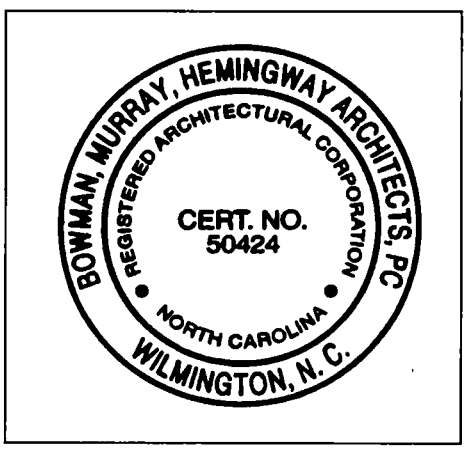
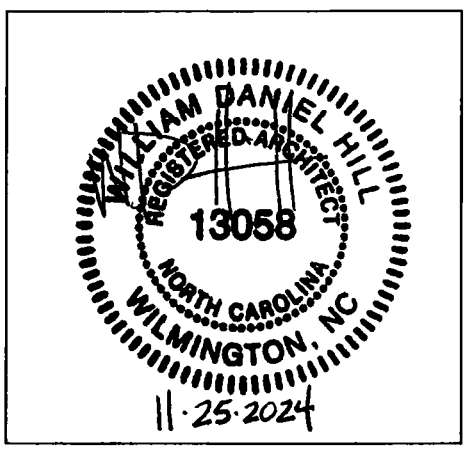
Coastal Carolina Community College

Learning Resources Center First Floor Renovation

SCO#: 23-26060-01A
444 Western Boulevard
Jacksonville, North Carolina

Volume 2 of 2





November 25, 2024

BOWMAN MURRAY HEMINGWAY ARCHITECTS
514 Market Street
Wilmington, North Carolina

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DIVISION 21–FIRE PROTECTION

Fire protection work shall be defined by drawings numbered with the prefix “FP-“, the general provision of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division-21 Fire Protection Specifications.

Engineer of Record for Division 21 is David M. Hahn, PE, CBHF Engineers, PLLC, 2246 Yaupon Drive, Wilmington, NC 28401.

11/25/2024

END OF SECTION 210000

SECTION 210000 - GENERAL FIRE PROTECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials and equipment and incidentals required to make ready for use complete Fire Protection systems as shown on the Drawings and specified herein.

B. Where Sub-Contracts are used to perform portions of the work, division of labor between sub trades is the responsibility of the Contractor.

C. Furnish all labor, materials and equipment and incidentals required to make ready for use complete Fire Protection systems as shown on the Drawings and specified herein.

D. Work includes furnishing, installing and testing the equipment and materials specified in other sections of the Division Specifications and shown on the Fire Protection Drawings. It is the intent of these Specifications that the Fire Protection systems shall be suitable in every way for the intended usage. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

E. The general scope work includes, but is not limited to, furnishing, coordinating, and installing the following.

1. Fire protection piping, valves, sprinkler, specialties and systems with connection to site utilities.

F. Visit all areas of the existing site, buildings and structures (as applicable) in which work under these sections is to be performed. Inspect carefully the existing conditions prior to bidding. Bid submission is evidence that the Contractor has examined the site and existing conditions, understands conditions under which the work will be performed, and takes full responsibility for complete knowledge of all factors governing the work.

G. Thoroughly test all Fire Protection systems after installation and make any minor corrections, changes or adjustments necessary for proper functioning of the systems and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

1.2 SUBMITTALS

A. Procedures for submittals: Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

Transmit each shop drawing submittal with provided Shop Drawing Submittal Cover Form, attached herewith for each item of equipment/material or each specification section/paragraph.

B. Clearly indicate proposed equipment and/or materials substitutions in shop drawings. Summarize all deviations from the specified quality, functionality, appearance or performance

of proposed equipment and/or materials in the preface of each submittal. Include documentation to support deviations.

C. Provide descriptive data on all materials and equipment as required to ascertain compliance with Specifications.

D. Fire Sprinkler Contractor: The Fire Sprinkler Contractor must submit working shop drawings, hydraulic calculations, and product data to the Architect and AHJ for review/approval. Shop drawings should include and be in accordance with working plan requirements of chapter 22 of NFPA 13. Product data must include and identify all material, equipment, and accessory selections to be installed. The hydraulic calculations and shop drawings must be signed by the fire sprinkler designer and include the NC Fire Sprinkler Contractor (FS) license number.

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with all applicable state and local codes, standards and regulations.

B. Furnish all materials and labor which is be required for compliance with codes, standards and regulations, whether specifically mentioned in these specifications or shown on the drawings.

C. Obtain required construction permit from the authority having jurisdiction and arrange, at the proper time, for all inspections required by such authority. Pay all permit and inspection costs required.

1.4 COORDINATION OF WORK

A. Contractor is responsible for coordination of work between trades. Provide fully complete and functional systems.

B. Compare Fire Protection drawings and specifications with the drawings and specifications for other trades.

C. Coordinate Fire Protection installation with the work of other trades. Report any pertinent discrepancies to the Architect/Engineer and obtain written instructions for any necessary revisions. Before starting any construction, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. No extras will be allowed for rework of uncoordinated installations.

D. Determine exact route and location of each Fire Protection item prior to fabrication and/or installation. Adjust location of piping and equipment, etc., to accommodate interferences anticipated and encountered.

E. Right of Way: General priority for right of way is as follows:

1. Items located per regulatory requirement.
2. Piping with pitch requirement (Fire Protection, drains, etc.).
3. Ductwork.
4. Piping without pitch requirement.

5. Electrical wiring (conduits, etc.).

F. Arrange all work to permit removal (without damage to other parts) of any equipment requiring periodic replacement.

G. Provide clearance and easy access to any equipment which requires periodic maintenance. Arrange piping and equipment to permit ready access and to clear the opening of swinging doors and access panels.

1.5 EQUIPMENT AND MATERIALS (GENERAL)

A. Provide all new materials unless specifically indicated otherwise.

B. Manufacturers and models listed in drawings and specifications are used for layout and to convey to bidders the general style, type, character and quality of product desired. Listed examples are used only to denote the quality standard of product desired and are not intended to restrict bidders to a specific brand, make, manufacturer or specific name.

C. Adjust layout, system connections and coordinate with other trades as required to properly install equivalent products.

D. Where equivalent products are submitted, include all associated costs related to substitution in bid.

E. Furnish materials bearing the manufacturer's name and trade name. Provide UL label where a UL standard has been established for the particular material.

F. Furnish standard products of manufacturers regularly engaged in production of equipment types required for the work. Use the manufacturer's latest approved design.

G. Use the same manufacturer for equipment and materials of the same general type throughout the work to obtain uniform appearance, operation and maintenance.

H. Protect equipment and materials from dirt, water, chemical or mechanical injury and theft at all times during construction. Provide covers or shelter as required.

I. If materials or equipment are damaged at any time prior to final acceptance of the work, repair such damage at no additional cost. If materials or equipment are damaged by water, provide replacement no additional cost.

J. Follow manufacturer's directions completely in the delivery, storage, protection and installation of all equipment and materials. Notify the Architect/Engineer in writing of any conflicts between any requirements of the contract documents and manufacturer's directions. Obtain written instructions before proceeding with the work. The Contractor is responsible for correction of any work that does not comply with the manufacturer's directions or written instructions from the Architect/Engineer at no additional cost.

K. Repair any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. Repaint entire damaged panel or section per the field painting specifications in Division 09 at no additional cost.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to individual Fire Protection sections and Division 01.

1.7 LOCATIONS AND MEASUREMENTS

A. Location of Fire Protection work is shown on the drawings as accurately as possible. Field-verify all measurements to insure that the work suits the surrounding trim, finishes and/or construction. Provide adjustment as necessary.

B. Make minor relocations of work prior to installation as required or as directed by the Architect/Engineer at no additional cost.

1.8 SUPERVISION

A. Contractor to provide an authorized and competent representative to constantly supervise the work from the beginning to completion and final acceptance. Insofar as possible, keep the same foreman and workmen throughout the project duration.

B. Representatives of Architect/Engineer, Owner, and local inspection authorities will make inspections during the progress of the work. Contractor to accommodate such inspections and correct deficiencies noted.

1.9 QUALITY AND WORKMANSHIP

A. Contractor to employ skilled tradesmen, laborers and supervisors. Final product to be a neat, well finished, and professional installation.

B. Remove and replace any work considered substandard quality in the judgment of the Architect/Engineer.

1.10 CLOSING IN WORK

A. Do not cover up or enclose work until it has been inspected, tested and approved by authorities having jurisdiction over the work. Uncover any such work for inspection and/or test at no additional cost. Restore the work to its original condition after inspection and/or test at no additional cost.

1.11 CUTTING AND PATCHING

A. Perform all cutting and patching necessary to install work under this Division.

B. Perform cutting and patching in professional, workmanlike manner.

C. Arrange work to minimize cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members without written permission from the Architect/Engineer.

E. Cut opening only large enough to allow easy installation of piping, wiring or ductwork.

F. Patching material to match material removed.

G. Restore patched surface to its original appearance at completion of patching.

H. Where waterproofed surfaces are patched, maintain integrity of waterproofing.

I. Remove rubble and excess patching materials from the premises.

1.12 INTERPRETATION OF DRAWINGS

A. Drawings and specifications under this Division are complementary each to the other. Provide any work specified herein and/or indicated on the drawings.

B. Drawings are diagrammatic and indicate generally the location of fixtures, piping, devices, equipment, etc. Follow drawings as closely as possible, but arrange work to suit the finished surroundings and/or trim.

C. The words “furnish”, “provide”, and/or “install” as used in these drawings and specifications are interpreted to include all material and labor necessary to complete the particular item, system, equipment, etc.

D. Any omissions from either the drawings or specifications are unintentional. Contractor is responsible for notifying the Architect/Engineer of any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.

1.13 ACCESSIBILITY

A. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment to include, but not be limited to, valves, traps, cleanouts, motors, controllers and drain points. If required for accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

B. Coordinate exact locations and size of access panels for each concealed device requiring service.

C. Access panels: Steel construction with 16 gauge frames and 18 gauge panels, factory primed with rust inhibiting paint, finish paint by Contractor. Provide suitable UL listed doors where installed in rated construction.

D. Coordinate access panel locations with architectural construction.

E. Access panels are not required for access to work located above a lift-out “T” bar type ceiling.

1.14 ELECTRICAL WORK IN CONNECTION WITH FIRE PROTECTION WORK

A. Comply with Division 26.

1.15 FIRE PROTECTION WORK IN CONNECTION WITH OTHER CONTRACTS

A. Provide Fire Protection services as required for items furnished by other contractors or vendors as shown on the Fire Protection drawings. Include rough-ins and final connections to equipment. Locations of connections shown on the drawings are approximate and some adjustment of actual connection locations should be anticipated. Coordinate exact connection requirements. Make final connections only after approval of the other contractor or vendor, in the contractor's or vendor's presence.

1.16 CONSTRUCTION IN EXISTING BUILDINGS

A. Provide safety barriers, protective devices, screening, etc., as required to maintain the safety of visitors in or near the work area.

B. Maintain clean work area. At the end of each working period, remove all debris, boxes, waste, etc. from the premises and dispose of properly.

C. Coordinate installation of new fire protection work in the existing building. Arrange piping and equipment to avoid interference with existing architectural, structural, mechanical and electrical work.

D. Contractor is responsible for any and all damage to existing buildings, grounds, walkways, pavement, etc. occurring during the course of his work. Repair any such damage to finish equal to that prior to damage to the satisfaction of the Architect/Engineer.

1.17 PROJECT RECORD DRAWINGS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specification Sections.

B. As the work progresses, legibly record all field changes on a set of project contract drawings, herein after called the “record drawings.”

C. Accurately show the installed condition of Fire Protection work on record drawings.

1.18 PHASING OF THE WORK

A. Schedule work in accordance with the relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

1.19 PROJECT CLOSEOUT

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 210000

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

    a. Galvanized-steel-pipe sleeves.

2. Concrete Slabs-on-Grade:

    a. Galvanized-steel-pipe sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

    a. Galvanized-steel-pipe sleeves.

4. Interior Partitions:

    a. Galvanized-steel-pipe sleeves.

END OF SECTION 210517

SECTION 210523 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Two-piece ball valves with indicators.
2. Bronze butterfly valves with indicators.
3. Iron butterfly valves with indicators.
4. Check valves.
5. Bronze OS&Y gate valves.
6. Iron OS&Y gate valves.
7. NRS gate valves.
8. Indicator posts.
9. Trim and drain valves.

1.3 DEFINITIONS

A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HLXS - Butterfly Valves.
3) Level 3: HMER - Check Valves.
4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:

1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear or traveling nut.
10. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
11. End Connections for Valves NPS 2-1/2: Grooved ends.

2.3 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear or traveling nut.

8. Body Design: Lug, wafer or Grooved-end connections.

2.4 CHECK VALVES

A. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.5 BRONZE OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. End Connections: Threaded.

2.6 IRON OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Stem: Brass or bronze.
6. Packing: Non-asbestos PTFE.

2.7 INDICATOR POSTS

A. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Underground.

3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Wrench.

2.8 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Description:

a. Pressure Rating: 250 psig.
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:

1. Description:

a. Pressure Rating: 250 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Description:

a. Pressure Rating: 250 psig.
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements of NFPA 13. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION 210523

SECTION 211313 - WET-PIPE SPRINKLER 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. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

B. Related Requirements:

1. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, and trim and drain valves.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and professional engineer.

B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

C. Fire-hydrant flow test report.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

E. Fire Sprinkler Contractor: The Fire Sprinkler Contractor should submit working shop drawings, hydraulic calculations, and product data to the design engineer of record and AHJ for review/approval. 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.

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: As required by NFPA 13.
b. Sprinkler Occupancy Hazard Classifications:

1) Building Service Areas: Ordinary Hazard, Group 1.
2) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
3) General Storage Areas: Ordinary Hazard, Group 1.
4) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
5) Office and Public Areas: Light Hazard.

2. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

3. Maximum Protection Area per Sprinkler: According to UL listing.
4. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft..
b. Storage Areas: 130 sq. ft..
c. Mechanical Equipment Rooms: 130 sq. ft..
d. Electrical Equipment Rooms: 130 sq. ft..
e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Malleable- or Ductile-Iron Unions: UL 860.

E. Malleable-Iron Threaded Fittings: ASME B16.3.

F. Gray-Iron Threaded Fittings: ASME B16.4

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

I. Grooved-Joint, Steel-Pipe Appurtenances:

1. Pressure Rating: 250-psig minimum.
2. Painted Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:

1. Standard: UL 193.
2. Design: For horizontal or vertical installation.
3. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
4. 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

G. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175-psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Branch Line Testers:

1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

C. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

D. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 250-psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.5 SPRINKLERS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes: Bronze and painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Plastic, white finish, one piece, flat.
2. Sidewall Mounting: Plastic, white finish, one piece, flat.

F. Sprinkler Guards:

1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.6 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

C. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. 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

2.7 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: 0- to 250-psig minimum.

D. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

M. Fill sprinkler system piping with water.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

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

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.9 DEMONSTRATION

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

3.10 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Recessed sprinklers.
3. Wall Mounting: Sidewall sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 220000 – PLUMBING

Plumbing work shall be defined by drawings numbered with the prefix "P-", the general provision of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division-22 Plumbing Specifications.

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11/25/2024

END OF SECTION 220000

SECTION 220000 - GENERAL PLUMBING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Instructions to Bidders, General Conditions of the Contract, Supplementary General Conditions and Division 01 Specifications Sections bound herewith are a component part of Division 22 specifications. Comply with all provisions, details and instructions of these sections in the accomplishment of work covered under Division 22.

B. Furnish all labor, materials and equipment and incidentals required to make ready for use complete plumbing systems as shown on the Drawings and specified herein.

C. Where Sub-Contracts are used to perform portions of the work, division of labor between sub trades is the responsibility of the Contractor.

D. Furnish all labor, materials and equipment and incidentals required to make ready for use complete plumbing systems as shown on the Drawings and specified herein.

E. Work includes furnishing, installing and testing the equipment and materials specified in other sections of the Division Specifications and shown on the Plumbing Drawings. It is the intent of these Specifications that the plumbing systems shall be suitable in every way for the intended usage. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

F. The general scope work includes, but is not limited to, furnishing, coordinating, and installing the following.

1. Sanitary waste and vent systems with connection to site utilities.
2. Domestic water distribution systems with connection to site utilities.
3. Roof drainage systems with connections to site utilities.
4. Fuel gas piping with connection to site gas supply.
5. Plumbing fixtures, specialties and equipment.

G. Visit all areas of the existing site, buildings and structures (as applicable) in which work under these sections is to be performed. Inspect carefully the existing conditions prior to bidding. Bid submission is evidence that the Contractor has examined the site and existing conditions, understands conditions under which the work will be performed, and takes full responsibility for complete knowledge of all factors governing the work.

H. Schedule all service interruptions in existing facilities at the Owner’s convenience with 72 hours (minimum) notice. Obtain prior approval for each interruption.

I. Thoroughly test all plumbing systems after installation and make any minor corrections, changes or adjustments necessary for proper functioning of the systems and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

1.2 SUBMITTALS

A. Procedures for submittals: Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

Transmit each shop drawing submittal with provided Shop Drawing Submittal Cover Form, attached herewith for each item of equipment/material or each specification section/paragraph.

