disinfection procedures, a sample will be taken at each blow-off or test point in the system, and sent to an approved laboratory for bacteriological testing. Samples will be taken in the presence of the Owner's Representative and tests shall be paid for the Contractor. Should the tests indicate the presence of bacteria, the system or affected segment shall be flushed, chlorinated, and retested as specified at no cost to the Owner.

END OF SECTION 33 10 00

SECTION 33 30 00 - SITE SANITARY SEWER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Cape Fear Public Utility Authority (CFPUA) Material Specification Manual.

1.2 SUMMARY

- A. This Section includes sewerage systems outside the building.
- B. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Division 31 Section "Cast-in-Place Concrete" for cast-in-place concrete structures.
 - 2. Section 02731 - Cape Fear Public Utility Authority (CFPUA) Technical Specification sections:
When project Sanitary Sewerage specifications conflict with the above listed Cape Fear Public Utility Authority (CFPUA) specifications, the Cape Fear Public Utility Authority (CFPUA) specifications will take precedence.

1.3 DEFINITIONS

- A. Sewerage Piping: System of sewer pipe, fittings, and appurtenances for gravity flow of sanitary sewage.

1.4 PERFORMANCE REQUIREMENTS

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

1.5 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for the following:
 - 1. Cleanouts.
 - 2. Pipe and fittings.
 - 3. Couplings.
 - 4. Manhole Apurtenances.
- C. Inspection and test reports specified in the "Field Quality Control" Article.

1.6 QUALITY ASSURANCE

- A. All materials, construction methods and testing shall comply with the requirements of the Cape Fear Public Utility Authority (CFPUA) standard specifications and details. Payment of all fees and permits shall be included in the base bid.

- B. Utility Compliance: Comply with regulations pertaining to sanitary sewerage systems. Include standards of water and other utilities where appropriate.
- C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Product Substitutions."
- D. All work within any NCDOT right-of-way shall conform to the requirements of the current version of the NCDOT's Policies and Procedures for Accommodating Utilities on Highway Rights of Way, the provisions and conditions of the encroachment agreement(s), and other applicable NCDOT standards and policies. The encroachment agreement(s) are considered part of the project specifications by reference. Copies of the agreement(s) will be provided upon request from the Architect.
- E. As-Built Survey / Record drawings at Project closeout of installed sewer system piping and products meeting all requirements of the Cape Fear Public Utility Authority (CFPUA). As-built survey shall be signed and seal by a NC Professional Land Surveyor and shall include the following:
1. Name of subdivision and owners, date, north arrow, scale.
 2. All inverts into and out of manholes shall be field verified to 1/100 ft.
 3. Surveyor's seal.
 4. Plans shall show stubs for individual services. Cleanouts (C.O.'s) shall be located by measuring from each manhole along the sewer main up stream to a point which lies on a line that is perpendicular to the sewer main and connects said point and C.O. – zero point shall be the immediate downstream manhole, i.e., 127/14R. No stations shall be used.
 5. Show approximate vertical and horizontal separations of sewer mains to proposed or existing utilities and structures.
 6. For each sewer reach, show pipe diameter, length, type, slope, existing surface elevations and proposed finish grades. Show station or distance to beginning and end of change in pipe material.
 7. Show all water supply wells within 50' & community wells within 100' of sewer main.
 8. Show manhole top elevation & flood elevation or surface water flow levels @ each MH.
 9. Elevations shall be tied to mean sea level. Indicate any benchmarks within project area.
 10. As-built plans shall be provided on mylar sheets. A CD disk (DXF format or Auto Cad 2000 equivalent) must be provided to the County. All lettering shall be at least 0.10 inches in height. All drawings shall become the property of New Hanover County.
 12. Lot numbers, lot lines and street names.
 13. Sheet numbers and number of total sheets.
 14. Indicate size of services greater than 4".
 15. Indicate manhole service taps, service casing &/or material transition.
 16. Manhole sewer monuments, if manhole is buried.
 17. Accurate location map and index planning map at a scale of 1 inch = 200 feet.
 18. Clearly indexed cover sheet with location of plan - profile sheets on cover sheet, by sheet number.
 19. Reference ties into existing sewer systems by title and page of as-built drawing for existing system. County will assist with obtaining this information, (i.e. existing manhole-number C.72.A, Howes Creeks, Phase II, Contract H, Page 36 or 65). Show information on plan-profile sheet and cover sheet.
 20. County note on all plan & profile sheets.
 21. C/O shown open circle, water meters open box.
 22. Total linear feet on cover sheet: Water lines____, Gravity sewer_____, Forcemain_____
 23. Water & sewer layers to be bolder line type than drainage, streets, etc.
 24. Make contour lines very light or turnoff.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 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 existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
 - 1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate sanitary sewerage system connections to utility company's sanitary sewer. Obtain all necessary permits for pavement cuts, line taps, etc. from the authorities having jurisdiction.
- B. Coordinate force main connection to existing force main with Owner.
- C. Coordinate with interior building drainage systems.
- D. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work are specified herein. Products by other manufacturers having equal performance characteristics may be considered, however approval must be acquired by the Contractor from the Cape Fear Public Utility Authority (CFPUA).

2.2 PIPES AND FITTINGS

- A. PVC Pipe, 4-in through 12-in: AWWA C-900 Polyvinyl Chloride, PVC, Pipe within steel encasement shall meet or exceed the following:
 - 1. ASTM D1784, manufactured from compounds with cell classification 12454A or 12454B.
 - 2. Joints: Restrained using separate couplings that have built in sealing gaskets (O-rings) and restraining grooves. Shall be joined using high-strength flexible plastic splines inserted into mating precision-machine grooves, which align when the pipe is fully inserted, providing a full 3600 restraint with evenly distributed loading. Joints shall meet ASTM D3139 testing requirements.

3. Gaskets per ASTM F477.
 4. Pipe shall be clean and ends shall be tarped during shipment.
 6. No solvent-cement weld pipe or fittings will be accepted.
 7. Color: Green. Pigment stabilizers and ultraviolet inhibitors shall be used to prevent fading for a period of six (6) months after delivery.
 8. Class: DR-14, 305-psi pressure class.
 9. Ductile iron pipe size in 20' standard joint length.
 10. Refer to the CFPUA Material Specification Manual for additional information.
- B. Ductile Iron Pipe: AWWA C150 and C151, Pressure Class 350 with polyethylene film encasement. All ductile-iron pipe shall be listed by ANSI/NSF Standard 61 for potable water contact. Pipe shall have ISO 9001 or later certification, or poured in a foundry located in USA. Pipe shall be Factory Mutual Approved (FM) and Underwriter Laboratory Listed (UL) as noted by (UL/FM) for sizes four (4") thru twelve (12") inch.
1. Interior Lining: Amine cured novolac epoxy, containing at least 20% by volume of ceramic quartz pigment "PROTECTO 401" or "PERMOX CTF" (40 mils nominal) or polyamine ceramic epoxy containing at least 20% by volume ceramic hollow microspheres "Tnemec Series 431 Perma-Shield PL" (40 mils nominal). The inside of the bell socket including a portion of the gasket cavity and a portion of the pipe barrel shall also be coated with the above products (6" mils nominal, 10 maximum).
 2. Gaskets, Glands, and Bolts and Nuts: AWWA C111.
 3. Push-On-Joint-Type Pipe: AWWA C111, rubber gaskets.
 4. Mechanical-Joint-Type Pipe: AWWA C111, rubber gaskets, ductile- or cast-iron glands, and steel bolts and nuts.
 5. Restrained-Joint Pipe: TR Flex as manufactured by McWane, HDSS as manufactured by US Pipe, or Flex-Ring as manufactured by American Pipe.
 6. Exterior Coating: AWWA C151, bituminous coating.
 7. Polyethylene Encasement: ANSI/ AWWA C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems. Shall have minimum thickness of 0.008" or 8-mil. Shall be linear low-density polyethylene film. Shall be supplied in rolled tube form, suitable for installation method "A" as outlined in reference standard. The tube shall be sized according to the pipe being protected. Film shall be color coded GREEN.
- C. Steel Encasement Pipe: Pipe shall be high strength steel, spiral welded or smoothwall seamless manufactured in accordance with ASTM A139 and ASTM A283 and consisting of grade "B" steel with a minimum yield strength of 35,000 psi.
1. All encasement pipes shall meet the applicable NCDOT, Municipal, or AREMA specifications.
 2. Exterior shall be coated with two coats of a compatible black epoxy with a total dry film thickness of 10 mils per coat. Epoxy coating shall be Tnemec Hi-Build Tneme-Tar Series 46H-413, or approved equal. Pipe shall be coated inside and outside in accordance with AWWA C203 and any additional requirements of the NCDOT. Pipe ends shall be right-angled and shall be provided with a Dresser Style 62, Type I or approved equal mechanical transition coupler.

2.3 CLEANOUTS

- A. Cleanout Box: A nominal 6" diameter by 12" cast-iron box and cover shall be furnished and installed flush with the final grade at the edge of the easement or right-of-way and other locations indicated. "C.O." shall be stamped on lid. The box shall conform to the standard detail.

- B. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, service class, cast-iron soil pipe and fittings.