B. Clearly indicate proposed equipment and/or materials substitutions in shop drawings. Summarize all deviations from the specified quality, functionality, appearance or performance of proposed equipment and/or materials in the preface of each submittal. Include documentation to support deviations.

C. Provide descriptive data on all materials and equipment as required to ascertain compliance with Specifications.

D. Design layout shown on drawings is based on physical sizes of reputable equipment manufacturers. If equipment other than models indicated is installed, any resulting conflicts with space, maintenance access, clearances or codes are the responsibility of the Contractor to correct at his expense.

E. Where specific models and manufacturers of materials and equipment are specified, substitutions as allowed by the specifications and State law will be considered. Substitutions must be equivalent in quality, function, suitability and arrangement to specified equipment. Architect/Engineer to have final authority as to equivalency of substitutions.

F. Equipment model numbers noted in these specifications or on the drawings are intended to establish a minimum standard of quality and do not necessarily relate to specific options or arrangement as shown. Provide equipment with all standard features and optional features as stated and arranged as shown on the drawings.

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with all applicable state and local codes, standards and regulations.

B. Furnish all materials and labor which is be required for compliance with codes, standards and regulations, whether specifically mentioned in these specifications or shown on the drawings.

C. Obtain required construction permit from the authority having jurisdiction and arrange, at the proper time, for all inspections required by such authority. Pay all permit and inspection costs required.

1.4 COORDINATION OF WORK

A. Contractor is responsible for coordination of work between trades. Provide fully complete and functional systems.

B. Compare plumbing drawings and specifications with the drawings and specifications for other trades.

C. Coordinate plumbing installation with the work of other trades. Report any pertinent discrepancies to the Architect/Engineer and obtain written instructions for any necessary revisions. Before starting any construction, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. No extras will be allowed for rework of uncoordinated installations.

D. Determine exact route and location of each plumbing item prior to fabrication and/or installation. Adjust location of piping and equipment, etc., to accommodate interferences anticipated and encountered.

E. Right of Way: General priority for right of way is as follows:

1. Items located per regulatory requirement.
2. Piping with pitch requirement (plumbing drains, etc.).
3. Ductwork.
4. Piping without pitch requirement.
5. Electrical wiring (conduits, etc.).

F. Arrange all work to permit removal (without damage to other parts) of any equipment requiring periodic replacement.

G. Provide clearance and easy access to any equipment which requires periodic maintenance. Arrange ducts, piping and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging doors and access panels.

1.5 EQUIPMENT AND MATERIALS (GENERAL)

A. Provide all new materials unless specifically indicated otherwise.

B. Manufacturers and models listed in drawings and specifications are used for layout and to convey to bidders the general style, type, character and quality of product desired. Listed examples are used only to denote the quality standard of product desired and are not intended to restrict bidders to a specific brand, make, manufacturer or specific name.

C. Adjust layout, system connections and coordinate with other trades as required to properly install equivalent products.

D. Where equivalent products are submitted, include all associated costs related to substitution in bid.

E. Furnish materials bearing the manufacturer’s name and trade name. Provide UL label where a UL standard has been established for the particular material.

F. Furnish standard products of manufacturers regularly engaged in production of equipment types required for the work. Use the manufacturer’s latest approved design.

G. Use the same manufacturer for equipment and materials of the same general type throughout the work to obtain uniform appearance, operation and maintenance.

H. Protect equipment and materials from dirt, water, chemical or mechanical injury and theft at all times during construction. Provide covers or shelter as required.

I. If materials or equipment are damaged at any time prior to final acceptance of the work, repair such damage at no additional cost. If materials or equipment are damaged by water, provide replacement no additional cost.

J. Follow manufacturer's directions completely in the delivery, storage, protection and installation of all equipment and materials. Notify the Architect/Engineer in writing of any conflicts between any requirements of the contract documents and manufacturer's directions. Obtain written instructions before proceeding with the work. The Contractor is responsible for correction of any work that does not comply with the manufacturer's directions or written instructions from the Architect/Engineer at no additional cost.

K. Repair any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. Repaint entire damaged panel or section per the field painting specifications in Division 09 at no additional cost.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to individual plumbing sections and Division 01.

1.7 PAINTING

A. Refer to Division 09.

B. Protect fixtures, valves, trim, etc. from field painting operations. Do not install escutcheons and trim until painting is complete.

1.8 LOCATIONS AND MEASUREMENTS

A. Location of plumbing work is shown on the drawings as accurately as possible. Field-verify all measurements to insure that the work suits the surrounding trim, finishes and/or construction. Provide adjustment as necessary.

B. Make minor relocations of work prior to installation as required or as directed by the Architect/Engineer at no additional cost.

1.9 SUPERVISION

A. Contractor to provide an authorized and competent representative to constantly supervise the work from the beginning to completion and final acceptance. Insofar as possible, keep the same foreman and workmen throughout the project duration.

B. Representatives of Architect/Engineer, Owner, and local inspection authorities will make inspections during the progress of the work. Contractor to accommodate such inspections and correct deficiencies noted.

1.10 QUALITY AND WORKMANSHIP

A. Contractor to employ skilled tradesmen, laborers and supervisors. Final product to be a neat, well finished, and professional installation.

B. Remove and replace any work considered substandard quality in the judgment of the Architect/Engineer.

1.11 EXCAVATION, TRENCHING AND BACKFILLING

A. Provide all excavation, trenching and backfilling as required to complete the work under this Division.

B. Contractor is responsible for investigating conditions prior to excavating and to exercise care during the excavation to avoid any utilities or other objects which may or may not be shown on the drawings.

C. Excavate so as not to endanger or damage existing utilities and structures. If damage occurs, repair damage to the satisfaction of the Architect/Engineer at no additional cost.

D. Lay out location of all ditching at grade and obtain approval from the Architect/Engineer prior excavating.

E. Remove and dispose of all surplus earth from the site.

F. Provide suitable backfill materials as required.

G. Perform excavation, trenching and shoring in accordance with rules and regulations set forth in Article XXI, Bulletin 1 “Trenching” as published in a separate bulletin by the North Carolina Department of Labor, Division of Standards and Inspection Construction Bureau.

H. Bid excavation work as unclassified with no extra payment for removal of rock, unsuitable soils, etc.

1.12 CLOSING IN WORK

A. Do not cover up or enclose work until it has been inspected, tested and approved by authorities having jurisdiction over the work. Uncover any such work for inspection and/or test at no additional cost. Restore the work to its original condition after inspection and/or test at no additional cost.

1.13 CUTTING AND PATCHING

A. Perform all cutting and patching necessary to install work under this Division.

B. Perform cutting and patching in professional, workmanlike manner.

C. Arrange work to minimize cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members without written permission from the Architect/Engineer.

E. Cut opening only large enough to allow easy installation of piping, wiring or ductwork.

F. Patching material to match material removed.

G. Restore patched surface to its original appearance at completion of patching.

H. Where waterproofed surfaces are patched, maintain integrity of waterproofing.

I. Remove rubble and excess patching materials from the premises.

1.14 INTERPRETATION OF DRAWINGS

A. Drawings and specifications under this Division are complementary each to the other. Provide any work specified herein and/or indicated on the drawings.

B. Drawings are diagrammatic and indicate generally the location of fixtures, piping, devices, equipment, etc. Follow drawings as closely as possible, but arrange work to suit the finished surroundings and/or trim.

C. The words “furnish”, “provide”, and/or “install” as used in these drawings and specifications are interpreted to include all material and labor necessary to complete the particular item, system, equipment, etc.

D. Any omissions from either the drawings or specifications are unintentional. Contractor is responsible for notifying the Architect/Engineer of any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.

1.15 ACCESSIBILITY

A. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment to include, but not be limited to, valves, traps, cleanouts, motors, controllers and drain points. If required for accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility.

B. Coordinate exact locations and size of access panels for each concealed device requiring service.

C. Access panels: Steel construction with 16 gauge frames and 18 gauge panels, factory primed with rust inhibiting paint, finish paint by Contractor. Provide suitable UL listed doors where installed in rated construction.

D. Coordinate access panel locations with architectural construction.

E. Access panels are not required for access to work located above a lift-out “T” bar type ceiling.

1.16 ELECTRICAL WORK IN CONNECTION WITH PLUMBING WORK

A. Comply with Division 26.

1.17 PLUMBING WORK IN CONNECTION WITH OTHER CONTRACTS

A. Provide plumbing services as required for items furnished by other contractors or vendors as shown on the plumbing drawings. Include rough-ins and final connections to equipment. Locations of connections shown on the drawings are approximate and some adjustment of actual connection locations should be anticipated. Coordinate exact connection requirements. Make final connections only after approval of the other contractor or vendor, in the contractor's or vendor's presence.

1. Natural Gas System- Provide complete gas piping supply from natural gas meter. Coordinate equipment gas requirements with supplier. Contractor is responsible for contacting natural gas supplier and complying with supplier connection and service piping requirements. Provide all required valves, regulators, accessories as shown on drawings.
2. Site Utilities- In general, work under this Division covers work to five feet outside buildings. Extend and connect work under this Division to site utilities as required.
3. Owner Furnished Equipment- Obtain exact plumbing requirements and rough-in locations for Owner furnished equipment. Provide complete plumbing installation for proper operation of equipment.
4. Kitchen Equipment- Obtaining exact plumbing requirements and rough-in locations for kitchen equipment. Provide complete plumbing installation for proper operation of equipment.

1.18 ALTERNATE BIDS

A. Alternate Bids are described in relevant sections of the General and Supplemental General Conditions and Division 01 Specification Sections.

1.19 PROJECT RECORD DRAWINGS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specification Sections.

B. As the work progresses, legibly record all field changes on a set of project contract drawings, herein after called the “record drawings.”

C. Accurately show the installed condition of plumbing work on record drawings.

1.20 PHASING OF THE WORK

A. Schedule work in accordance with the relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

1.21 PROJECT CLOSEOUT

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 01 Specifications Sections.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220000

SECTION 220010 - EXISTING PLUMBING CONDITIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Procedures for plumbing work in existing building.

1.2 PROJECT CONDITIONS

A. Conform to the requirements of Division 01 for cutting and patching. Conform to the requirements of Division 02 and Section 220020 for demolition.

B. Conduct work to minimize interference with adjacent and occupied building areas.

C. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

PART 2 - GENERAL

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

PART 3 - GENERAL

3.1 PREPARATION

A. Coordinate plumbing service interruptions with the Owner.

B. Provide temporary and/or permanent plumbing as shown and/or as required by conditions to maintain existing systems in service during construction. Use hot-tapping valves if required.

C. Existing Plumbing Systems: Maintain existing plumbing systems in service. Disable systems outside construction area only to make tie-ins or switchovers. Obtain permission from the Owner at least 72 hours before partially or completely disabling plumbing. Minimize duration. Make temporary connections as required to maintain service in areas adjacent to work area.

D. Drawings are based on casual field observation and existing record documents. Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

E. Field-verify existing conditions as related to interconnection of New Work. Determine exact methods of interface to obtain proper operation.

F. Coordinate existing and New Work interface prior to beginning any work. Adjust work to suit existing conditions. Some deviations in plan layout vs. actual conditions should be expected.

G. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor=s employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

3.2 EXISTING CONDITIONS

A. Verify existing conditions in field and determine which affect plumbing work. Secure utilities as required to prevent spills, leakage, etc.

B. Protect existing work to remain. Do not cut or remove any structural members.

C. Rework existing services to remain which interfere with new work.

END OF SECTION 220010

SECTION 220020 - PLUMBING DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Selective plumbing demolition.

B. Conform to the requirements of Division 01 for cutting and patching.

C. Conform to the requirements of Division 02 for selective demolition.

1.2 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

1.3 DEFINITIONS

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

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

PART 2 - GENERAL

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

B. Coordinate cutting and patching requirements.

PART 3 - GENERAL

3.1 PREPARATION

A. Demolition Drawings are based on casual field observation. No record documents are available. Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

B. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

C. Protect existing materials and existing improvements which are not to be demolished.

D. Prevent movement of structure; provide temporary bracing and shoring required to ensure safety of existing structure.

E. The plumbing contractor shall review the drawings and specifications for demolition requirements and layout his work in a compatible and complementary manner. Remove all fixtures, equipment, piping, supports, accessories, etc. made obsolete by these alterations as shown in the plumbing drawings. All items to be removed or modified may not be shown, however, this contractor shall remove any plumbing work as required by the construction or as directed by the owner or the engineer. Survey the affected areas before submitting a bid.

F. All existing plumbing fixtures, equipment and piping shall remain unless specifically noted to be removed.

G. These drawings are compiled by the architect/engineer from the owner's as-built record drawings and limited field verification of existing conditions for the purpose of indicating the work required and are believed to be correct. Notwithstanding, the plumbing contractor shall verify all piping, fixture locations, dimensions, materials and all field conditions affecting his work.

H. Where plumbing systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation. Advise the architect/engineer immediately if such conditions are uncovered before proceeding with additional work.

I. Protect all existing life safety systems, fire alarm and public address systems and maintain them in operation throughout the progress of the work. Notify the owner and architect/engineer in writing when shutdowns are required prior to any outage of service. Where the duration of a proposed outage cannot be tolerated by the owner, provide temporary connections as required to maintain service.

J. Survey the affected areas before submitting a bid as all existing conditions cannot be completely depicted on the drawings and some unusual conditions may exist.

3.2 DEMOLITION

A. Disconnect, remove, cap, and identify plumbing work as indicated. Secure utilities as required to prevent spills, leakage, etc.

B. Demolish in an orderly and careful manner. Protect existing work to remain. Do not cut or remove any structural members.

C. Terminate all demolition work in a neat finished manner.

D. Conceal or enclose abandoned work within building construction except as specifically noted.

E. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

F. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

END OF SECTION 220020

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Grout.
3. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anti-corrosion coated, with plain ends and integral welded waterstop collar.

B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

2.2 GROUT

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

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves will be considered defective if they do not pass tests and inspections.

3.3 SLEEVE SCHEDULE

A. Use sleeves for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.
b. Piping NPS 6 and Larger: Steel pipe sleeves.

2. Concrete Slabs Above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.
b. Piping NPS 6 and Larger: Steel pipe sleeves.

3. Interior Partitions:

a. Piping Smaller Than NPS 6: PVC-pipe sleeves.
b. Piping NPS 6 and Larger: PVC-pipe sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated or polished brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.

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

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.

5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

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

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

2.3 DIAL-TYPE PRESSURE GAGES

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

1. Standard: ASME B40.100
2. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Description: Test-station fitting made for insertion in piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install test plugs in piping tees.

I. Install flow indicators in piping systems in accessible positions for easy viewing.

J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

K. Install permanent indicators on walls or brackets in accessible and readable positions.

L. Install connection fittings in accessible locations for attachment to portable indicators.

M. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Each side of mixing valves.

N. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Suction and discharge of each domestic water pump.
3. Each side of back flow preventer.

3.2 CONNECTIONS

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

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

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

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be the following:

1. Metal-case, liquid-in-glass, 9 inch long with a range of 30 to 240 deg. F, 2 degree scale division and an accuracy of plus or minus 1 percent of range.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 PRESSURE-GAGE SCHEDULE

A. Pressure gages shall be the following:

1. Cast aluminum, 4½inch diameter glass window, with a range of two times operating pressure and an accuracy of plus or minus 1 percent of middle half of scale.

3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.

B. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION 220519

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze ball valves.
2. Steel ball valves

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to Plumbing Valve Schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Handlever.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.

j. Port: Full.

2.3 STEEL BALL VALVES

A. Steel Ball Valves with Full Port, Class 150:

1. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 285 psig.
c. Body Design: Split body.
d. Body Material: Carbon steel, ASTM A 216, Type WCB.
e. Ends: Flanged or threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below:

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze ball valves, two-piece with full port and stainless-steel trim.

B. Pipe NPS 2-1/2 and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Steel ball valves, Class 150 with full port.

END OF SECTION 220523

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze swing check valves.
2. Iron swing check valves with closure control.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

1. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

2.3 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:

1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and spring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Install valve tags. Comply with requirements for valve tags and schedules in Section 220553 "Identification for Plumbing Piping and Equipment."

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Steel Piping, NPS 2-1/2 to NPS 6: Flanged ends.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves with Nonmetallic Disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. NPS 2-1/2 to NPS 12: Iron swing check valves with lever and spring-closure control, Class 125.

END OF SECTION 230523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

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

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 EQUIPMENT SUPPORTS

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

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping ins.