2.4 MANHOLES

- A. Precast Concrete Manholes: ASTM C 478 and C913, 4,000-psi precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints.
1. Openings shall be manufactured per ASTM C76, coring shall be specified per plans.
 2. Structure to be watertight and resist buoyant force.
 3. Standard manhole precast riser sections shall not exceed 4-feet.
 4. Concrete shall conform to:
 - Compressive strength 4,000 psi @ 28-days.
 - a. Air content 4% min.
 - b. Aggregate: ASTM C33.
 - c. Cementitious materials: minimum of 564 lbs./cu.yd.
 - d. Free of organic impurities.
 5. Manholes 4-feet deep or less shall have an eccentric cone or a flat top.
 6. Manholes over 4-feet deep shall have an eccentric cone.
 7. Manholes shall have a minimum inside diameter of 4 feet for sewer mains 12-inches and smaller. 4-foot manholes shall have a 6" extended base with a minimum thickness of 6-inches.
 8. Manholes shall be 5-feet for sewer mains larger than 12-inches. 5-foot manholes shall have an 8" extended base with a minimum thickness of 6-inches.
 9. Manholes at ground level and located in traffic areas shall have anti-inflow inserts.
 - a. Deep-dish design to allow for easy removal and replacement of the manhole cover (i.e., cover rotation).
 - b. Body shall be manufactured of 304 stainless steel with a thickness of not less than 18-gauge.
 - c. Shall have a sealing gasket made of Nitrile Buna-N (Acrylonitrile butadiene (NBR)), EPDM (Ethylene • Propylene Diene Monomer) or closed cell neoprene.
 - d. Shall have a handle made of 1/8" minimum, 304 stainless steel cable. Plastic coating of handle is optional or 1" heavy weight polypropylene. The handle shall be attached using two 304 stainless steel round head bolts with flat washers and self locking bolts or stainless steel pop rivets.
 10. Lift and handling devices shall have safety factor of 4 or greater.
 11. Corrosion linings as specified and indicated on design drawings.
 12. Watertight joints using ASTM C990 preformed flexible sealants.
 13. Pipe to manhole connections shall conform to ASTM C923.
 - a. Manhole adapters shall create a watertight flexible seal around pipes entering sanitary manhole walls.
 - b. The material shall resistant to ozone, weathering, aging, and chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products.
 - c. Shall be made of elastomeric Poly Vinyl Chloride (PVC), ethylene propylene (EPDM) or polyisoprene rubber.
 - d. The size and application colophons must be cast on each adapter.
 - e. Bands and screw assembly shall be manufactured from totally non-magnetic series 300 stainless steel.

14. Cylindrical wall seals per Section K. • The location of the pipe connectors shall vary from the plans no more than ½-inch vertically and 5-degrees horizontally.
- B. Manhole Frames and Covers: ASTM A48, Class 35B, cast iron or ASTM Standards A536 Grade 65-45-12 ductile iron. ISO 9001 or later certification. Include 24-inch inside clear opening diameter by 7-1/2-inch riser with 4-inch minimum width flange, and cover. Include indented top design with "SANITARY SEWER" cast into cover.
 1. Shall be designed, constructed and capable of withstanding a minimum H-20 type loading.
 2. Shall be cleaned according to good foundry practice, chipped and ground as needed to remove fins and rough places on castings.
 3. Bearing surfaces shall be machined to ensure a proper fit and prevent rattling and fit flush without forcing.
 4. All covers shall have lifting bars in lieu of pick holes.

2.5 IDENTIFICATION

- A. Metallic-Lined Plastic Underground Warning Tapes: Polyethylene plastic tape with metallic core, 6 inches wide by 4 mils thick, solid green in color with continuously printed caption in black letters "CAUTION - SEWER LINE BURIED BELOW."
- B. Copper Tracer Wire: #12 gauge solid (bare) copper and continuous to the greatest extent possible. The tracer wire shall be securely bonded together at all wire joints with an approved industrial crimp connector to provide electrical continuity and extended to the top of all sewer manholes and cleanouts.

PART 3 - EXECUTION

3.1 GENERAL

- A. All construction shall conform to the Standard Specifications and Details of the New Hanover County and the NCDOT as applicable in addition to the requirements state herein.

3.2 UTILITY TRENCH EXCAVATION

- A. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe, unless otherwise indicated.
 1. Clearance: As indicated
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, and fittings. Remove stones and sharp objects to avoid point loading.
 1. Where encountering rock or another unyielding bearing surface, carry trench excavation 6 inches (150 mm) below invert elevation to receive bedding course.
- D. Soil excavated from trenches that is to be used as backfill or fill shall be moisture conditioned as needed prior to placement and compaction as backfill or fill.

3.3 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on rock and other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Pipe sleeves and concrete backfill trenches that carry below or pass under footings and that are excavated within 18 inches (450 mm) of footings. Place concrete to level of bottom of footings. Contact the Architect or the Owner's independent testing agency to coordinate details, procedures and possible alternatives.
- C. Install copper tracer wire attached directly to pipes.
- D. Place and compact initial backfill of satisfactory soil material or base course material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.
 - 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
 - 2. Moisture condition soil materials as needed prior to placement as backfill.
- E. Coordinate backfilling with utilities testing.
- F. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.
- G. Place and compact final backfill of satisfactory soil material to final subgrade.
 - 1. Moisture condition soil materials as needed prior to placement as backfill.
- H. Install detectable warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.4 IDENTIFICATION INSTALLATION

- A. Install continuous plastic underground warning tape during back-filling of trench for underground sewer main and service piping. Locate 6 inches to 8 inches below finished grade, directly over piping.
- B. Install copper tracer wire during back-filling of trench for all underground sewer lines in such a manner as to be able to properly trace all mains and service laterals without loss or deterioration of signal or without the transmitted signal migrating off the trace wire. Tracer wire shall be securely bonded together at all wire joints with an approved industrial crimp connector to provide electrical continuity. Test ports shall be provided at each manhole and cleanout with the tracing wire brought up outside the manhole/cleanout and wrapped around the manhole or cleanout stack twice at a depth of approximately twelve (12) inches below grade. Extend a loop of the wire to the top of manhole or cleanout. The wire shall be protected from damage during the execution of the work. No breaks or cuts in the tracer wire shall be permitted. Industrial crimps shall be used to provide electrical continuity and the crimps shall be similar metal to eliminate galvanic corrosion. Contractor shall perform a continuity test on all tracer wire in the presence of the Owner or Owner's representative. If the tracer wire is found to be not continuous after testing, Contractor shall repair or replace the failed segment of wire at their own expense.
 - 1. For new sewer lines where no tracer is installed on the existing main, provide an anode (one (1) pound minimum) for the tracing wire termination at the point of the new tap on the main.

2. For installations less than eight (8) feet in depth, the tracing wire shall be attached to the pipe. Tracer wire shall be laid flat and securely affixed to the pipe at ten (10) foot intervals.
3. For installations deeper than eight (8) feet, the tracing wire shall be installed at a depth of seven (7) to eight (8) feet directly above the pipe.
4. For lines installed in encasement pipe, the tracing wire shall be routed through the encasement pipe.

3.5 SEWERAGE PIPING APPLICATIONS

- A. General: Include watertight joints.
- B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products. Refer to the drawings type of pipe to be installed.

3.6 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground sewerage piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.
- B. Install piping beginning at low point of systems, 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 recommendations 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 proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.
- D. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.
- E. Extend gravity sewerage piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.
- F. Install gravity sewerage piping pitched down in direction of flow, at minimum and cover as indicated.
- G. Tunneling: Install pipe under streets or other obstructions, that cannot be disturbed, by tunneling, jacking, or a combination of both.

3.7 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to the following.
- B. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: With rubber compression gaskets according to CISPI "Cast Iron Soil Pipe and Fittings Handbook," Volume I. Use gaskets that match class of pipe and fittings.
- C. Ductile-Iron Pipe with Ductile-Iron or Cast-Iron Fittings: With push-on-joint, rubber gaskets according to AWWA C600.

- D. PVC Gravity Sewer Pipe and Fittings: Join pipe and gasketed fittings with gaskets according to ASTM D2321 and manufacturer's written instructions.

3.8 MANHOLE INSTALLATION

- A. General: Manholes shall be constructed of precast concrete rings in accordance with the Drawings. The precast concrete base shall be placed on a six inch (minimum) stone bedding foundation which shall extend up around the pipes to at least 3 inches above the top line of the pipes. The stone bedding shall be considered as incidental to the unit price bid for the installed manhole. Pipes entering the precast sections of the manhole shall be inserted into the adaptor couplings provided. All precast manhole components shall be lifted and moved by use of suitable lifting slings and plugs that will not damage the precast manhole lip. All damage to precast sections shall be thoroughly repaired in the presence of the Engineer. Repair and patching of minor breaks shall be done by chipping and scarifying the defective area before application of grout. Precast sections shall be subject to rejection on account of failure to conform to any of the specification requirements. In addition, individual sections of manhole sections may be rejected because of fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint; defects that indicate imperfect proportioning, mixing, and molding; surface defects indicating honey-combed or open texture; damaged or cracked end, where such damage would prevent making a satisfactory joint; and/or any continuous crack having a surface which width of 0.01 inches or more and extending for a length of 12 inches or more, regardless of position in the section wall.
- B. The Contractor is responsible for getting the manhole tops to proper grade. Profiles on the plans are for cost estimates only. The top of the precast manhole may be brought to proper grade for receiving manhole frames by using brick with a maximum adjustment of 12 inches from precast cone to the cast iron ring. Masonry construction shall be preformed by experienced and qualified workmen. All work shall be laid plumb, straight, level, square, and true. The Contractor shall set and bond the manhole frame in a full bed of mortar. All manhole steps and miscellaneous items shall be properly bedded. The masonry walls shall be parged on the inside and outside with a ½-inch coat of Type S mortar.
1. Wedging or the placing of the shims to secure proper level will not be used in setting of manhole sections. Manholes located in unpaved roads shall be constructed with top of lid located 8 inches below road surface and a concrete reference marker shall be placed at the adjacent right of way line.
- C. Invert Channels: The invert channels shall be 3/4 the depth of the largest pipe and shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of channels shall be made gradually and evenly. The invert channels shall be formed directly in the concrete of the manhole base or shall be built up with solid brick and Type S mortar.
1. All upstream pipes (including services) shall have sloped invert channel slides that provide smooth transitions to the downstream invert channel. Invert channel slides shall be the diameter of the entering pipe and be formed as a channel that is at least 3/4 pipe deep. Upstream pipes that enter at the shelf shall have their invert channel slides smoothly cast into the shelf with a sloping transition to the downstream pipe invert.
 2. The floor of the manhole outside the channels, or slides, shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot. No laser bowl invert manholes shall be permitted.