3.2 EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

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 a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
12. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.3 ACTION SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Comply with ASME A13.1.
3. Background Color: Comply with ASME A13.1.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Labels shall include equipment number, area(s) served (use actual room numbers used at the facility-not architectural room numbers), Final Acceptance date, extended warranty period, temperature setting, and capacity. The following are examples of labelling to be used:

Water Heaters:	GWH01 (Mechanical Room) S.C.: 11/16/2005 Capacity: 500 gallon Temperature Setting: 140 deg. F
Pumps:	HWRP01 (HW Rec. Pump - Buildings 100 & 200) S.C.: 11/16/2005 Capacity: 20 gpm @ 15 ft head.
Access Doors:	Domestic Water Isolation Valves Restroom 102

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.
3. Colors: Comply with ASME A13.1, unless otherwise indicated.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link chain, beaded chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be permanently affixed to wall inside Boiler Room 43. Schedule shall be laminated designating valve location and rooms served.
2. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Paint and color-code all exposed piping located in equipment rooms. Piping shall be color coded as follows with flow arrows and labels located at 10 foot intervals, at all turns and at each floor or wall partition:

Domestic Cold Piping:	Dark Blue
Domestic Hot Piping:	Dark Red
Natural Gas Piping:	Yellow

B. Provide ceiling valve marker for valves located above lay-in ceilings. Above ceiling valve markers shall be 1/2 inch diameter self-adhesive color-coded circle. Color code as noted above. Attach valve marker to adjacent ceiling grid.

C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Domestic Water Piping

   a. Background: Comply with ASME A13.1.
   b. Letter Colors: Comply with ASME A13.1.

2. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Comply with ASME A13.1.
   b. Letter Color: Comply with ASME A13.1.

3.5 PIPE PAINTING

A. Paint and color-code all exposed piping located in mechanical rooms. Piping shall be color coded as follows with flow arrows and labels located at 10 foot intervals, at all turns and at each floor or wall partition:

1. Gas Lines: Yellow.

3.6 VALVE-TAG INSTALLATION

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

B. Contractor to furnish valve schedule mounted behind glass in a frame located in main mechanical room.

C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches, round.
   b. Hot Water: 1-1/2 inches, round.
   c. Gas: 1-1/2 inches, round.

2. Valve-Tag Colors:

   a. Cold Water: Comply with ASME A13.1.
   b. Hot Water: Comply with ASME A13.1.
   c. Flammable Fluids: Black letters on a safety-yellow background.

3. Letter Colors:

   a. Cold Water: Comply with ASME A13.1.
   b. Hot Water: Comply with ASME A13.1.
   c. Gas: Comply with ASME A13.1.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. ASJ Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14. Prime metal jacket with paint grip finish.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
d. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.

6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.11 SECUREMENTS

A. Bands:

1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy.

2.12 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for

above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

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

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified in Section 220553 “Identification for Plumbing Piping and Equipment.”

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded

fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

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

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold and Hot Water:

1. Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Recirculated Hot Water:

1. Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, exposed insulated lines within 8 ft. above floor in occupied spaces:

1. Painted Aluminum, Smooth: 0.024 inch thick, Color-Coded by System.

C. Piping, exposed in equipment rooms:

1. Painted field applied cloth woven glass fiber fabric, Color-Coded by System.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. This Division is applicable to domestic cold and hot water piping within building to a point 5 feet outside the building.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G.

C. Comply with NSF Standard 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys.

B. Flux: ASTM B 813, water flushable.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Description:

a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket end.

D. Plastic-to-Metal Transition Unions:

1. Description:

a. CPVC or PVC four-part union.
b. Solvent-cement-joint plastic end.
c. Rubber O-ring.
d. Union nut.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5. Do not locate joints below slab of building.

D. Install shutoff valve, hose-end drain valve, pressure gage, and test tee with valve inside the building at domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install domestic water piping level without pitch and plumb.

G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

K. Install piping to permit valve servicing.

L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

P. Install pressure gages on suction and discharge piping for each plumbing pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

Q. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

R. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

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

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

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

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired. The water distribution system shall be tested not less than 100 psi water pressure in accordance with 2018 NC Plumbing Code 312.5.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

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

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

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

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Under-building-slab, domestic water, building-service piping shall be the following:

1. Soft copper tube, ASTM B 88, Type K; no joints.

C. Aboveground domestic water piping shall be any of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.12 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Drain valves.
6. Outlet boxes.
7. Hose bibbs.
8. Roof hydrants.
9. Water-hammer arresters.

B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Refer to Plumbing Fixture Schedule for further information.
5. Accessories:

a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.

B. Beverage-Dispensing-Equipment Backflow Preventers:

1. Standard: ASSE 1022.
2. Operation: Continuous-pressure applications.
3. Size: NPS 1/4 or NPS 3/8.
4. Body: Stainless steel.
5. End Connections: Threaded.
6. Refer to Plumbing Fixture Schedule for further information.

C. Hose-Connection Backflow Preventers:

1. Standard: ASSE 1052.
2. Operation: Up to 10-foot head of water back pressure.
3. Inlet Size: NPS 1/2 or NPS 3/4.
4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
5. Capacity: At least 3-gpm flow.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Type: Ball valve with two readout ports and memory-setting indicator.
2. Body: bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves, MX1:

1. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. Body: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: Threaded.
6. Finish: Rough or chrome-plated bronze.
7. Tempered-Water Setting: 110 deg F.
8. Tempered-Water Design Flow Rate: 1.5 gpm.

2.7 DRAIN VALVES

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

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

2.8 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
3. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
5. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

6. Inlet Hoses: Two 60-inch-long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
7. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 ROOF HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:

1. Standard: ASSE 1052 listed.
2. Type: Nonfreeze, exposed-outlet post hydrant.
3. Operation: RH lever.
4. Hydrant Support: Cast Iron.
5. Inlet: NPS 1.
6. Outlet: Garden-hose thread complying with ASME B1.20.7.
7. Drain: Designed with hole to drain into ground when shut off.
8. Vacuum Breaker:

    a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install balancing valves in locations where they can easily be adjusted.

C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

D. Install Y-pattern strainers where indicated on plans and risers.

E. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

F. Nonfreeze, Draining-Type Post Hydrants: Install with [**1 (0.75)**] <**Insert dimension**> cu. yd. (cu. m) of crushed gravel around drain hole. Set post hydrants in concrete paving or in [**1 (0.03)**] <**Insert dimension**> cu. ft. (cu. m) of concrete block at grade.

G. Install water-hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Double-check, backflow-prevention assemblies.
2. Outlet boxes.
3. Primary, thermostatic, water mixing valves.
4. Calibrated balancing valves.

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

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

SECTION 221123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Joining materials.
3. Manual gas shutoff valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.

B. 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.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.6 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. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide purging and startup of natural-gas supply in accordance with requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Architect's written permission.

1.7 COORDINATION

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

B. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 220553 "Identification of Plumbing Piping and Equipment."

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each product type from a single source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 54.

B. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

C. Natural-Gas System Pressure:

1. Two pressure ranges. Primary pressure is more than 0.5 psig, but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

2.3 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
3. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

4. Mechanical Couplings:

    a. Coupling is to be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    b. Steel body couplings installed underground on plastic pipe are to be factory equipped with anode.

B. PE Pipe: ASTM D2513, SDR 11.

1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet is threaded or flanged or suitable for welded connection.
    e. Tracer wire connection.
    f. UV shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

2.5 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.

5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.

2.6 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping in accordance with NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 requirements for preventing accidental ignition.

3.3 INSTALLATION OF OUTDOOR PIPING

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping in accordance with ASTM D2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

3.4 INSTALLATION OF VALVES

A. Install underground valves with valve boxes.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install anode for metallic valves in underground PE piping.

3.5 PIPING 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:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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 Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Support horizontal piping within 12 inches of each fitting.

C. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Where installing piping adjacent to appliances allow space for service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.8 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Test, inspect, and purge natural gas in accordance with NFPA 54 and authorities having jurisdiction.
2. Natural-gas piping will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.10 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping is to be one of the following:

1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping is to be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

3.11 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter are to be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 231123

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Standards: ASTM C 1277 and ASTM C 1540.
2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C 1173.
    b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.
    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Shielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C 1460.
    b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. End Connections: Same size as and compatible with pipes to be joined.

4. Pressure Transition Couplings:

    a. Standard: AWWA C219.
    b. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

c. Center-Sleeve Material: [Manufacturer's standard] [Carbon steel] [Stainless steel] [Ductile iron] [Malleable iron].
d. Gasket Material: Natural or synthetic rubber.
e. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

5. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in piping.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, vent piping shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Underground, soil, waste, and vent piping shall be the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Air-admittance valves.
3. Roof flashing assemblies.
4. Through-penetration firestop assemblies.
5. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected drainage piping
3. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Standard: ASME A112.36.2M for adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Threaded, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Threaded.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Square.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure Plug:

    a. Brass.
    b. Countersunk or raised head.
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as or not more than one size smaller than cleanout size.

5. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Description: Manufactured assembly approved by roof manufacturer.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2: 4-inch-minimum water seal.
    b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

E. Assemble open drain fittings and install with top of hub 2 inches above floor.

F. Install deep-seal traps on floor drains and other waste outlets, if indicated.

G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

H. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

I. Install wood-blocking reinforcement for wall-mounting-type specialties.

J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Comply with roof manufacturer's requirements.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

2.2 FLOOR DRAINS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

2.3 FLOOR SINKS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.

1.3 DEFINITIONS

A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS, FLUSHOMETER VALVES AND TOILET SEATS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.

C. Install toilet seats on water closets.

D. Wall Flange and Escutcheon Installation:

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

E. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224213.16 - COMMERCIAL URINALS

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. Urinals.
2. Supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Waterless Urinal Trap-Seal Liquid: Equal to 1 gal. for each urinal installed.
2. Waterless Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.

PART 2 - PRODUCTS

2.1 WATERLESS URINALS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

2.2 SUPPORTS

A. Type I Urinal Carrier:

1. Standard: ASME A112.6.1M.

B. Type II Urinal Carrier:

1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

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

3.2 INSTALLATION

A. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
4. Install trap-seal liquid in waterless urinals.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

C. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.16

SECTION 224216.13 - COMMERCIAL LAVATORIES

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. Lavatories.
2. Faucets.
3. Supply fittings.
4. Waste fittings.
5. Supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 LAVATORIES AND FAUCETS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

2.2 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2.
2. ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.3 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.

3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

2.4 SUPPORTS

A. Type II Lavatory Carrier:

1. Standard: ASME A112.6.1M.

B. Type III Lavatory Carrier:

1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

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

3.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

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. Service basins.
2. Service sinks.
3. Sink faucets.
4. Supports.
5. Supply fittings.
6. Waste fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sinks to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.

2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

2.2 SERVICE SINKS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

2.3 SINK FAUCETS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

2.4 SUPPORTS

A. Type II Sink Carrier:

1. Standard: ASME A112.6.1M.

2.5 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2.
2. Chrome-plated, rigid-copper pipe.

2.6 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2.
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

2.7 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

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

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224716 - PRESSURE WATER COOLERS

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 pressure water coolers and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Refer to Plumbing Fixture Schedule on design drawings for further information.

2.2 SUPPORTS

A. Type I Water Cooler Carrier:

1. Standard: ASME A112.6.1M.

B. Type II Water Cooler Carrier:

1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Set freestanding pressure water coolers on floor.

C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.

E. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."

F. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224716

SECTION 230000 – MECHANICAL

Mechanical work shall be defined by drawings numbered with the prefix "M-", the general provision of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division-23 Mechanical Specifications.

Engineer of Record for Division 23 is David M. Hahn, PE, CBHF Engineers, PLLC, 2246 Yaupon Drive, Wilmington, NC 28401.

11/25/2024

END OF SECTION 230000

SECTION 230000 - GENERAL MECHANICAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work shall include furnishing, installing and testing the equipment and materials specified in other sections of the Mechanical Specifications and shown on the Drawings. It is the intent of these Specifications that the mechanical systems shall be suitable in every way for the intended usage. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

B. Division 01 Specifications Sections bound herewith are a component part of Division 23 specifications. Comply with all provisions, details and instructions of these sections in the accomplishment of work covered under Division 23.

C. Furnish all labor, materials and equipment and incidentals required to make ready for use complete mechanical systems as shown on the Drawings and specified herein.

D. Where Sub-Contracts are used to perform portions of the work, division of labor between sub trades is the responsibility of the Contractor.

E. The general scope work includes, but is not limited to, furnishing, coordinating, and installing the following:

1. Heating, air conditioning and ventilation equipment.
2. Ductwork, air distribution.
3. HVAC piping, specialties and equipment.
4. Controls and wiring.
5. Commissioning, testing and balancing.

F. Visit all areas of the site in which work under these sections is to be performed. Inspect carefully the existing conditions prior to bidding. Bid submission is evidence that the Contractor has examined the site and existing conditions, understands conditions under which the work will be performed, and takes full responsibility for complete knowledge of all factors governing the work.

G. Schedule all service interruptions in existing facilities at the Owner’s convenience with 24 hours (minimum) notice. Obtain prior approval for each interruption.

H. Thoroughly test all mechanical systems at the completion of work and make any minor correction changes or adjustments necessary for all the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

1.2 SUBMITTALS

A. Procedures for submittals: Submit under provisions of relevant sections of Division 01 Specifications Sections.

Transmit each shop drawing submittal with provided Shop Drawing Submittal Cover Form, attached as Appendix B, for each item of equipment/material or each specification section/paragraph

B. Clearly indicate proposed equipment and/or materials substitutions in shop drawings. Summarize all deviations from the specified quality, functionality, appearance or performance of proposed equipment and/or materials in the preface of each submittal. Include documentation to support deviations.

C. Provide descriptive data on all materials and equipment as required to ascertain compliance with Specifications.

D. Design layout shown on drawings is based on physical sizes of reputable equipment manufacturers. If equipment other than models indicated is installed, any resulting conflicts with space, maintenance access, clearances or codes are the responsibility of the Contractor to correct at his expense.

E. Where specific models and manufacturers of materials and equipment are specified, substitutions as allowed by the specifications and State law will be considered. Substitutions must be equivalent in quality, function, suitability and arrangement to specified equipment. Architect/Engineer to have final authority as to equivalency of substitutions.

F. Equipment model numbers noted in these specifications or on the drawings are intended to establish a minimum standard of quality and do not necessarily relate to specific options or arrangement as shown. Provide equipment with all standard features and optional features as stated and arranged as shown on the drawings.

1.3 REGULATORY REQUIREMENTS

A. Perform Work in accordance with all applicable state and local codes, standards and regulations.

B. Furnish all materials and labor which is be required for compliance with codes, standards and regulations, whether specifically mentioned in these specifications or shown on the drawings.

C. Obtain required construction permit from the authority having jurisdiction and arrange, at the proper time, for all inspections required by such authority. Pay all permit and inspection costs required.

1.4 COORDINATION OF WORK

A. Contractor is responsible for coordination of work between trades. Provide fully complete and functional systems.

B. Compare mechanical drawings and specifications with the drawings and specifications for other trades.

C. Coordinate mechanical installation with the work of other trades. Report any pertinent discrepancies to the Architect/Engineer and obtain written instructions for any necessary

revisions. Before starting any construction, make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. No extras will be allowed for rework of uncoordinated installations.

D. Determine exact route and location of each mechanical item prior to fabrication and/or installation. Adjust location of ducts, piping and equipment, etc., to accommodate interferences anticipated and encountered.

E. Right of Way: General priority for right of way is as follows:

1. Items located per regulatory requirement.
2. Piping with pitch requirement (plumbing drains, etc.).
3. Ductwork.
4. Piping without pitch requirement.
5. Electrical wiring (conduits, etc.).

F. Arrange all work to permit removal (without damage to other parts) of any equipment requiring periodic replacement.

G. Provide clearance and easy access to any equipment which requires periodic maintenance. Arrange ducts, piping and equipment to permit ready access to valves, starters, motors, control components, etc., and to clear the opening of swinging doors and access panels.

1.5 EQUIPMENT AND MATERIALS (GENERAL)

A. Provide all new materials unless specifically indicated otherwise.

B. Manufacturers and models listed in drawings and specifications are used for layout and to convey to bidders the general style, type, character and quality of product desired. Listed examples are used only to denote the quality standard of product desired and are not intended to restrict bidders to a specific brand, make, manufacturer or specific name.

C. Adjust layout, system connections and coordinate with other trades as required to properly install equivalent products.

D. Where equivalent products are submitted, include all associated costs related to substitution in bid.

E. Furnish materials bearing the manufacturer’s name and trade name. Provide UL label where a UL standard has been established for the particular material.

F. Furnish standard products of manufacturers regularly engaged in production of equipment types required for the work. Use the manufacturer's latest approved design.

G. Use the same manufacturer for equipment and materials of the same general type throughout the work to obtain uniform appearance, operation and maintenance.

H. Protect equipment and materials from dirt, water, chemical or mechanical injury and theft at all times during construction. Provide covers or shelter as required.

I. If materials or equipment are damaged at any time prior to final acceptance of the work, repair such damage at no additional cost. If materials or equipment are damaged by water, provide replacement no additional cost.

J. Follow manufacturer's directions completely in the delivery, storage, protection and installation of all equipment and materials. Notify the Architect/Engineer in writing of any conflicts between any requirements of the contract documents and manufacturer's directions. Obtain written instructions before proceeding with the work. The Contractor is responsible for correction of any work that does not comply with the manufacturer's directions or written instructions from the Architect/Engineer at no additional cost.

K. Repair any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. Repaint entire damaged panel or section.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Refer to individual mechanical sections and Division 01.

1.7 PAINTING

A. Protect sensors, controllers, etc. against painting. Do not install thermostats, devices or trim until painting is complete.

1.8 CONDENSATE DRAIN PIPING

A. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints. Insulate entire length of condensate piping from unit connection to discharge location.