- D. Grade Rings: Manhole castings shall be installed to grade using 24 inch inside diameter precast concrete grade rings, or brick grouted in place, for a maximum adjustment of 12 inches. Manhole sections shall be used for greater adjustment, unless approved otherwise. Flat top manholes shall not be adjusted by more than one course of brick.
- E. Drop Manholes: Inside drop only with minimum 5' diameter. Where sewer lines enter on a grade 30 inches or more above the invert of the discharge line, a drop manhole shall be constructed as directed by the Engineer. The drop or drops, shall be constructed in accordance with the Standard Detail, as shown on the plans, of 316 stainless steel or better excluding pipe with intermediate supports on 30-inch spacing as required.

3.9 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 a 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 paving with tops flush with surface of paving.
- D. Set cleanout box on 4-inches of washed stone.

3.10 FIELD QUALITY CONTROL – GRAVITY SEWER

- A. General: The Contractor shall be responsible for providing all equipment necessary for tests of displacement, deflection, and leakage. Tests for deflection and leakage shall be performed by the Contractor and observed by the Owner's representative. Each segment of line shall be tested after 30 days prior to final acceptance of the project if required and in any event, all segments of main and all services shall be cameraed in the presence of the District's representative at no cost to the District. The camera inspection must be performed upon completing of cleaning and potable water introduced into the system to be tested. All defects in the pipeline and appurtenances shall be remedied by the Contractor at no additional expense to the District or New Hanover County and will be reinspected as outlined above. Acceptance of any deviation from these requirements is at the sole discretion of the District.
- B. Test for Displacement of Sewers: Sewer mains will be checked by the Owner's representative to determine whether any displacement of the pipe has occurred. The test will be as follows: A light will be flashed between manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, or any other defects, the defects shall be remedied by the Contractor. Water will be introduced into the pipe to aid in detection of defects. The owner may choose to re-inspect the pipe at its discretion, using all appropriate tests including inspecting the pipes by using a closed-circuit television camera. Any observed leakage shall be repaired, regardless of leakage rate. Acceptance of any deviation from these requirements is at the sole discretion of the District.
- C. Test for Deflection: Deflection tests may be performed on all sections of flexible pipe.
 - 1. Maximum allowable deflection shall be 5 percent at any point.
 - 2. Deflection shall be measured with a pin-type mandrel "Go/No Go" gauge. The gauge shall be pulled through the pipe by means of a strong cord or cable.
 - 3. Any section of pipe not meeting the 5 percent maximum deflection requirement shall be excavated, backfilled, recompacted and retested.

- D. Test for Leakage: All segments of completed line may be tested for leakage by low pressure air test, except that the infiltration test may be used as approved by the Owner's representative. The County may choose to camera the pipe. Acceptance of any deviation from these requirements is at the sole discretion of the District.
1. The Contractor shall remedy all visible leaks in pipes, manholes, and appurtenances.
 2. Maximum allowable leakage for the system shall be 0 gallons per inch pipe diameter per linear mile of pipe per 24 hours, including manhole infiltration. No single segment of line (manhole to manhole) shall exceed this requirement.
 3. Air Testing: Air testing shall be required if, in the sole opinion of the Cape Fear Public Utility Authority (CFPUA), conditions are such that infiltration measurements may be inconclusive. The test shall be conducted in the presence of the County Engineer and shall conform to the following requirements:
 - a. Test pressure shall be 3.5 psi increased by the ground water pressure above the top of the sewer.
 - b. Pressure loss from 3.5 psi shall not exceed 0.5 psi during the required testing time.
 - c. Testing time in minutes shall be calculated as $0.625 \times \text{nominal pipe size (inches)}$.
- E. Testing Manholes:
1. Each manhole shall be tested immediately after assembly and prior to backfilling.
 2. All lift holes shall be plugged with an approved non-shrink grout.
 3. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole. Unless plugs are mechanically restrained, it is recommended that the plugs are used with a minimum of 2 times safety factor above the test pressure.
 4. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturers' recommendations.
 5. A vacuum of 10 inches (5 psig) of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for 48" diameter, 75 seconds for 60".
- F. Test Results: Certified copies of all test results shall be furnished to the Owner and the Owner's representative within 1 week after the test.
- G. Repairs: Make all necessary repairs to bring new sewer into compliance with test requirements.

END OF SECTION 33 30 00

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SECTION 33 40 00 - SITE STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes site drainage systems outside the building. Systems include the following:
 - 1. Storm drainage.
 - 2. Foundation drainage connections outside of building.
 - 3. Roof drainage connections outside of building.
- B. Related Sections: The following Sections contain requirements that relate to this Section.
 - 1. Division 31 Section "Earth Moving."
 - 2. Division 31 Section "Sediment and Erosion Controls."
 - 3. Division 3 Section "Cast-In-Place Concrete."
 - 4. Division 22 Sections for storm drainage inside the building.

1.3 DEFINITIONS

- A. Drainage Piping: System of pipe, fittings, and appurtenances for gravity flow of storm drainage.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. As-Built Survey / Record drawings of installed drainage system piping and basins.

1.5 QUALITY ASSURANCE

- A. Environmental Agency Compliance: Comply with regulations pertaining to storm drainage systems.
- B. Utility Compliance: Comply with regulations pertaining to storm drainage systems.
- C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components and are based on specific manufacturer types indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Products."
- D. All work within any NCDOT right-of-way shall conform to the requirements of the current version of the NCDOT's Policies and Procedures for Accommodating Utilities on Highway Rights of Way, the provisions and conditions of the encroachment agreement(s), and other applicable NCDOT standards and policies. The encroachment agreement(s) are considered part of the project specifications by reference. Copies of the agreement(s) will be provided upon request from the Architect.

- E. Perform As-Built Survey of installed drainage system piping and basins and all stormwater management devices (ponds, wetlands, bio-retention areas). As-built survey shall be signed and seal by a NC Professional Land Surveyor and shall include the following:
1. All inlet, junction box and manhole locations with no less than two primary reference dimensions from permanent above grade features.
 2. As-built rims and inverts noted.
 3. Pipe materials and sizes, plus slopes and distances between structures.
 4. As-built dimensions for installed riprap dissipater pads.
 5. Topography of embankments and interiors of drained stormwater management ponds, wetlands and bio-retention cells. Topography shall include all survey point elevations.
 6. Detailed as-built dimensions and elevations of stormwater management device outlet structures, weirs, orifices, and outlet pipes.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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. Field verify locations and elevations of existing storm drainage infrastructure at locations of connection to new work prior to beginning storm drainage installation. Notify Architect if discrepancies are discovered that required design modifications.
- D. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.
 1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without receiving Architect's written permission.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate storm drainage system connections to utility company's storm sewer.
- B. Coordinate storm drainage system connections to existing on-site storm sewer.
- C. Coordinate with interior building drainage systems.
- D. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

- A. General: Refer to plans for specific pipe material applications.

- B. Ductile-Iron Pipe: ANSI/AWWA C150/A21.50 and C151/A21.51, minimum pressure class 250 with polyethylene encasement.
1. Lining: AWWA C104, cement mortar, coal tar epoxy lined.
 2. Gaskets, Glands, and Bolts and Nuts: AWWA C111.
 3. Push-On-Joint-Type Pipe: AWWA C111, rubber gaskets.
 4. Coating: AWWA C151, bituminous coating.
 5. Polyethylene Encasement: ANSI/ AWWA C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems. Shall have minimum thickness of 0.008" or 8-mil. Film shall be color coded BLACK.
- C. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D-1785, SCH 40 PVC for solvent-cemented or gasketed joints.
1. Primer: ASTM F 656.
 2. Solvent Cement: ASTM D 2564.
 3. Gaskets: ASTM F 477, elastomeric seal.
- D. Reinforced-Concrete Sewer Pipe and Flared End Sections: ASTM C 76, Class III. Provide Class IV where noted on the drawings.
1. Standard Joints: Plastic cement putty seal meeting ASTM C990 and Federal Specification SS-S-00210.
- E. High Density Polyethylene (HDPE) Pipe and Fittings (4-in thru 12-in): ASTM F2648. Dual-wall with smooth interior and corrugated exterior. All sizes shall conform to the AASHTO classification Type S or D. N-12 by ADS or approved equal.
1. Watertight Joints: Watertight per ASTM D3212, bell and spigot, rubber gasket, ASTM F477.
 2. Fittings: ASTM F2306, welded on the interior and exterior at all junctions. Only fittings supplied or recommended by the pipe manufacturer shall be used.
- F. Polypropylene Pipe (PP) and Fittings: ASTM F2881 or AASHTO M330. Dual-wall with smooth interior and corrugated exterior. Pipe within public right of way shall comply with NCDOT Specification Section 1032-9. Pipe shall be HP Storm pipe by ADS or approved equal.
1. Watertight Joints: Watertight per ASTM D3212, AASHTO M330, bell and spigot, rubber gasket, ASTM F477.
 2. Fittings: Conform to ASTM F2881 or AASHTO M330. Connections shall be watertight bell and spigot utilizing a welded or integral bell and valley or inline gaskets. Only fittings supplied or recommended by the pipe manufacturer shall be used.

2.2 STORM SUB-DRAIN AND FOUNDATION DRAIN PIPING

- A. Storm Sub-Drain Pipe and Fittings: SCH 40 PVC or dual-wall, smooth interior HDPE as specified above, with ½-in drilled perforations. Minimum 4-inch diameter unless otherwise indicated on the drawings. Non perforated pipe shall be used outside of area to be drained to connect sub-drains to drainage inlets.
- B. Drainage Filter Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

1. Grab Tensile Strength: 110 lbf (490 N); ASTM D 4632.
2. Tear Strength: 40 lbf (178 N); ASTM D 4533.
3. Puncture Resistance: 50 lbf (222 N); ASTM D 4833.
4. Water Flow Rate: 150 gpm per sq. ft. (100 L/s per sq. m); ASTM D 4491.
5. Apparent Opening Size: No. 50 (0.3 mm); ASTM D 4751.