1.9 LOCATIONS AND MEASUREMENTS

A. Location of mechanical work is shown on the drawings as accurately as possible. Field verify all measurements to insure that the work suits the surrounding structure, trim, finishes and/or construction. Provide adjustment as necessary.

B. Make minor relocations of work prior to installation as required or as directed by the Architect/Engineer at no additional cost.

1.10 SUPERVISION

A. Contractor to provide an authorized and competent representative to constantly supervise the work from the beginning to completion and final acceptance. Insofar as possible, keep the same foreman and workmen throughout the project duration.

B. Representatives of Architect/Engineer, Owner, and inspection authorities will make inspections during the progress of the work. Contractor to accommodate such inspections and correct deficiencies noted.

1.11 QUALITY AND WORKMANSHIP

A. Contractor to employ skilled tradesmen, laborers and supervisors. Final product to present a neat, well finished, and professional installation.

B. Remove and replace any work considered substandard quality in the judgment of the Architect/Engineer.

1.12 CLOSING IN WORK

A. Do not cover up or enclose work until it has been inspected, tested and approved by authorities having jurisdiction over the work. Uncover any such work for inspection and/or test at no additional cost. Restore the work to its original condition after inspection and/or test at no additional cost.

1.13 CUTTING AND PATCHING

A. Perform all cutting and patching necessary to install work under this Division.

B. Perform cutting and patching in professional, workmanlike manner.

C. Arrange work to minimize cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members without written permission from the Architect/Engineer.

E. Cut opening only large enough to allow easy installation of piping, wiring or ductwork.

F. Patching material to match material removed.

G. Restore patched surface to its original appearance at completion of patching.

H. Where waterproofed surfaces are patched, maintain integrity of waterproofing.

I. Remove rubble and excess patching materials from the premises.

1.14 INTERPRETATION OF DRAWINGS

A. Drawings and specifications under this Division are complementary each to the other. Provide any work specified herein and/or indicated on the drawings.

B. Drawings are diagrammatic and indicate generally the location of fixtures, piping, devices, equipment, etc. Follow drawings as closely as possible, but arrange work to suit the finished surroundings and/or trim.

C. The words “furnish”, “provide”, and/or “install” as used in these drawings and specifications are interpreted to include all material and labor necessary to complete the particular item, system, equipment, etc.

D. Any omissions from either the drawings or specifications are unintentional. Contractor is responsible for notifying the Architect/Engineer of any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.

1.15 ACCESSIBILITY

A. Locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment to include, but not be limited to, valves, motors, controllers, and dampers. If required for accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility. Lack of access doors on drawings does not relieve Contractor of responsibility to provide access doors, if needed to properly service equipment.

B. Coordinate exact locations and size of access panels for each concealed device requiring service.

C. Coordinate access panel locations with architectural construction.

D. Access panels are not required for access to work located above a lift-out “T” bar type ceiling.

1.16 ELECTRICAL WORK IN CONNECTION WITH MECHANICAL CONTRACTS

A. Comply with Division 26. Any required Division 23 electrical work not specifically specified to be furnished by Division 26 Contractor shall be provided by Division 23 Contractor.

B. All electrical work performed Division 23 shall comply with Division 26 specification requirements. Install control wiring in conduit.

C. Coordinate electrical interface of supplied mechanical equipment with electrical system. Division 26 electrical work for mechanical systems is based on values scheduled on mechanical drawings. Division 23 Contractor is responsible for any costs to modify the contracted electrical work to service equipment with electrical characteristics different than those scheduled.

D. Under Division 26, power wiring shall be provided up to a termination point consisting of a 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.

E. Refer to diagram on drawing clarifying who is to provide and install the termination point, such as (trough, VFD, individual starter, disconnect switch, JB, --- etc.).

1.17 MECHANICAL WORK IN CONNECTION WITH OTHER CONTRACTS

A. Provide mechanical services as required for items furnished by other contractors or vendors as shown on the Drawings. Actual requirements may vary from Drawings. Coordinate with equipment installed. Make final connections only after approval of the other contractor or vendor, in the contractor's or vendor’s presence.

1.18 ALTERNATE BIDS

A. Alternate Bids, IF ANY, are described in relevant sections of Division 01 Specification Sections.

1.19 PROJECT RECORD DRAWINGS

A. Submit under provisions of relevant sections of Division 01 Specifications Sections.

B. As the work progresses, legibly record all field changes on a set of project contract drawings, herein after called the “record drawings.”

C. Record drawings shall accurately show the installed condition of mechanical work.

1.20 PHASING OF THE WORK

A. Schedule work in accordance with the relevant sections of Division 01 Specifications Sections.

1.21 PROJECT CLOSEOUT

A. Submit under provisions of relevant sections of Division 01 Specifications Sections.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230000

SECTION 230010 – EXISTING CONDITIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Procedures for mechanical work in existing building.

1.2 RELATED WORK

A. Conform to the requirements of Division 1 for cutting and patching. Conform to the requirements of Division 2 [and Section 23 00 20 for demolition.]

B. Conduct work to minimize interference with adjacent and occupied building areas.

C. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate mechanical service interruptions with the Owner.

B. Provide temporary and/or permanent mechanical as shown and/or as required by conditions to maintain existing systems in service during construction. Use hot-tapping valves if required.

C. Existing Mechanical Systems: Maintain existing mechanical systems in service. Disable systems outside construction area only to make tie-ins or switchovers. Obtain permission from the Owner at least 24 hours before partially or completely disabling mechanical. Minimize duration. Make temporary connections as required to maintain service in areas adjacent to work area.

D. Drawings are based on casual field observation and existing record documents. Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

E. Field-verify existing conditions as related to interconnection of New Work. Determine exact methods of interface to obtain proper operation.

F. Coordinate existing and New Work interface prior to beginning any work. Adjust work to suit existing conditions. Some deviations in plan layout vs. actual conditions should be expected.

G. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

3.2 EXISTING CONDITIONS

A. Verify existing conditions in field and determine which affect mechanical work. Secure utilities as required to prevent spills, leakage, etc.

B. Protect existing work to remain. Do not cut or remove any structural members.

C. Rework existing services to remain which interfere with new work.

END OF SECTION 230010

SECTION 230020 – MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Selective mechanical demolition.

B. Conform to the requirements of Division 01 for cutting and patching.

C. Conform to the requirements of Division 02 for selective demolition

1.2 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

1.3 DEFINITIONS

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

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. As specified in individual Sections.

PART 3 - EXECUTION

3.1 PREPARATION

A. Demolition Drawings are based on casual field observation [and existing record documents]. [No record documents are available.] Survey the affected areas before submitting bid proposal. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

B. Provide, erect, and maintain temporary dust screens, safeguards, barricades, signage and similar measures, for protection of the public, Owner, Contractor's employees, and existing construction to remain. Provide protective barriers indicated in the contract drawings.

C. Protect existing materials and existing improvements which are not to be demolished.

D. Prevent movement of structure; provide temporary bracing and shoring required to ensure safety of existing structure.

3.2 DEMOLITION

A. Demolish mechanical work as indicated. Secure utilities as required to prevent spills, leakage, etc.

B. Demolish in an orderly and careful manner. Protect existing work to remain. Do not cut or remove any structural members.

C. Terminate all demolition work in a neat finished manner.

D. Conceal or enclose abandoned work within building construction except as specifically noted.

E. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

F. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

G. Coordinate cutting and patching requirements.

END OF SECTION 230020

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor. .

B. Efficiency: Energy efficient, complying with NEMA Standard Publication General Specification for Consultants, Industrial and Municipal: NEMA Premium Efficiency Electric Motors (600 Volts or Less).

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Re-greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Grout.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, and walls.

B. Install sleeves in concrete floors and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

3.2 SLEEVE SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Galvanized-steel-pipe sleeves.

2. Concrete Slabs-on-Grade:

a. Galvanized-steel-pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Interior Partitions:

a. Galvanized-steel-pipe sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types: Handlever.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece Bronze Ball Valves with Full Port and Stainless-Steel Trim:

1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.4 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Two piece, full port, bronze with stainless-steel trim.

END OF SECTION 230523.12

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze swing check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

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

1. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.

3.5 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 150, bronze disc.

END OF SECTION 230523.14

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Equipment supports.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

1.5 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

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

B. Copper Pipe Hangers:

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

1.6 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

1.7 EQUIPMENT SUPPORTS

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

1.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

1.9 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger

and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

J. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

1.10 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead.

B. Provide lateral bracing, to prevent swaying, for equipment supports.

1.11 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

1.12 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

1.13 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

1.14 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230533 - HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes heat tracing for freeze prevention of HVAC piping with self-regulating, parallel-resistance, electric heating cables:

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables and controls to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Source Limitations: Obtain all heat tracing from one manufacturer.

B. Standard: IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG tinned, or nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Grounding Cover: Copper braid.

F. Cable Cover: Stainless steel braid and polyolefin outer jacket with ultraviolet inhibitor.

G. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.

H. Maximum Operating Temperature (Power On): 150 deg F.

I. Maximum Exposure Temperature (Power Off): 185 deg F.

J. 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.

K. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft.
2. Number of Parallel Cables: 1.
3. Electrical Characteristics for Single-Circuit Connection:

    a. Volts: 120 V.
    b. Phase: 1.
    c. Hertz: 60 Hz Hz.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb temperature-control unit with adjustable range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote temperature-sensing bulb on capillary, resistance temperature device, or thermistor for directly sensing ambient air or pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.
5. Single-point control of heat tracing for freeze protection.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.2 INSTALLATION

A. Install electric heating cable at locations indicated and in accordance with NFPA 70.

B. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables in accordance with IEEE 515.1.

E. Install insulation over piping with electric cables in accordance with Section 230719 "HVAC Piping Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

I. Install outside air and pipe temperature sensors.

3.3 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect temperature-control unit to interrupt power supply to electric heating cable when outside air is above set point.

D. Connect remote electronic temperature sensors.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Perform tests after cable installation but before application of coverings, such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

D. Cables will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 230533

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric hangers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ELASTOMERIC HANGERS

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

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

B. Install elastomeric hangers at suspended fan installations.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Stencils.
4. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 STENCILS

A. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
2. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.

2.4 VALVE TAGS

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

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. For concealed valves, equipment, and devices needing service, provide identification markers visible from floor. Use color dot stickers placed on ceiling grid where valves, equipment, and devices needing service are installed above. Color scheme to be in accordance with Owner's color coding standard.

3.3 EQUIPMENT LABEL INSTALLATION

A. All major HVAC equipment, including air-to-water heat pumps, fans and pumps shall be properly identified with equipment tag stating equipment ID, ratings and date of installation.

B. Install or permanently fasten labels on each major item of mechanical equipment.

C. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Condenser-Water Piping: White letters on a safety-green background.
2. Refrigerant Piping: White letters on a safety-purple background.

3.5 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Condenser Water: 2 inches, round.

2. Valve-Tag Colors:

a. Potable and Other Water: White letters on a safety-green background.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems (including water-to-air heat pumps).

2. Balancing Hydronic Piping Systems:

a. Variable-flow hydronic systems.

3. Testing, Adjusting, and Balancing Equipment:

a. Motors.
b. Heat-transfer coils.

4. Duct leakage tests.
5. Control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

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

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.

c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Record log of duct leakage tests submitted to designer and/or commissioning agent upon completion.

I. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1.6 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Final Acceptance. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine terminal units and verify that they are accessible and their controls are connected and functioning.

J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Examine operating safety interlocks and controls on HVAC equipment.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.

i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts. Mark exterior of repaired duct insulation with location of test holes for Commissioning purposes.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.
7. Adjust expansion tank pressure to make-up water pressure.

3.7 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

    a. Measure and balance coils by either coil pressure drop or temperature method.

b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

   a. Re-measure and confirm that total water flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

   a. Measure total water flow.

      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

   b. Measure pump TDH as follows:

      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gage heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

   c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

   a. Measure flow in main and branch pipes.

b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

a. Measure differential pressure, and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
c. Mark final settings.

13. Verify that memory stops have been set.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.

4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.9 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

D. Maintain a copy of every duct leakage test report.

3.10 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.11 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets (labs): Plus or minus 5 percent
3. Air Outlets and Inlets (other): Plus or minus 10 percent.
4. Heating-Water Flow Rate: Plus or minus 5 percent.
5. Cooling-Water Flow Rate: Plus or minus 5 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.12 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.

c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.
f. Pressure set-point in inches wg.

F. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

G. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.

e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Final calibration factor for achieving design air flow.
h. Duct static air pressure readings for laboratory terminal units.
i. Individual inlet and outlet readings and sum at maximum air flow rate and at minimum air flow rate in cfm.
j. Space temperature in deg F.

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.

h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.
l. Pressure set-point in feet of head or psig.

J. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.14 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager and commissioning authority. Prepare test and inspection reports.

B. Verification of TAB will include 10% of all redundant equipment such as terminal units. Verification of TAB will include limited readings of 100% of major equipment (all AHUs, EFs, etc.).

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, supply, return, exhaust and outdoor air.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (factory-applied).

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule article for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

2.4 SEALANTS

A. FSK Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

2.5 FACTORY-APPLIED JACKETS

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

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Keep insulation materials dry during application and finishing.

F. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

G. Install insulation with least number of joints practical.

H. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

J. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

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

3.4 PENETRATIONS

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

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

4. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing insulation in layers in reverse order of their installation. Extent of inspection shall be limited to five location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 DUCT INSULATION SCHEDULE, GENERAL

A. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Rectangular and round duct in conditioned and unconditioned attic space, insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

A. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

2.3 SEALANTS

A. ASJ Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

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

B. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 PIPING INSULATION SCHEDULE, GENERAL

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

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following: Flexible Elastomeric: 1 inch thick.

END OF SECTION 230719

SECTION 230923 - DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 RELATED SECTIONS

A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section, including several from Division 25.

1.3 STANDARD TERMS

A. Standard
   1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
   2. AHU: Air Handling Unit
   3. BACnet: Building Automation Controls Network
   4. BMS: Building Management System
   5. DDC: Direct Digital Control
   6. EIA: Electronic Industries Alliance
   7. GUI: Graphical User Interface
   8. HVAC: Heating, Ventilation, and Air Conditioning
   9. IEEE: Institute Electrical Electronic Engineers
   10. MER: Mechanical Equipment Room
   11. PID: Proportional, Integral, Derivative
   12. VAV: Variable Air Volume Box

B. Communications and protocols
   1. ARP: Address Resolution Protocol
   2. CORBA: Common Object Request Broker Architecture
   3. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
   4. DDE: Dynamic Data Exchange
   5. FTT: Free Topology Transceivers
   6. HTTP: Hyper Text Transfer Protocol
   7. IIOP: Internet Inter-ORB Protocol
   8. LAN: Local Area Network
   9. LON: Echelon Communication – Local Operating Network
   10. MS/TP: Master Slave Token Passing
   11. ODBC: Open Database Connectivity
   12. ORB: Object Request Broker

13. SNVT: Standard Network Variables Types
14. SQL: Structured Query Language
15. UDP: User Datagram Protocol
16. XML: eXtensible Markup Language

C. Controllers
1. ASD: Application Specific Device
2. AAC: Advanced Application Controller
3. ASC: Application Specific Controller.
4. CAC: Custom Application Controller.
5. DCU: Distributed Control Unit
6. LCM: Local Control Module
7. MC: MicroControllers
8. MCI: MicroInterface
9. NSC: Network Server Controller
10. PPC: Programmable Process Controller
11. SDCU: Standalone Digital Control Units
12. SLC: Supervisory Logic Controller
13. UEC: Unitary Equipment Controller
14. VAVDDC: Variable Air Volume Direct Digital Controller

D. Tools and Software
1. AMBCx: Automated Monitoring Based Commissioning
2. APEO: Automated Predictive Energy Optimization
3. DR: Demand Response
4. CCDT: Configuration, Commissioning and Diagnostic Tool
5. BPES: BACnet Portable Engineering Station
6. LPES: LON Portable Engineering Station
7. POT: Portable Operator's Terminal

1.4 QUALIFICATIONS OF BIDDER

A. Control building automation systems shall be by the Schneider Electric factory branch in Morrisville, NC. Contact person is Tyler Beacham, tyler.beacham@se.com

B. The control system shall be by Schneider Electric SmartStruxure system and connect to the existing Coastal Carolina Community College - Schneider Electric Struxureware Enterprise Server

1.5 SCOPE OF WORK

A. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification or drawing notes. All components of the system – workstations, servers, application controllers, unitary controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2007, or EIA

standard 709.1, the LonTalk™ protocol, or Modbus protocol. The only exception will be field controllers within the Schneider I/NET, Continuum, and NETWORK 8000 family. No gateways shall be used for communication to controllers furnished under this section.

B. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system.

C. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

D. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

E. Provide services and manpower necessary for check out and testing of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.

F. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.6 SYSTEM DESCRIPTION

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): Unless already existing on the customer main site, the BAS Contractor shall furnish (qty) Administration and Programming Workstation Computers as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable.
2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports,

graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.

3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.

   Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Network Server Controllers (B-BC).

4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL).

B. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, XML and HTTPS for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

D. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol and/or ANSI / ASHRAE™ Standard 135-2007, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2007, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

E. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2008, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2008, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

F. LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth where necessary or desired.

1. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide functionality lines for such encapsulation and shall be based on industry standard protocols.
2. The products used in constructing the BMS shall be LonMark™ compliant.
3. In those instances in which Lon-Mark™ devices are not available, the BMS contractor shall provide device resource files and external interface definitions for LonMark devices.

G. The software tools required for network management of the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2008, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 4; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. Physical connection of LonWorks devices shall be via Ethernet IP or FTT-10A.

H. The system shall support Modbus TCP and RTU protocols natively, and not require the use of gateways.

I. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.
1. The supplied system must incorporate HTML5 and NOT require Java. Browser access that requires Java-enabled browsers will not be accepted.
2. Data shall reside on a supplier-installed server for all database access.
3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

J. All work described in this section shall be installed, wired, and circuit tested by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 10 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility within 150 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.

K. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personal computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC)

monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

L. Provide (existing) the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC), monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

M. The system shall have the capability to provide a web-based AMBCx (automated monitoring based commissioning) system. The AMBCx system shall be able to interface directly with the project BAS and energy/performance metering system to provide information on HVAC systems that are being controlled. Pricing is to be a separate line item from the BAS proposal. See specification section 25 08 01 for exact requirements.

N. The system shall have the capability to provide a web-based APEO (automated predictive energy optimization) system and enable effective participation in local utility Demand Response (DR) programs. The vendor shall provide software and ongoing services that will identify actionable energy saving and peak reduction opportunities to assist the facility in achieving its energy and sustainability objectives, and automatically and continuously operate the systems necessary to achieve the targeted savings and reductions. Pricing is to be a separate line item from the BAS proposal. See specification section 25 13 13 for exact requirements.

1.7 WORK BY OTHERS

A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor unless scheduled or specified to be provided with the equipment.

1.8 CODE COMPLIANCE

A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

C. All wiring shall conform to the National Electrical Code.

D. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

E. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.9 SUBMITTALS

A. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information.

B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of

each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

C. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.

D. Submittals shall contain narrative descriptions of sequences of operation. Diagrams shall be on 11" by 17" foldouts.

E. Submit five (5) electronic copies and (2) hardcopies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.

F. The Engineer will make corrections, if required, and return to the Contractor.

G. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built".
   1. System architecture drawing.
   2. Layout drawing for each control panel
   3. Wiring diagram for individual components
   4. System flow diagram for each controlled system
   5. Instrumentation list for each controlled system
   6. Sequence of control
   7. Operation and Maintenance Manuals

H. Information common to the entire system shall be provided. This shall include but not be limited to the following.
   1. Product manuals for the key software tasks.
   2. Operating the system.
   3. Administrating the system.
   4. Engineering the operator workstation.
   5. Application programming.
   6. Engineering the network.
   7. Setting up the web server.
   8. Report creation.
   9. Graphics creation.
   10. All other engineering tasks.
   11. System Architecture Diagram.
   12. Reference the product manual that includes instructions on executing the task.
   13. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
   14. Licenses, guarantees, and warranty documents for equipment and systems.
   15. Submit one copy for each building, plus two extra copies.

I. Information common to the systems in a single building shall be provided.
   1. System architecture diagram for components within the building annotated with specific location information.
   2. As-built drawing for each control panel.
   3. As-built wiring design diagram for all components.
   4. Installation design details for each I/O device.

5. As-built system flow diagram for each system.
6. Sequence of control for each system.
7. Product data sheet for each component.
8. Installation data sheet for each component.
9. Submit two copies for each building and two extra copies.

J. Software shall be provided:
1. Submit a copy of all software installed on the servers and workstations.
2. Submit all licensing information for all software installed on the servers and workstations.
3. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
4. Submit all licensing information for all of the software used to execute the project.
5. All software revisions shall be as installed at the time of the system acceptance.
6. Firmware Files
7. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
8. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
9. Submit a copy of all application files that were created during the execution of the project.
10. Submit a copy of all graphic page files created during the execution of the project.

1.10 COORDINATION

A. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," "Miscellaneous Integrated systems" and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems. It is expected that qualified vendor representatives will be present during startup for any of the above mentioned integrations as required. Costs for this support should be covered by the associated vendor as part of their base bid.
B. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
C. Coordinate location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete".
D. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

1.11 OWNERSHIP

A. The Owner shall retain licenses to software for this project.
B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
   1. Server and workstation software
   2. Application programming tools
   3. Configuration tools
   4. Network diagnostic tools
   5. Addressing tools
   6. Application files
   7. Configuration files
   8. Graphic files
   9. Report files
   10. Graphic symbol libraries
   11. All documentation

1.12 QUALITY ASSURANCE - SYSTEM STARTUP AND COMMISSIONING

A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

B. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.

C. The BAS Contractor shall provide a technician up to 3 days manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

D. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test completion. Any deviations from the submitted installation plan shall also be recorded.

E. Required elements of the startup testing include:
   1. Measurement of voltage sources, primary and secondary
   2. Verification of proper controller power wiring.
   3. Verification of component inventory when compared to the submittals.
   4. Verification of labeling on components and wiring.
   5. Verification of connection integrity and quality (loose strands and tight connections).

6. Verification of bus topology, grounding of shields and installation of termination devices.
7. Verification of point checkout.
8. Each I/O device is landed per the submittals and functions per the sequence of control.
9. Analog sensors are properly scaled and a value is reported
10. Binary sensors have the correct normal position and the state is correctly reported.
11. Analog outputs have the correct normal position and move full stroke when so commanded.
12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
14. Documentation of Loop tuning (sample rate, gain and integral time constant).

F. A Startup and Testing Report shall be provided upon test completion.

1.13 WARRANTY AND MAINTENANCE

A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

1.14 TRAINING

A. The BAS Contractor shall provide on-site training to the Owner’s representative and maintenance personnel per the following description:

B. On-site training shall consist of a minimum of (4) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
1. System Overview
2. System Software and Operation
3. System access
4. Software features overview
5. Changing setpoints and other attributes
6. Scheduling
7. Editing programmed variables
8. Displaying color graphics
9. Running reports
10. Workstation maintenance
11. Viewing application programming
12. Operational sequences including start-up, shutdown, adjusting and balancing.

13. Equipment maintenance.

PART 2 - PRODUCTS

2.1 Control system shall be SmartStruxure system with SmartX IP, Room Controllers, Network 8000, or I/A BACnet or LON field controls by Schneider Electric as an extension of the Coastal Carolina Community College/Schneider Electric Enterprise control system – contact for controls questions is Tyler Beacham

A. Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
   1. Electric Components
      a. Schneider-Electric and Veris Field Devices
   2. Electronic Components
      a. Schneider-Electric and Veris Field Devices
   3. Direct Digital Control Systems Devices:
      a. Schneider-Electric I/A BACnet.

2.2 SYSTEM ARCHITECTURE

A. General
   1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
   2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
   3. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
   4. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
   5. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol.
   6. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported. A sub-network of SDCUs using the BACnet MS/TP, LonTalk FTT-10A, and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

B. TCP/IP Level

1. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

C. Fieldbus Level with Standalone Digital Control Units (SDCUs)

1. The fieldbus layer shall support all the following types of SDCUs:
    a. BACnet IP SDCU requirements: The system shall consist of one or more BACnet IP field buses managed by the Network Server Controller. Minimum speed of not less than 100Mbps. The field bus controllers shall support daisy chain topology of up to 50 controllers. The field bus controllers shall also support, where applicable, RSTP loop whereby up to 39 controllers are supported. These devices shall support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
    b. BACnet MS/TP SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.
    c. LonWorks SDCU requirements: The system shall consist of one or more LonWorks FTT-10A field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer shall consist of up to 64 Lonworks SDCUs using peer-to-peer, event-driven communication for operation of HVAC and lighting equipment. If using TAC Xenta controllers, a total combination of Xenta and LonWorks SDCUs should consist of up to 64 in total, with a maximum of 30 for the Xenta line. If using I/A MNL controllers only, you may have up to 127 SDCUs per field bus level.
    d. Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 31 SDCUs for operation of HVAC, power metering, and lighting equipment. If utilizing Modbus TCP, the field bus layer shall consist of up to 100 SDCUs for operation of HVAC, power metering, and lighting equipment. The NSCs shall be capable of at least two Modbus RTU field buses for a total capability of 62 SDCUs per NSC.
    e. NETWORK 8000 SDCU requirements: The system shall consist of one or more ASD or LCM field buses managed by the Network Server Controller. The field bus layer shall consist of up to 128 ASD SDCUs or 31 LCM SDCUs for operation of HVAC, power metering, and lighting equipment.
    f. I/NET SDCU requirements: The system shall consist of one or more controller LANs and subLANs managed by the Network Server Controller. The network shall consist of up to 100,000 I/NET points capable through numerous links and devices for operation of HVAC, power metering, and lighting equipment.

D. BAS LAN Segmentation
   1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

E. Standard Network Support
   1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

F. System Expansion
   1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
   2. Web-based operation shall be supported directly by the NSCs and require no additional software.
   3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

G. Support For Open Systems Protocols
   1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 OPERATOR WORKSTATION REQUIREMENTS

A. General
   1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 10 concurrent operator users and/or 2 concurrent engineering users within the enterprise server.
   2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
   3. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
   4. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will

automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. Administration/Programming Workstation & Enterprise Server Requirements

1. The Enterprise Server (existing) shall consist of the following:
   a) Processor
      1. Minimum: Intel Core i5 @ 2.0 GHz or equivalent
      2. Recommended: Intel Core i5 @ 3.0 GHz or better
   b) Memory
      1. Minimum: 4GB
      2. Recommended: 8GB or higher
   c) Operating systems:
      1. Microsoft Windows 7 64-bit
      2. Microsoft Windows 10 64-bit
      3. Microsoft Windows Server 2012 R2 64-bit
      4. Microsoft Windows Server 2016
      5. Microsoft Windows Server 2019
   d) 10/100MBPS Ethernet NIC
   e) Storage
      1. Minimum: 100GB
      2. Recommended: 1TB
      3. Solid State Drive recommended
   f) Required additional software:
      1. Microsoft .Net 4.7.2 and later
   g) License agreement for all applicable software
   h) External log storage option
      1. PostgreSQL 11.0 and later
      2. TimescaleDB 1.2 and later
2. The workstation (existing) shall consist of the following:
   a) Processor
      1. Minimum: Intel Core i5 @ 2.0 GHz or equivalent
      2. Recommended: Intel Core i5 @ 3.0 GHz or better
   b) Memory
      1. Minimum: 4GB
      2. Recommended: 8GB or higher
   c) Operating systems:
      1. Microsoft Windows 7 64-bit
      2. Microsoft Windows 10 64-bit
      3. Microsoft Windows Server 2012 R2 64-bit
      4. Microsoft Windows Server 2016
      5. Microsoft Windows Server 2019
   d) 10/100MBPS Ethernet NIC
   e) Storage
      1. Minimum: 20GB

2. Recommended: 1TB
3. Solid State Drive recommended

f) Required additional software:
1. Microsoft .Net 4.7.2 and later

g) License agreement for all applicable software

C. Web-Based Operator PC Requirements
1. Any user on the network can access the system, using the following software:
a) Minimum:
1. Google Chrome 61 or higher
2. Mozilla Firefox 60 or higher
3. Microsoft Edge (EdgeHTML) 16 or higher
4. Safari 11.1 or higher

b) Recommended:
1. Google Chrome 71 or higher
2. Mozilla Firefox 64 or higher
3. Microsoft Edge (EdgeHTML) 17 or higher
4. Safari 11.4 or higher

D. General Administration and Programming Workstation Software
1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

E. User Interface:
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might

be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
4. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.

F. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.

G. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

2. Requirements of the color graphic subsystem include:
    a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
    b. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
    c. The editor shall use Scalable Vector Graphics (SVG) technology.
    d. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
    e. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
    f. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
    g. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
    h. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
    i. Graphics should rescale based on whatever monitor or viewing device is being used.
    j. Be able to create graphics on varying layers the can be moved and repeated.
    k. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
    a. Create and save pages.
    b. Group and ungroup symbols.
    c. Modify an existing symbol.
    d. Modify an existing graphic page.
    e. Rotate and mirror a symbol.
    f. Place a symbol on a page.
    g. Place analog dynamic data in decimal format on a page.
    h. Place binary dynamic data using state descriptors on a page.
    i. Create motion through the use of animated .gif files or JavaScript.
    j. Place test mode indication on a page.
    k. Place manual mode indication on a page.
    l. Place links using a fixed symbol or flyover on a page.
    m. Links to other graphics.

n. Links to web sites.
o. Links to notes.
p. Links to time schedules.
q. Links to any .exe file on the operator work station.
r. Links to .doc files.
s. Assign a background color.
t. Assign a foreground color.
u. Place alarm indicators on a page.
v. Change symbol/text/value color as a function of an analog variable.
w. Change a symbol/text/value color as a function of a binary state.

x. Change symbol/text/value as a function of a binary state.

I. Automatic monitoring
1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management
1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
a. A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
c. Playing an audible sound on alarm initiation or return to normal.
d. Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.
e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
f. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
g. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.

h. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

i. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.

j. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to 'normal' and the quantity of disabled and hidden alarms.

k. An operator shall have the capability to assign an alarm to another user of the system.

K. Report Generation

1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.
4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
6. All reports shall be able to be set up to automatically run or be generated on demand.
7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
8. Reports can be of any length and contain any point attributes from any controller on the network.
9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
10. It shall be possible to run other executable programs whenever a report is initiated.
11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
12. Minimum supplied reports shall include:
    a. Activities Per Server Report
    b. Activities Per User Report
    c. Alarm Amount by Category Report
    d. Alarm Amount by Type Report
    e. Alarms Per Sever Report
    f. Current Alarm Report
    g. Most Active Alarm Report
    h. System Errors Per Server Report
    i. Top Activities Report
    j. Top Alarms Report

k. Top System Errors Report
l. Trend Log Comparison Report
m. User Logins Report
n. Users and Groups Reports

13. Minimum Energy Reports shall include:
    a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
    b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
    c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

L. Scheduling
1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
10. It should accommodate a minimum of 16 priority levels.
11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer's Environment
1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.

4. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
6. It shall be possible to view graphical programming live and real-time from the Workstation.
7. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
8. Key terms should appear when typing (IntelliType).
9. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
10. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

N. Saving/Reloading
1. The workstation software shall have an application to save and restore NSC and field controller memory files.
2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail
1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
4. It shall be capable to search and view all forced values within the system.

P. Fault Tolerant Enterprise Server Operation (Top level NSC)
1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software
1. General:
a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.

b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.

2. Graphic Displays
   a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
   b. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
3. Alarm Management
   a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
   b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

R. Groups and Schedules
1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

S. User Accounts and Audit Trail
1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

T. Web Services
1. The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.
   a. Shall be able to "consume" data into the system via SOAP and REST web services.

2.4 NETWORK SERVER CONTROLLERS (NSCS)

A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

E. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

F. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization by means of an Internet site including automatic synchronization
   6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
   7. Network Management functions for all LonWorks based devices

G. Hardware Specifications
   1. Memory:
      a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
   2. Each NRC shall provide the following on-board hardware for communication:
      a. One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet
      b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
      c. One TP/FT port for communication to LonWorks devices.
      d. One Device USB port
      e. Two host USB Ports
   3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

H. Modular Expandability:
   1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
   2. One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic
   3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

I. Universal Input Temperatures
   1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
      1) 10 kohm Type I (Continuum)
      2) 10 kohm Type II (I/NET)
      3) 10 kohm Type III (Satchwell)
      4) 10 kohm Type IV (FD)
      5) Linearized 10 kohm Type V (FD w/11k shunt)
      6) Linearized 10 kohm (Satchwell)
      7) 1.8 kohm (Xenta)
      8) 1 kohm (Balco)
      9) 20 kohm (Honeywell)
      10) 2.2 kohm (Johnson)
   2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.
      1) PT100 (Siemens)
      2) PT1000 (Sauter)
      3) Ni1000 (Danfoss)

J. Local Status Indicator Lamps:
   1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

K. Real Time Clock (RTC):
   1. Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.

L. Power Supply:
   1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
   2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

M. Automatic Restart After Power Failure:
   1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

N. Battery backup:
   1. The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least

30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.

O. Software Specifications
   1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
   2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

P. User Programming Language:
   1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
   2. Network Server Controllers that use a “canned” program method will not be accepted.

Q. Control Software:
   1. The NSC shall have the ability to perform the following pre-tested control algorithms:
      a. Proportional, Integral plus Derivative Control (PID)
      b. Two Position Control
      c. Digital Filter
      d. Ratio Calculator
      e. Equipment Cycling Protection

R. Mathematical Functions:
   1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

S. NSCs shall have the ability to perform any or all of the following energy management routines:
   1. Time of Day Scheduling
   2. Calendar Based Scheduling
   3. Holiday Scheduling
   4. Temporary Schedule Overrides
   5. Optimal Start

6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

T. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.

U. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be

possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.

6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

V. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

2.5 BACNET FIELDBUS AND BACNET SDCUS

A. Networking

1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
2. IP To Field Bus Routing Devices
    a. A Network Server Controller shall be used to provide this functionality.
    b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
    c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination

1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
2. Each field bus shall have a termination resistor at both ends of each segment.