2.3 SPECIAL PIPE COUPLINGS AND FITTINGS

- A. Connection from roof downspout to underground storm pipe.
1. Vertical stainless-steel downspout adapter with sch. 40 PVC pipe outlet sized to fit over downspout and underground piping. Adapter shall have a self-cleaning debris trap consisting of a hinged cover and removable debris screen. Powder-coat color to be selected by Architect from manufacturer's full range of colors. As manufactured by Piedmont Pipe Construction.
 2. Manufactured fitting of material similar to downspout sized to connect to standard round pipe shape of underground piping.

2.4 DROP INLETS AND CATCH BASINS

- A. General: Brick and mortar or precast concrete, of depth, shape, and dimensions indicated. Knock-out "waffle" boxes shall not be used. All structures shall be designed to withstand AASHTO HS-20 loads and meet NCDOT standards.
- B. Brick Inlets: Brick and mortar or precast concrete, of depth, shape, and dimensions indicated.
1. Base, Channel, and Bench: Concrete.
 2. Wall: ASTM C 32, Grade MS, clay brick masonry units.
 - a. Option: ASTM C 55, Grade S-II, solid concrete brick masonry units may be used instead of clay brick.
 3. Mortar: ASTM C 270, Type S, using ASTM C 150, Type I, portland cement.
- C. Precast Concrete Inlets: ASTM C913, precast, reinforced concrete, of depth, shape, and dimensions indicated designed for HS-20 loading. Precast boxes shall include grade rings to allow adjustment to rim elevations. Knock-out waffle boxes shall not be used.
1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 2. Riser Sections: 4-inch minimum thickness and lengths to provide depth indicated.
 3. Top Section: Flat-slab-top type is indicated.
 4. Joint Sealant: ASTM C990, bitumen or butyl rubber.
 5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 6. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness to allow field adjustment of rim elevation.
- D. Steps: Individual FRP steps or deformed, 1/2-inch steel reinforcing rods encased in polypropylene plastic, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 42 inches.

- E. Pipe Connectors: ASTM C923, resilient, of size required, for each pipe connecting to base section.
- F. Frames and Grates: ASTM A48, Class 35B, cast iron, H-20 loading. Include flat grate with small square or short-slotted drainage openings as indicated on the drawings.
 - 1. Provide drop inlet grates with openings compliant with ADA standards when located within sidewalk or other pedestrian walking areas and/or where specifically indicated on drawings.
- G. Catch Basin Hood Casting: ASTM A48, Class 35B, cast iron, H-20 loading.

2.5 AREA, IN-LINE, BASIN AND FLOOR DRAINS

- A. Floor Drains: 12-inch diameter or 12-inch square top drain, Dura-Coated cast iron body with 6-inch bottom outlet, seepage pan, adjustable extension frame and medium duty slotted grate. Top shall be polished nickel bronze and secured with slotted screws.
- B. Area Drains or Planter Drains: 15-inch square top drain designed to be attached with a watertight connection to vertical HDPE or PVC pipe, ductile iron slotted surface grate, watertight pipe adapters. Grates shall be pedestrian-type where set in pavement or sidewalk. Grates shall be dome-type where set in mulched areas.
- C. In-Line Drains: 12-inch ductile iron drain designed to be attached with a watertight connection to vertical HDPE or PVC pipe, slotted surface grate of shape indicated on the drawings, watertight pipe adapters. Grates shall be pedestrian-type where set in pavement or sidewalk. Grates shall be dome-type where set in mulched areas.
- D. Drain Basin: 15-inch or 18-inch diameter PVC body drain basin with ductile iron grates and integral pipe connection stubs formed to provide a watertight connection to HDPE pipe. Basins shall be as manufactured by Nyloplast or approved equal.

2.6 TRENCH DRAINS

- A. Description, 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. Medium-Duty Pedestrian Area Drain: Trench drain system in sidewalks and non-vehicular use areas shall be medium-duty sloped-invert, polymer-concrete system and shall include the following components:
 - 1. Channel Sections: Interlocking-joint, precast, modular units with end caps. Include 4-inch minimum inside width and deep, rounded bottom, with built-in invert slope of 0.5 percent minimum and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth. ACO KlassikDrain K100 or approved equal.
 - 2. ADA Ductile Iron Grates, 1,100-psi min. loading, ADA compliant, with slots that fit recesses in channels. ACO Type 476D or approved equal.
 - 3. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- C. Heavy-Duty Loading Dock Drain: Trench drain system in loading dock and other vehicular use areas shall be large capacity and heavy-duty sloped-invert, polymer-concrete system.

1. Channel Sections: Interlocking-joint, precast, modular units with end caps. Include 12-inch minimum inside width and deep, rounded bottom, with built-in invert slope of 0.5 percent minimum and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth. ACO PwerDrain S300K or approved equal.
2. Ductile Iron Grates with manufacturer's designation "heavy-duty," 3,400-psi min. loading, with slots that fit recesses in channels. ACO S300K Slotted Iron or approved equal.
3. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

2.7 MANHOLES

- A. Precast Concrete Storm Drainage Manholes: ASTM C-478 precast reinforced concrete, eccentric cone. All structures shall be designed to withstand AASHTO H-20 loads.
 1. Base, Channel, and Bench: Concrete.
 2. Joint: Preformed flexible plastic gaskets complying with Fed. Spec. SS-S-210A.
 3. Size: As required to accommodate proposed pipes indicated on the drawings, 4-ft diameter minimum.
- B. Frames and Covers: ASTM A48, Class 35B, heavy-duty cast iron. Include flat, round grate with 1-1/2" wide slotted drainage openings with a minimum total open area of 150-sq.in.