C. Repeaters

1. Repeaters are required to connect two segments.
2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices

1. General Requirements
    a. Devices shall have a light indicating that they are powered.
    b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
    c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Network Server Controllers (NSCs)

    a. If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
    b. Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.

c. Shall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.
d. Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.
e. Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.
f. Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.
g. Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
h. Shall provide time schedule support for all of the devices on the field bus.
i. Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
j. Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.
k. Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.
l. Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
m. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
n. Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.
o. Shall support the “Who is?” and “I am.” BACnet service.
p. Shall support the “”Who has?” and “I have.” BACnet service.
q. Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.
r. Shall be BTL certified.

F. Advance Application Controllers (AAC)
1. The key characteristics of a AAC are:
a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
c. The application to be executed by a AAC is created by an application engineer using the vendor’s application programming tool.

d. If local time schedules are embedded, the AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
e. If local trend logging is embedded, the AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
f. If local alarm message initiation is embedded, the AAC shall:
    1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
    2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
i. Shall support the "Who is" and "I am." BACnet services.
j. Shall support the "Who has" and "I have." BACnet services.

2. Analog Input Circuits
    a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
    b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
    c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
    d. For non-linear sensors such as thermistors and flow sensors the AAC shall provide software support for the linearization of the input signal.
3. Binary Input Circuits
    a. Dry contact sensors shall wire to the controller with two wires.
    b. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
    a. Pulse input sensors shall wire to the controller with two wires.
    b. An external power supply in the sensor circuit shall not be required.
    c. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
    a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to

ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).

b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

6. Binary Output Circuits
   a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
   b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.
7. Program Execution
   a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.
8. Local Interface
   a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. Via this local interface, an operator shall be able to:
      1) Adjust application parameters.
      2) Execute manual control of input and output points.
      3) View dynamic data.

G. Application Specific Devices
1. Application specific devices shall have fixed function configurable applications.
2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
3. Application specific devices shall be BTL certified

2.6 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors
1. Acceptable Manufacturers: Veris Industries
2. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
3. Room Sensor: Standard space sensors shall be available in an [off white] [black] enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series

   1) Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
   2) Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters.

Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.

4. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series
5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series
6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series
7. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series
8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Wall Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/- 2 % at full scale.
3. Transmitter shall have replaceable sensing element.
4. Sensor type shall be thin-film capacitive.
5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
6. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F
7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
9. Transmitter shall be available in an [off white] [black] enclosure made of high impact ABS plastic for mounting on a standard electrical box.
10. Transmitter shall have LCD display
11. Transmitter shall be available with a certification of NIST calibration
12. Transmitter shall be available with an integrated temperature sensor
13. Basis of Design: Veris HWL Series

C. Humidity Duct Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/-2 % at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
8. Output shall be 4-20 mA or 0-5/0-10 VDC.

9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall be available with a certification of NIST calibration
11. Transmitter shall be available with an integrated temperature sensor
12. Basis of Design: Veris HD Series

D. Humidity Outdoor Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/- 2% at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall be available with a certification of NIST calibration
11. Transmitter shall be available with an integrated temperature sensor
12. Basis of Design: Veris HO Series

E. Carbon Dioxide Wall Transmitter:
1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change
6. Outputs shall be field selectable [Analog: 4-20mA or 0-5/0-10VDC] [Protocol: Modbus or BACnet] with [SPDT Relay 1A@30VDC] [temperature setpoint slider]
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: [32° to 122°F (CO2 only)] [50° to 95°F (with humidity option)]
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Transmitter shall be available in an [off white] [black] enclosure for mounting on a standard electrical box.
11. Transmitter shall have LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
12. Transmitter shall be available with an integrated [humidity sensor] [temperature sensor]
13. Basis of Design: Veris CWL

F. Carbon Dioxide Duct Transmitter:
1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change

6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: 32° to 122°F
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.
11. Enclosure lid shall require no screws and make use of snap on features for attachment
12. Enclosure shall be made of high impact ABS plastic
13. Transmitter shall have LCD display
14. Transmitter shall be available with an integrated [humidity sensor] [temperature sensor]
15. Basis of Design: Veris CDL

G. Air Pressure Transmitters.
1. Acceptable Manufacturers: Veris Industries
2. Sensor shall be microprocessor profiled ceramic capacitive sensing element
3. Transmitter shall have 14 selectable ranges from 0.1 – 10" WC
4. Transmitter shall be +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Transmitter shall be field configurable to mount on wall or duct with static probe
6. Transmitter shall be field selectable for Unidirectional or Bidirectional
7. Maximum operating pressure shall be 200% of design pressure.
8. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power
10. Response time shall be field selectable T95 in 20 sec or T95 in 2 sec
11. Transmitter shall have an LCD display
12. Units shall be field selectable for WC or PA
13. Transmitter shall have provision for zeroing by pushbutton or digital input.
14. Transmitter shall be available with a certification of NIST calibration
15. Basis of Design: Veris model PXU.

H. Liquid Differential Pressure Transmitters:
1. Acceptable Manufacturer: Veris Industries
2. Transmitter shall be microprocessor based
3. Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
4. Transmitter shall have 4 switch selectable ranges
5. Transmitter shall have test mode to produce full-scale output automatically.
6. Transmitter shall have provision for zeroing by pushbutton or digital input.
7. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
8. Transmitter shall have field selectable electronic surge damping
9. Transmitter shall have an electronic port swap feature
10. Transmitter shall accept 12-30 VDC or 24 VAC supply power
11. Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.
12. Performance:
    a. Accuracy shall be ±1% F.S. and ±2% F.S. for lowest selectable range

b. Long term stability shall be ±0.25%
c. Sensor temperature operating range shall be -4° to 185°F
d. Operating environment shall be 14° to 131°F; 10-90% RH noncondensing
e. Proof pressure shall be 2x max. F.S. range
f. Burst pressure shall be 5x max. F.S. range

13. Transmitter shall be encased in a NEMA 4 enclosure
14. Enclosure shall be white powder-coated aluminum
15. Transmitter shall be available with a certification of NIST calibration
16. Transmitter shall be available as preinstalled on a bypass valve manifold
17. Basis of Design: Veris PW

I. Current Sensors

1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris Industries

J. Current Status Switches

1. Acceptable Manufacturer: Veris Industries
2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
3. Visual LED indicator for status.
4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
5. Normally open current sensor output. 0.1A at 30 VAC/DC.
6. Basis of Design: Veris Model H608.

K. Liquid Flow, Insertion Type Turbine Flowmeter:

1. Acceptable Manufacturer: Veris Industries
2. General: Turbine-type insertion flow meter designed for use in pipe sizes 1 1/2” and greater. Available in hot tap configuration with isolation valves and mounting hardware to install or remove the sensor from pipeline that is difficult to shut down or drain
3. Performance:
   1) Accuracy ±1% of rate over optimum flow range; ≥10 upstream and ≥5 downstream straight pipe diameters, uninterrupted flow
   2) Repeatability ±0.5%
   3) Velocity Range: 0.3 to 20 FPS
   4) Pressure Drop 0.5 psi or less @ 10 ft/sec for all pipe sizes 1.5” dia and up
   5) Pressure Rating: 1000 psi @ 70°F
4. Maximum Temperature Rating: 300°F
5. Materials: Stainless Steel or Brass body; Stainless steel impeller
6. Transmitter:
   1) Power Supply: 12 - 30VAC or 8 - 35VDC.
   a) Output: [Frequency] [4-20 mA] [Scaled Pulse]
   2) Temperature Range: 14° to 150°F
   3) Display: 8 character 3/8" LCD (Optional)
   4) Enclosure: NEMA 4, Polypropylene with Viton® sealed acrylic cover

7. Basis of Design: Veris SDI series

L. Liquid Flow/Energy Transmitter, Non-invasive Ultrasonic (Clamp-on):
1. Acceptable Manufacturer: Veris Industries
2. General: Clamp-on digital correlation transit-time ultrasonic flow meter designed for clean liquids or liquids containing small amounts of suspended solids or aeration. Optional temperature sensors for BTU calculations.
3. Liquid: water, brine, raw sewage, ethylene, glycol, glycerin, others. Contact manufacturer for other fluid compatibility
4. Pipe Surface Temperature: Pipe dia 1/2" to 2":-40-185°F; Pipe dia > 2": -40-250°F
5. Performance:
   1) Flow Accuracy:
      a) Pipe dia 1/2" to 3/4" 1% of full scale
      b) Pipe dia 1" to 2" 1% of reading from 4-40 FPS
      c) Pipe dia 2" to 100" 1% of reading from 1-40 FPS
   2) Flow Repeatability ±0.01% of reading
   3) Velocity Range: (Bidirectional flow)
      a) Pipe dia 1/2" to 2" 2 to 40 FPS
      b) Pipe dia 2" to 100" 1 to 40 FPS
   4) Flow Sensitivity 0.001 FPS
   5) Temperature Accuracy (energy): 32-212°F; Absolute 0.45°F; Difference 0.18°F
   6) Temperature Sensitivity: 0.05°F
   7) Temperature Repeatability: ±0.05% of reading
6. Transmitter:
   1) Power Supply: 95 to 264 VAC, 47 to 63 Hz or 10 to 28 VDC.
   2) Output: [RJ45] [Modbus TCP/IP] [Ethernet/IP] [BACnet/IP] [Pulse] [4-20 mA] [RS-485 Modbus RTU}
   3) Temperature Range: -40 to +185°F
   4) Display: 2 line backlit LCD with keypad
   5) Enclosure: NEMA 4, (IP65), Powder-coated aluminum, polycarbonate
7. Agency Rating: UL 1604, EN 60079-0/15, CSA C22.2, CSA Class 1 (Pipe > 2")
8. Basis of Design: Veris FST & FSR series

M. Analog Electric/Pneumatic Transducer:
1. Acceptable Manufacturer: Veris Industries
2. General: Micro-controlled poppet valve for high accuracy and with no air loss in the system. Field configurable for pressure sensing in multiple applications.
3. Power Supply: 22-30VDC, 20-30VAC
4. Control Input: 4-20mA, 0-10V, 0-5V; jumper selectable
5. Performance:
   1) Accuracy: 1% full scale; combined linearity, hysteresis, repeatability
   2) Compensated Temperature Range: 25° to 140°F
   3) Temp Coefficient: ±0.05%°C
   4) Operating Environment: 10-90% RH, non-condensing; 25° to 140°F
6. Supply Pressure: 45 psig max.
7. Manual Override: Jumper selectable mode, digital pushbutton adjust

8. Alarm Contact: 100mA@30VAC/DC (Optional)
9. Control Range 0-20 psig or 3-15 psig; jumper selectable
10. Pressure Differential 0.1 psig (supply to branch)
11. Pressure Indication Electronic, 3-1/2 digit LCD
12. Housing: Mounted on standard SnapTrack; Optional clear dust cover
13. Basis of Design: Veris EP Series

N. Control Valves
1. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve required leakage specification.
2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.
3. Trim material shall be stainless steel for steam and high differential pressure applications.
4. Electric actuation should be provided on all terminal unit reheat applications unless electric heat is provided.
5. Basis of design: Schneider Electric valve assemblies

O. Dampers
1. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
2. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetyl or bronze bearings shall also be provided.
3. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.
4. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.
5. Control and smoke dampers shall be Ruskin, or approved equal.
6. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

P. Damper Actuators
1. Damper actuators shall be electronic, and shall be direct coupled over the shaft, without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical or electrical capacitance type, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.

Q. Airflow Measuring Stations

1. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.
2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

2.7 ELECTRICAL POWER MEASUREMENT

A. Electrical Power Monitors, Single Point (Easy Install):
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Consist of three split-core CTs, factory calibrated as a system, hinged at both axes with the electronics embedded inside the master CT. The transducer shall measure true (rms.RMS) power demand real power (kW) consumption (kWh). Conform to ANSI C12.1 metering accuracy standards.
   3. Voltage Input: Load capacity as shown on drawings. 208-480 VAC, 60 Hz
   4. Maximum Current Input: Up to 2400A
   5. Performance:
      1) Accuracy: +/- 1% system from 10% to 100% of the rated current of the CT's
      2) Operating Temperature Range: 32-140°F, 122°F for 2400A.
   6. Output: 4 to 20 mA, Pulse. or Modbus RTU
   7. Ratings:
      1) Agency: UL508 or equivalent
      2) Transducer internally isolated to 2000 VAC.
      3) Case isolation shall be 600 VAC.
   8. Basis of Design: Similar to Hawkeye Veris H80xx40 series
   9. Accessories: [BACnet] [LON] communications gateway

B. Electrical Power Monitors, Single Point (High Accuracy):
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), and reactive power (kVARar), and power factor (PF) per phase and total load for a single load. Factory calibrated as a system using split core CT's. Neutral voltage connection is required.
   3. Voltage Input: 208-480 VAC, 60 Hz
   4. Current Input: Up to 2400A
   5. Performance:
      1) Accuracy: +/- 1% system from 2% to 100% of the rated current of the CT's
      2) Operating Temperature Range: 32-122°F
   6. Output: Pulse, BACnet, Modbus RTU
   7. Display: Backlit LCD
   8. Enclosure: NEMA 1
   9. Agency Rating: UL508 or equivalent
   10. Basis of Design: Veris Industries H81xx00 series.

C. Electrical Power Monitors, Single Point (High Accuracy/Versatility):
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), reactive power (kVAR), apparent power (kVA) and power factor

(PF) per phase and total load for a single load. Available with data logging , Bi-directional (4-quadrant) metering, and pulse contact accumulator inputs.

3. Voltage Input: 90-600 VAC, 50/60 Hz, 125-300 VDC
4. Current Input: 5A – 32,000A, selectable 1/3V or 1V CT inputs
5. Performance:
    1) Accuracy shall be +/- [0.2%] [0.5%] revenue grade
    2) Operating Temperature Range: -22-158°F
6. Output shall be [Pulse] [BACnet] [Modbus RTU] [LON]
7. Display: Backlit LCD
8. Enclosure: NEMA 4x optional
9. Agency Rating: UL508, ANSI C12.20
10. Basis of Design: Veris E5xxx series.

D. Electrical Power Monitors, Multiple Point (92 loads, High Accuracy):

1. Acceptable Manufacturer: Veris Industries.
2. General: Revenue grade meter. Measures volts, amps, power and energy for each circuit. 1/4 amp to 200 amp monitoring. 4 configurable alarm threshold registers
3. Voltage Input: 90-277 VAC, 60 Hz
4. Current Input: 5A – 32,000A, 1/3V CT inputs
5. Performance:
    1) Accuracy: +/- 0.5% meter (split core), +/- 1% system from 1/4-100A (solid core)
    2) Operating Temperature Range: 32-140°F
6. Output: Modbus RTU
7. Agency Rating: UL508, ANSI C12.10, IEC Class 1
8. Basis of Design: Veris E3xxx series.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

A. General

1. Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor

.

B. Code Compliance

1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.

C. Cleanup

1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 WIRING, CONDUIT, AND CABLE

A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	Per Mfr.	300 Volt
Class Three	Per Mfr.	300 Volt
Communications	Per Mfr.	Per Mfr.

B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

E. Flexible metallic conduit shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

G. Where allowed by code the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings.

H. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.

I. Only glass fiber is acceptable, no plastic.

J. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

3.3 HARDWARE INSTALLATION

A. Installation Practices for Wiring

B. All controllers are to be mounted per the manufacturer’s installation documentation.

C. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.

D. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.

E. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
F. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
G. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
H. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
I. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
J. Wire will not be allowed to run across telephone equipment areas.

3.4 INSTALLATION PRACTICES FOR FIELD DEVICES

A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
B. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
C. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
D. For duct static pressure sensors, the high pressure port shall be connected to a static pressure probe inserted into the duct. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
E. For building static pressure sensors, the high pressure port shall be inserted into the space via a static pressure pick-up. Pipe the low pressure port to the outside of the building.

3.5 ENCLOSURES

A. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
B. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
C. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated.
D. All wiring to and from the FIP will be to screw type terminals or lever nuts. Analog or communications wiring may use the FIP as a raceway without terminating.
E. All outside mounted enclosures shall meet the NEMA-3R rating.

3.6 IDENTIFICATION

A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
B. All field enclosures, other than controllers, shall be labeled.
C. Junction box covers will be marked to indicate that they are a part of the BAS system.
D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be labeled.

E. All I/O field devices inside FIP's shall be labeled.

3.7 EXISTING CONTROLS.

A. Existing controls which are to be reused must each be tested for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.

3.8 CONTROL SYSTEM SWITCH-OVER

A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.
B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.
C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

3.9 LOCATION

A. The location of sensors is per mechanical and architectural drawings.
B. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
C. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
D. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.10 SOFTWARE INSTALLATION

A. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.11 DATABASE CONFIGURATION.

A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.12 COLOR GRAPHIC DISPLAYS.

A. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

3.13 REPORTS.

A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:
   1. Trend comparison data
   2. Alarm status and prevalence information
   3. System user data

3.14 POINT TO POINT CHECKOUT.

A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.

3.15 CONTROLLER AND WORKSTATION CHECKOUT.

A. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software.

3.16 SYSTEM ACCEPTANCE TESTING

A. All application software will be verified and compared against the sequences of operation.
B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint.
C. Test alarms in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.).
D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended.
E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION 230923

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Condenser-water piping.
2. Condensate-drain piping.

1.3 ACTION SUBMITTALS

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

1. Polypropylene pipe and fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Polypropylene (PP-R) Pipe and Fittings Installers: Installers shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join polypropylene piping with manufacturer-recommended methods of installation.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Condenser-Water Piping: 80 psig at 150 deg F.
2. Condensate-Drain Piping: 150 deg F.
3. Air-Vent Piping: 180 deg F.

2.2 POLYPROPYLENE PIPE, FITTINGS AND VALVES

A. Pipe and Piping Products: Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

B. Fittings: Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

C. Valves. Valves shall be manufactured in accordance with the manufacturer’s specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L and ASTM B 88, Type M.

B. Wrought-Copper Unions: ASME B16.22.

2.4 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.5 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Condenser-water piping, aboveground shall be the following:

1. Polypropylene (PP-R) piping in SDR 7.4, 11, or 17.6 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.

B. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

C. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

D. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523.12 "Ball Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
3. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.

D. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE 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. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Fusion-Welding Joints:

1. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer’s specifications and product standards.
2. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
3. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer’s specifications.
4. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer’s specifications.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

3.6 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air vents.
3. Expansion tanks and fittings.
4. Air/dirt separators and purgers.
5. Strainers.
6. Flexible connectors.

B. Related Requirements:

1. Section 230500 "Common Work Results for HVAC" for expansion fittings and loops.
2. Section 230523 "General-Duty Valves for HVAC Piping" for specification and installation requirements for general-duty valves common to most piping systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators in accordance with ASME BPVC, Section IX.

B. Pressure-relief and safety-relief valves and pressure vessels bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC, Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

B. Automatic Flow-Control Valves:

1. Body: Brass or ferrous metal.
2. Combination Assemblies: Include bronze or brass-alloy ball valve.
3. Identification Tag: Marked with zone identification, valve number, and flow rate.
4. Size and Capacity: For each application, provide a valve with rated capacity equal to or greater than the capacity of device being served.
5. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
6. Minimum CWP Rating: 175 psig.
7. Maximum Operating Temperature: 200 deg F.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Brass.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPDM.
6. Low inlet-pressure check valve.
7. Inlet Strainer: Removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size and Capacity: As indicated on Drawings.
10. Operating Pressure: Factory set and field adjustable.

D. Diaphragm-Operated Pressure-Relief Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Brass.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPDM.
6. Valve Seat and Stem: Noncorrosive.

7. Valve Size, Capacity, and Operating Pressure: Comply with ASME BPVC, Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.2 AIR VENTS

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

2.3 EXPANSION TANKS AND FITTINGS

A. Diaphragm-Type ASME Expansion Tanks:

1. Tank: Welded steel, rated for 125 psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
2. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.4 AIR/DIRT SEPARATORS

A. Coalescing-Type Air and Dirt Separators:

1. Tank: Fabricated steel tank; ASME constructed and stamped for 125 psig working pressure and 270 deg F maximum operating temperature.
2. Coalescing Medium: Stainless steel.
3. Air Vent: Threaded to top of separator.
4. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
5. Blowdown Connection: Threaded to bottom of separator.
6. Size: Match system flow capacity.

2.5 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless steel, 40-mesh strainer or perforated stainless steel basket.
4. CWP Rating: 125 psig.

2.6 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:

1. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all piping specialties for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Examine threads on all devices for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 INSTALLATION OF VALVES

A. Install calibrated-orifice balancing valve at each branch connection to return main.

B. Install calibrated-orifice, balancing valve in the return pipe of each heating or cooling terminal.

C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

D. Install pressure-relief and safety-relief valves as required by ASME BPVC. Pipe drain to nearest floor drain. Comply with ASME BPVC, Section VIII, Division 1, for installation requirements.

3.3 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

D. Install diaphragm- or bladder-type expansion tanks on the floor.

E. Vent and purge air from hydronic system and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

1.3 CLOSEOUT SUBMITTALS

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

B. Report for pump start-up.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Source Limitations: Obtain pumps from single source from single manufacturer.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tapping at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft Sleeve: Type 304 stainless steel.

4. Pump Stub Shaft: Type 304 stainless steel.
5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and NBR rubber bellows and gasket. Include water slinger on shaft between motor and seal.
6. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.

D. Shaft Coupling: Rigid, axially-split spacer coupling to allow service of pump seal without disturbing pump or motor.

E. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure: Totally enclosed, fan cooled.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. 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.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Variable-speed motor.

F. Capacities and Characteristics:

1. Refer to Schedule on Design Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.1-1.2 and HI 1.3.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

E. Provide variable frequency motor controller for each hydronic pump located per plans. Variable frequency motor controllers shall comply with Specification section 262923 - Variable Frequency Motor Controllers.

F. Ground equipment according to Section 260526 “Grounding and Bonding for Electrical Systems." Connect wiring according to Section 260519 “Building Wire and Cable."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup check according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. 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.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor. Open discharge valve slowly.

3.5 DEMONSTRATION

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

END OF SECTION 232123

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water treatment for closed-loop hydronic systems.
2. Manual chemical-feed equipment.

B. Related Requirements:

1. Contract with Coastal Carolina Community College's water chemical treatment service provider for this work:

a. Bond Water Technologies, Inc., Gaithersburg, MD, 804-912-3895.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.

1.3 INFORMATIONAL SUBMITTALS

A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Field quality-control reports.

C. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

D. Water Analysis: Illustrate water quality available at Project site.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: Contract with Bond Water Technologies, Inc.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Provide steel feeders with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Provide quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal..
2. Minimum Working Pressure: 125 psig.

2.3 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require

servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.

B. Bypass Feeders: Install in closed hydronic system and equip with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
2. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
3. Install full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
4. Install a swing check on the inlet after the isolation valve.

3.3 PIPING CONNECTIONS

A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings.

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."

E. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

D. Equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

END OF SECTION 232513

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealant and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, duct-mounting access doors, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

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

1. Sealants and gaskets.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.

6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Where ducts pass through non-fire-rated interior partitions and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give seven days' advance notice for testing.

C. Prior to the use or concealment of any portion of a grease duct system, a leakage test shall be performed in the presence of the Engineer or qualified representative from engineering team. Ducts shall be considered to be concealed where installed in shafts or covered by coatings or wraps that prevent the ductwork from being visually inspected on all sides. The contractor shall be responsible to provide the necessary equipment and perform the grease duct leakage test.

1. A light test shall be performed to determine that all welded and brazed joints are liquid tight. A light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open so as to emit light equally in all directions perpendicular to the duct walls. A test shall be performed for the entire duct system, including the hood to duct connection. The ductwork shall be permitted to be tested in sections, provided that every joint is tested. For listed factory-built grease ducts, this test shall be limited to duct joints assembled in the field and shall exclude factory welds.

D. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

E. Duct system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3 micron size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

~~D. Clean the following components by removing surface contaminants and deposits:~~

~~1. Air outlets and inlets (registers, grilles, and diffusers).~~
~~2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.~~
~~3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.~~
~~4. Coils and related components.~~
~~5. Return air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.~~
~~6. Supply air ducts, dampers, actuators, and turning vanes.~~
~~7. Dedicated exhaust and ventilation components and makeup air systems.~~

~~E. Mechanical Cleaning Methodology:~~

~~1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.~~
~~2. Use vacuum collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.~~
~~3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.~~
~~4. Clean fibrous glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.~~
~~5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.~~
~~6. Provide drainage and cleanup for wash down procedures.~~
~~7. Antimicrobial Agents and Coatings: Apply EPA registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.~~

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:

1. Ducts Connected to Water-to-Air Heat Pumps:

a. Pressure Class: Positive 2-inch wg.

b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round: 8.

C. Return Ducts:

1. Ducts Connected to Water-to-Air Heat Pumps:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round: 8.

D. Outdoor-Air Ducts:

1. Ducts Connected to Water-to-Air Heat Pumps:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round: 8.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Flange connectors.
3. Turning vanes.
4. Duct-mounted access doors.
5. Flexible connectors.
6. Flexible ducts.
7. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Standard leakage rating, with linkage outside airstream.
2. Suitable for horizontal or vertical applications.
3. Frames:

    a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch thick.

5. Blade Axles: Galvanized steel.
6. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel.

2.4 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

C. Vane Construction: Single wall.

2.6 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

    a. Double wall, rectangular.
    b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    c. Vision panel.
    d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
    e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.

2.7 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

F. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.
2. Non-Clamp Connectors: Liquid adhesive plus tape.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.

1. Install steel volume dampers in steel ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. At outdoor-air intakes.
2. At outdoor-air intakes and mixed-air plenums.
3. Downstream from manual volume dampers.
4. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

I. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

L. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

M. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place. Connect flexible ducts to metal ducts with liquid adhesive plus tape and draw bands.

N. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diffusers, registers, and grilles.

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

PART 2 - PRODUCTS

2.1 DIFFUSERS, REGISTERS, AND GRILLES

A. Refer to schedule on drawings for performance, physical characteristics and accessories.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pleated panel filters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.3 CLOSEOUT SUBMITTALS

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

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

1. Provide two complete set(s) of filters for FILTER GRILLE.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

2.2 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

B. Filter Unit Class: UL 900, Class 1.

C. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.

1. Media shall be coated with an antimicrobial agent.
2. Separators shall be bonded to the media to maintain pleat configuration.
3. Welded-wire grid shall be on downstream side to maintain pleat.
4. Media shall be bonded to frame to prevent air bypass.
5. Support members on upstream and downstream sides to maintain pleat spacing.

D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

E. Capacities and Characteristics:

1. MERV Rating: 8 when tested according to ASHRAE 52.2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filters in position to prevent passage of unfiltered air.

B. Install filter gage for each filter bank.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

D. Coordinate filter installations with duct and air-handling-unit installations.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

1. Test for leakage of unfiltered air while system is operating.

C. Air filter will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 234100

SECTION 236500 – DRY CLOSED-CIRCUIT COOLERS

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. Factory assembled and tested dry closed-circuit cooler.

1.3 DEFINITIONS

A. BMS: Building management system.

1.4 PERFORMANCE REQUIREMENTS

A. Refer to equipment schedules on drawings.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.

B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Certificates: For certification required in "Quality Assurance" Article.

D. Startup service reports.

E. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

F. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

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

C. CTI Certification: Thermal performance according to CTI Standard 201. Lacking such certification, a field acceptance test shall be conducted prior to project closeout in accordance with CTI Acceptance Test Code ATC-105DS, by a Licensed CTI Thermal Testing Agency.

1.7 COORDINATION

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

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. All components of cooling tower.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CLOSED-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Evapco Inc.
2. Poolpak
3. Direct Coil

B. IBC Compliance: Unit structure shall be designed, analyzed, and constructed in accordance with the latest edition of International Building Code (IBC) for: IP = 1.0, SDS = 1.6; z/h = 0, P = 59.5 psf.

C. Casing and structure: Heavy gauge Type 304 Stainless Steel. Coil casement shall be constructed of Type 304 Stainless Steel and coil tube sheets shall be constructed of Aluminum. Fan cowl and guard shall be constructed of Powder Coated Steel.

D. Fan(s): Direct drive high efficiency axial propeller type and integral to the motor assembly. Each fan shall be dynamically balanced and installed in a closely fitted cowl with venturi air inlet.

E. Heat Transfer Coil: Type 304L Stainless Steel tubes, roll formed, continuously welded and annealed. Tubes shall be expanded into aluminum fins with hydrophilic lacquer coating. Fins shall have fully drawn collars completely covering the tubes. Header connections shall be Schedule 40 Type 304L Stainless Steel. 250 psi coil design pressure in compliance with ASME/ANSI B31.5. Coil assembly shall be strength tested in accordance with ASME/ANSI B31.5 and subsequently leak tested using air under water.

F. Motors and drives: Zero maintenance electronically commutated, ball bearing type with minimum IP55 protection degree. Motor shall be class F insulated. Motor(s) shall contain integrated PID controller, thermal overload protection, reverse polarity protection, locked-rotor protection, and Modbus connectivity. 0-10v or 4-20mA shall be the control input. Motor shall be capable of operating continuous duty within a temperature range of -13° F to 149° F.

G. Accessories:

1. Removal maintenance access for internal coil inspection.
2. Forklift channels.
3. Coil header cover plate.

H. Controls: Refer to Drawing Schedule.

I. Capacities and Characteristics:

1. Refer to Drawing Schedule.

2.2 SOURCE QUALITY CONTROL

A. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before cooler installation, examine roughing-in for support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.

1. Dry cooler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 INSTALLATION

A. Install dry closed-circuit coolers on support structure indicated on drawings.

B. Maintain manufacturer's recommended clearances for service and maintenance.

C. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 WATER TREATMENT

A. Inspect piping and equipment to determine that all new piping and equipment have been cleaned, flushed, and filled with water, and are ready for operation. Do not allow interconnection to existing wellfield system until water treatment is in place.

B. Prior to opening any valves connected to existing system, test new piping and connected equipment at static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

C. Contract with Owner’s water treatment provider to add any required treatment chemicals needed to accommodate new equipment and piping.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coolers to allow service and maintenance.

C. Provide drain piping with valve at cooler drain connections and at low points in piping.

D. Geothermal Water Piping: Comply with applicable requirements in Section 232113 “Hydronic Piping.” Connect to cooler entering connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, and drain connection with valve. Connect to cooler leaving connection with shutoff valve. Make connections to cooling tower with a union, flange, or mechanical coupling.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Dry closed-circuit coolers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance.
h. Replace defective and malfunctioning units.

D. Start dry closed-circuit cooler. Follow manufacturer's written starting procedures. Prepare a written startup report that records the results of tests and inspections.

3.7 ADJUSTING

A. Set and balance water flow to each cooler inlet.

3.8 DEMONSTRATION

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

END OF SECTION 236500

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Filters: One set(s) for each air-handling unit provided at Final Completion.

1.7 QUALITY ASSURANCE

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

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.8 COORDINATION

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

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: One year(s) from date of Final Acceptance.
b. For Parts: One year(s) from date of Final Acceptance.
c. For Labor: One year(s) from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM HEAT PUMPS

A. Refer to schedule on drawings for performance, physical characteristics and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

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

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

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

END OF SECTION 238126

SECTION 238146.13 - WATER-TO-AIR HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concealed horizontal or vertical units, 6 tons and smaller.
2. Exposed, console water-source heat pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, furnished specialties, and accessories for each model.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of water-source unitary heat pump, signed by product manufacturer.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water-to-air heat pumps to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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.

1. Two (2) sets of filters for each unit.

1.6 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. ASHRAE 15.
2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. Comply with NFPA 70.

C. Comply with safety requirements in UL 484 for assembly of free-delivery, water-source heat pumps.

D. Comply with safety requirements in UL 1995 for duct-system connections.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, refrigeration components.
2. Warranty Period:

a. Labor: One (1) year from date of Final Acceptance.
b. Parts: Full unit five (5) years from date of Final Acceptance.

PART 2 - PRODUCTS

2.1 CONCEALED WATER-SOURCE HEAT PUMPS, 6 TONS AND SMALLER

A. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Refer to schedule on drawings for performance, physical characteristics, and accessories.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.2 EXPOSED, CONSOLE WATER-SOURCE HEAT PUMPS

A. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

B. Cabinet and Chassis: Manufacturer's standard-height, flat-top, galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch thick, complying with UL 181, ASTM C1071, and ASTM G21.
4. Cabinet Insulation, Fibrous Glass Duct Liner Standard: Glass-fiber liner, minimum 1/2 inch thick, complying with ASTM C1071 and NAIMA AH124, "Fibrous Glass Duct Liner Standard."

5. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting to unit exterior and complying with ASHRAE 62.1.

    a. Condensate Overflow Protection: Solid state electronic; mechanical float switch not permitted.

6. Discharge Grille: Steel, aluminum, or plastic grille for adjustable discharge air pattern.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Fan: Direct driven, centrifugal, with multispeed motor mounted on a removable fan-motor board.

1. General requirements for motors are specified in Section 230500 "Common Work Results for HVAC."
2. Motor: Multispeed, permanently lubricated, ECM.

D. Water Circuit:

1. Refrigerant-to-Water Heat Exchanger: Coaxial heat exchanger with copper water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to 450 psig for refrigerant side and 400 psig for water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
2. Water-Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.

E. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

F. Refrigerant Circuit Components:

1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
3. Charging Connections: Service fittings on suction and liquid for charging and testing.
4. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
5. Compressor: Hermetic rotary compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:

    a. Antirecycle timer.
    b. High-pressure cutout.
    c. Low-pressure cutout or loss of charge switch.
    d. Internal thermal-overload protection.

e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 35 deg F.
f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
g. Water-coil, low-temperature switch.
h. Air-coil, low-temperature switch.

6. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
7. Pipe Insulation: Refrigerant minimum 3/8-inch-thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes per ASTM E84.
8. Refrigerant Metering Device: Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.
9. Hot-Gas Reheat Valve: Pilot-operated, sliding-type valve with replaceable magnetic coil.

G. Electric Heating Coil: Energized on call for heating when entering-water-loop temperature is less than 60 deg F.

H. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

I. Outdoor-Air Damper: Two-position, motorized outdoor-air damper for fixed minimum intake up to 100 percent of fan capacity.

J. Filters:
1. Disposable, pleated type, 1 inch thick and with a minimum efficiency reporting value of 7 according to ASHRAE 52.2.

K. Electrical Connection: Single electrical connection with fused disconnect.

2.3 HOSE KITS

A. General: Hose kits shall be designed for minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

B. Hose: Length 24 inches or 36 inches braided stainless steel, complete with adapters. Minimum diameter, equal to water-source, heat-pump connection size.