2.8 CLEANOUTS

- A. Description: ASME A112.36.2M, round, cast-iron housing with clamping device and round, secured, scoriated, cast-iron cover. Include cast-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug. Cleanout shall be rated for "heavy duty" top-loading classifications.
 1. Cleanout Box: Cleanouts located in paved areas subject to vehicular traffic shall be protected by an 8-in diameter, ductile-iron cleanout box. 'STORM' marking shall be cast into the lid.

2.9 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
 1. Cement: ASTM C 150, Type I, 3,000-psi.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Structures: Portland-cement design mix, 4000 psi minimum, with 0.45 maximum water-cement ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

- A. Special Pipe Couplings: Use where indicated and where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

3.3 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical. Refer to drawings for material and structure types for specific applications.

1. Orient grates of drainage structures in paved areas to align with general pattern of pavement joints and scoring.

- B. Install piping beginning at low point of systems, 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 recommendations 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 proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

- D. Extend drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

- E. Install drainage piping pitched down in direction of flow, at minimum slope of 1 percent and 36-inch minimum cover, except where otherwise indicated.

- F. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:

1. Join solvent-cement-joint pipe and fittings with solvent cement according to ASTM D 2855 and ASTM F 402.
2. Join pipe and gasketed fittings with elastomeric seals according to ASTM D 2321.
3. Join profile sewer pipe and ribbed drain pipe and gasketed fittings with elastomeric seals according to ASTM D 2321 and manufacturer's written instruction.
4. Install according to ASTM D 2321.

- G. Install PP and HDPE pipe in accordance with ASTM D2321 with the exception that minimum cover in trafficked areas shall be 12-inches.

1. Slightly scarify and grade the trench base to provide a uniform trench bottom. Before installing pipe, bring bedding material or trench bottom to grade along the entire length of the pipe. For 42" pipe and larger, shallow bell holes shall be provided.
2. Trench width shall be wide enough to accommodate compaction equipment. Refer the manufacturer's recommendations. Pipe backfill to springline shall be compacted to 95% Standard Proctor density regardless of pipe location.
3. Provide bedding, haunching and initial backfill of Class 1 or 2 granular materials per manufacturer's recommendation or as detailed on the drawings.
4. Excessive groundwater necessitates dewatering. Pipe will float in standing water, requiring immediate haunching and initial backfill to hold line and grade.
5. Join pipe per manufacturer's instructions.
6. PP and HDPE pipe shall only be installed where indicated on the drawings and shall not be installed where other pipe materials are indicated.

- H. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems' materials and dimensions.
- I. Install stormwater control measure outlet pipes through embankments with concrete support cradle from the bottom of the pipe trench to the springline of the pipe.

3.4 CATCH BASIN AND DROP INLET INSTALLATION

- A. Construct inlets to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.
- C. Install prefabricated area drains per manufacturer's instructions.

3.5 TRENCH DRAIN INSTALLATION

- A. Install trench drains in accordance with the manufacturer's written instructions and as indicated on the drawings. Install surrounding concrete with surfaces with $\frac{1}{4}$ " per foot slopes to rim of grate.
- B. Extend drain pipe from in-line catch basin to large capacity site storm drainage system and install hardware mesh rodent screen over outlet of drain pipe and 12"x24" concrete splash block at discharge of drain pipe.
- C. Utilize half-meter channel sections at curved alignments (such as D-zones of 400-m track). Miter-cut ends of channel sections per manufacturer's instructions to prevent gaps at section joints.
- D. Protect trench drain with non-woven filter fabric under grate during construction. Ensure trench and entire length of outlet pipe are clear of sediment and debris at completion of construction.

3.6 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. In Paved Areas: Cleanouts shall be installed within a protective cleanout box set flush with surface of paving.
- C. In Non-Paved Areas: Set cleanout tops 1 inch above surrounding earth grade.

3.7 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping that is 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 of the following procedures:
 - 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.
- B. Abandoned Structures: Excavate around structure as required and use either of the following procedures:

1. Remove structure and close open ends of remaining piping.
2. Backfill to grade according to Division 31 Section "Earth Moving."

3.8 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as the 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 whenever work stops.
 3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.
- 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 the 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 visual between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a 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. All PP and HDPE pipe and fittings 12-inch in diameter and greater shall be inspected by the pipe supplier/manufacturer following delivery to the construction site for damage caused during transit. Damaged or defective materials shall be removed from the site. A record of this inspection(s) shall be submitted to the Architect. Contractor shall supply documentation of experience in the installation of PP and HDPE storm drainage pipe or shall provide for installation supervision by the supplier/manufacturer.
- D. 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 their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.
 4. Submit separate reports for each test.

END OF SECTION 33 40 00

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