C. Isolation Valves: Two-piece, bronze-body ball valves with stainless-steel, standard-port ball and stem with normal pipe thread (NPT) connections, and galvanized-steel lever handle. Provide valve for supply and return. If balancing device is combination shutoff type with memory stop, the isolation valve may be omitted on the return.

D. Strainer: Y-type with blowdown valve in supply connection.

E. Balancing Device: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.

1. Automatic balancing valve, factory set to operate within 10 percent of design flow rate over a 40:1 differential pressure range of 2 to 80 psig.

F. Motorized Water Valve: Slow-acting, 24-V dc, with NPT connections.

2.4 CONTROLS

A. DDC controllers and control devices must be furnished and field installed by the Division 230923 contractor. Water source heat pump equipment must be furnished with a terminal connection board for remote controller/thermostat/humidistat control. Factory installed equipment BACnet/Lon controls are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduits before installation.

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

3.2 INSTALLATION

A. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Install sensors as required in Section 230923.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Connect supply and return hydronic piping to heat pump with hose kits.
2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:

1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Inspect operation of barometric dampers.
10. Verify bearing lubrication on fan.
11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Adjust fan belts to proper alignment and tension.
13. Start unit according to manufacturer's written instructions.
14. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Occupancy Adjustments: When requested within 12 months of the date of Final Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to the Project during other-than-normal occupancy hours for this purpose.

3.7 CLEANING

A. Replace filters used during construction prior to air balance or Final Acceptance. After completing installation of exposed, factory-finished, water-source heat pumps, inspect exposed finishes and repair damaged finishes.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-source heat pumps.

END OF SECTION 238146.13

DIVISION 26 – ELECTRICAL

Electrical work shall be defined by drawings numbered with the prefix "E-", the general provision of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division-26 Electrical Specifications.

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END OF SECTION 260000

SECTION 260500 - GENERAL ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Instructions to Bidders, General Conditions of the Contract, Supplementary General Conditions and Division 1 bound herewith are a component part of this Division of the specifications and shall apply to this Division with equal force and shall be consulted in detail for instructions pertaining to the work.

B. Requirements in Divisions 26, 27 and 28 of the specifications and shall, as applicable, apply to all these Divisions.

C. Furnish all labor, materials and equipment and incidentals required to make ready for use complete electrical systems as shown on the Drawings and specified herein.

D. It is the intent of these Specifications that the electrical systems shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

E. The work shall include, but not be limited to, furnishing, coordinating, and installing the following:

1. Underground electrical service from the utility company pad mounted transformer to service equipment.
2. Electrical distribution system for power, lighting, receptacles and miscellaneous power as shown on the contract drawings.
3. Electrical lighting systems as shown on the contract drawings, complete with indicated switching, circuiting, etc.
4. Electrical receptacle systems as shown on the contract drawings.
5. Exit and emergency lighting systems.
6. Power supplies for equipment furnished by others as detailed in Specification Section 260580.
7. Cable tray system.
8. Existing Fire Detection and Alarm System extensions.
9. Standby Emergency Power System.
10. Raceway, outlet and cabling systems for data and other special systems.
11. Grounding.
12. Seismic restraint systems.
13. Other special requirements and/or systems where shown.

F. Each bidder (or Representative) shall, before preparing a proposal, visit all areas of the existing site. If the work includes demolition, restoration, renovation and/or addition; then existing buildings and structures should be carefully inspected. The submission of the proposal by this Bidder shall be considered evidence that the Bidder (or Representative) has visited the site and noted the locations and conditions under which the work will be performed and that the Bidder takes full responsibility for a complete knowledge of all factors governing the work.

G. All power interruptions to existing equipment shall be at the Owner's convenience with 24 hours (minimum) notice. Each interruption shall have prior approval.

H. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for all the proper functioning of the system and equipment. All work shall be of the highest quality; substandard work will be rejected.

I. Field verify all existing underground electrical and mechanical piping.

1.2 SUBMITTALS

A. Shop drawings shall be submitted for all equipment, apparatus, and other items as required by the Architect/Engineer. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submittals are required for all materials shown in the individual specifications sections.

C. Submittals are required for materials used for penetrations of rated assemblies and for seismic restraints.

D. All shop drawings and submittals shall be submitted at the same time. Partial shop drawing and submittals will be rejected and not processed. Materials and equipment with long lead times or other materials and equipment requiring special handling, if identified and requested by the contractor, will be processed separately.

E. Proposed equipment and/or materials substitutions shall be clearly indicated in shop drawings. All deviations from the specified quality, functionality, appearance or performance of the proposed equipment and/or materials shall be clearly summarized in the preface of each submittal. If none are disclosed, and the deviation specifically approved, the Contractor is responsible for providing the specified materials regardless of submittal approval.

F. The project shall be bid based on the equipment listed in these specifications and on the drawings. After award of the Electrical Contract the Contractor may wish to substitute equipment other than that specified, subject to approval. The Electrical Contractor shall bear the "burden of proof" for demonstrating substitute equipment equivalency and suitability.

G. The Electrical Contractor shall be required to replace installed "equivalent" equipment if the operation of this equipment does not meet the full design intent of the specified system.

H. Physical size of equipment used in the design layout are those of reputable equipment manufacturers. The Contractor is responsible for providing equipment which will fit the space provided. If the Contractor elects to use other manufacturer's equipment, any resulting conflicts with space clearance or codes shall be the responsibility of the Contractor to correct at the Contractor's expense.

I. The Contractor assumes all responsibility for providing code clearances. Submit a scale drawing of each electrical equipment room showing exact size and location of all proposed electrical equipment with code clearances and working space clearly indicated and dimensioned.

1.3 COORDINATION OF WORK

A. It is understood and agreed that the Contractor is, by careful examination, satisfied as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the general and local conditions and all other matters which can and may affect the work under this contract. The Contractor shall be held responsible for visiting the site and thoroughly familiarizing himself with the existing conditions and also any contractual requirements as may be set forth in the other Divisions of these Specifications. No extras will be considered because of additional work necessitated by obvious job conditions that are not indicated on the drawings.

B. The Contractor shall compare the electrical drawings and specifications with the drawings and specifications for other trades, and shall report any discrepancies between them to the Architect/Engineer and obtain written instructions for changes necessary in the electrical work. The electrical work shall be installed in cooperation with other trades installing interrelated work. Before installation, the Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor caused by neglect to do so shall be made at the expense of the Contractor.

C. Location of electrical raceways, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The Contractor shall determine the exact route and location of each electrical raceway prior to make up and assembly.

1. Right of Way: Lines which pitch shall have the right of way over those which do not pitch. For example, steam, condensate and plumbing drains shall normally have right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
2. Offsets and changes in direction of electrical raceways shall be made as required to maintain proper headroom and to clear pitched lines whether or not indicated on the drawings. The Contractor shall furnish and install elbows, pull boxes, etc., as required to affect these offsets, transitions, and changes in directions. Conflicts between electrical raceways, fixtures, etc., and ductwork or piping which cannot be resolved otherwise, will be resolved by the Architect/Engineer.

D. Installation and Arrangements: The Contractor shall install all electrical work to permit removal (without damage to other parts) of any equipment requiring periodic replacement or maintenance. The Contractor shall arrange electrical raceways and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging and overhead doors and of access panels.

1.4 EQUIPMENT AND MATERIALS (GENERAL)

A. In compliance with North Carolina General Statute 133.3, the Architect/Engineer has, wherever possible, specified the required performance and design characteristics of all materials utilized in this construction. In some cases it is impossible to specify the required performance and design characteristics and when this occurs the Architect/Engineer has specified three or more examples of equal design or equivalent design, establishing an acceptable range for items of equal or equivalent design. Cited examples are used only to denote the quality standard of product desired and do not restrict bidders to a specific brand, make, manufacturer or specific name and are used only to set forth and convey to bidders the

general style, type, character and quality of product desired. Equivalent products will be acceptable.

B. Substitution of materials, items, or equipment of equal or equivalent design shall be submitted to the Architect/Engineer for approval or disapproval. Equal or equivalent shall be interpreted to mean an item of material or equipment, similar to that named and which is suitable for the same use and capable of performing the same functions as that named, the Architect/Engineer being the judge of equality.

C. The materials used in all systems shall be new, unused and as hereinafter specified and shall bear the manufacturer's name, trade name and a qualified third party testing agency label in every case where a standard has been established for the particular material. Equipment furnished under this specification shall be essentially the standard product of manufacturers regularly engaged in the production of the required type of equipment, and shall be the manufacturer's latest approved design. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturer's specifications shall be submitted for approval as required by the Architect/Engineer.

D. Protection: Electrical equipment shall at all times during construction be adequately protected against damage. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury and theft. Electrical equipment shall be stored in dry, and heated if required to reduce condensation, permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner. At the completion of the work, fixtures, equipment, and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect/Engineer. Damage or defects, developing before acceptance of the work shall be made good at the Contractor's expense.

E. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting specifications in Division 9, at no additional cost to the Owner.

F. Where materials such as wiring devices and plates, fire alarm equipment, paging system components, etc. are specified to match existing, provide materials to match existing equipment in finish, color, capacity, ratings, operating characteristics, performance, etc.

G. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, and heated if required to reduce condensation, but readily accessible for inspection by the Architect/Engineer until installed.

H. Equipment and materials of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.

I. Manufacturer's directions shall be followed completely in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflicts between any requirements of the Contract Documents and the manufacturer's directions and shall obtain the Architect/Engineer's written instructions before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's direction or such written instructions

from the Architect/Engineer, the Contractor shall bear all costs arising in correcting the deficiencies.

1.5 OPERATION AND MAINTENANCE MANUALS

A. Submit under relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. The Contractor shall provide three compilations of catalog data, bound in suitable looseleaf binders, for each manufactured item of equipment used in the electrical work. These shall be presented to the Architect/Engineer for transmittal to the Owner before the final inspection is made. Data shall include printed installation, operation and maintenance instructions for each item, indexed by product with heavy sheet dividers and tabs. All warranties shall be included with each item. Each manufacturer's name, address and telephone number shall be clearly indicated.

C. Shop drawings with Architect/Engineer's "as noted" markings are not acceptable for the above. "Approved" shop drawings are acceptable if adequate information is contained therein. Generally, shop drawings alone are not adequate.

D. Installation information packed with lighting fixtures, devices and equipment shall be retained for inclusion in the operations and maintenance manuals.

1.6 PAINTING

A. All painting will be performed by the General Contractor for the project, unless specifically indicated otherwise.

B. The Electrical Contractor shall clean all exposed electrical work for painting. Should the Electrical Contractor delay in installing exposed conduit and outlets until the General Contractor has begun painting, the Electrical Contractor shall be required to paint all exposed electrical work at the Electrical Contractor's own expense. Such painting will be accomplished in accordance with the detailed specifications for the Project.

C. Conductors exposed in boxes and cabinets shall be protected against painting. Devices, cover plates, trims, etc., for panelboards and cabinets shall not be installed until painting has been completed.

D. The Electrical Contractor shall be responsible for touch up painting that may be required for electrical material or apparatus furnished with factory applied finish.

1.7 LOCATIONS AND MEASUREMENTS

Outlets and appliances are shown and located on the drawings as accurately as possible. All measurements shall be verified on the project and in all cases the work shall suit the surrounding trim, finishes and/or construction. The locations of outlets for special appliances shall be installed so that when extended, they are flush with the finished wall or ceiling and permit the proper installation of fixtures and/or devices. Heights of all outlets shown on the drawings are approximate only. Slight relocations of outlets, devices and equipment shall be made by the Contractor as required or as directed by the Architect/Engineer at no additional cost to the Owner.

1.8 QUALITY OF WORK

All work shall be executed as required by this specification and the accompanying drawings and shall be done by skilled mechanics, and shall present a neat, trim, and mechanical appearance when completed. All work shall be performed as required by the progress of the job.

1.9 SUPERVISION

A. The Contractor shall personally, or through an authorized and competent representative, constantly supervise the work from the beginning to completion and final acceptance. So far as possible, the Contractor shall keep the same foreman and mechanics throughout the project duration.

B. During the progress of the work it shall be subject to inspection by representatives of the Architect/Engineer, the Owner, and local inspection authorities, at which time the Contractor shall furnish such required information and data on the project as requested.

C. The Electrical Contractor shall coordinate the electrical work with other Contractors and cooperate in the preparation and maintenance of a master schedule for the completion of the project.

1.10 EXCAVATION, TRENCHING AND BACKFILLING

A. The Electrical Contractor shall do all excavating, trenching and backfilling in connection with this contract. All such excavation shall be done in a manner as not to endanger or damage existing utility lines and other structures. If damage occurs, the Contractor shall pay for and repair damage to the satisfaction of the Architect/Engineer.

B. It shall be the responsibility of the Contractor to investigate conditions before excavation and to exercise care during the excavation to avoid any utilities or other objects which may not be shown. Whether or not utilities, etc., are shown on the drawings shall not relieve the Contractor from the responsibility to repair any damage caused by this work. Location of all ditching shall be laid out at grade and shall be approved by the Architect/Engineer before excavating and no work shall be done until such approval has been obtained.

C. All surplus earth shall be removed by the Contractor from the site and disposed of at the Contractor's expense.

D. All excavation, trenching and shoring shall be in accordance with rules and regulations set forth in Article XXI, Bulletin 1 "Trenching" as published in a separate bulletin by the North Carolina Department of Labor, Division of Standards and Inspection Construction Bureau.

E. Backfilling shall be in 6" layers with each layer tamped. No boulders or debris shall be used for backfill material. Where trenching passes through areas designated as streets, driveways, walkways, or parking areas, backfill shall be tamped with power tamps to 95 percent compaction.

F. Excavation shall be bid unclassified with no extra payment for removal of rock.

1.11 CLOSING IN WORK

Work shall not be covered up or enclosed until it has been inspected, tested and approved by the authorities having jurisdiction over this work. Should any of the work be enclosed or covered up before such inspection and test, the Contractor shall uncover the work at the Contractor's expense; after it has been inspected, tested and approved, the Contractor shall restore the work to its original condition. The electrical contractor is responsible for notifying the appropriate Code Officials to schedule required inspections including rough-in, above ceiling and final inspections.

1.12 REFERENCE STANDARDS

A. All electrical equipment, materials, and installation shall be in accordance with the latest edition of the following codes and standards:

1. American Association of Edison Illuminating Companies (AEIC)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. Building Officials Code Administrators (BOCA)
5. Energy Code 90.1 (ASHRAE/IES)
6. Institute of Electrical and Electronic Engineers (IEEE)
7. Insulated Cable Engineers Association (ICEA)
8. International Code Council (ICC)
9. International Conference of Building Officials (ICBO)
10. National Electrical Code (NEC) 2020 edition
11. National Electrical Contractor's Association (NECA)
12. National Electrical Installation Standards (NEIS)
13. National Electrical Manufacturer's Association (NEMA)
14. National Electrical Safety Code (NESC)
15. National Fire Protection Association (NFPA)
16. North Carolina State Building Code (NCSBC)
17. North Carolina Construction Manual with GS as listed (NCCM)
18. Occupational Safety and Health Act (OSHA)
19. Requirements of the Americans with Disabilities Act (ADA), latest edition.
20. Underwriters Laboratories Inc (U.L.)
21. Southern Building Code Congress International (SBCCI)
22. Toxicity Characteristics Leaching Procedure (TCLP)

B. All electrical equipment and material shall be listed by a qualified third party testing agency. Acceptable qualified third party testing laboratories/agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment. Equipment and materials shall bear the appropriate testing agency's listing mark or classification marking. Equipment, materials, etc. utilized not bearing a third party testing agency certification shall be field or factory third party testing agency certified prior to equipment acceptance and use.

C. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

1.13 ENCLOSURE TYPES

Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

1. NEMA 1 for dry, indoor locations.

2. NEMA 3R for outdoor locations, rooms below grade (including basements and buried vaults), “DAMP” and “WET” locations.
3. NEMA 4X for locations subject to corrosion when specifically noted.

1.14 CODES, INSPECTION AND FEES

A. All equipment, materials and installation shall be in accordance with the requirements of the local authority having jurisdiction.

B. The Electrical Contractor shall obtain all necessary permits and pay all fees required for permits and inspections of electrical work.

C. The Electrical Contractor shall contact Code Officials to schedule any and all required inspections.

1.15 TESTS AND SETTINGS

A. Test all systems furnished under Divisions 26, 27 and 28 and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner’s personnel in the proper operation of the systems.

B. See other Sections for specific testing and acceptance requirements.

C. Make the following minimum tests and checks prior to energizing electrical equipment:
1. Mechanical inspection, testing and settings of all circuit breakers, disconnect switches, motor starters, control equipment, etc., for proper operation. All overcurrent protective devices shall be set as recommended by the Selective Coordination Study, if applicable.
2. Check all wire and cable terminations. Verify to the Architect/Engineer that connections meet the equipment torque requirements.
3. Check rotation of motors, obtain permission from other contractors to start motor, and proceed to check for proper rotation. If the motor rotates in the wrong direction, correct it. Take all necessary precautions not to damage any equipment.
4. Provide all instruments and equipment for the tests specified herein.

D. All testing shall be scheduled and coordinated by the Contractor. Notify the Owner at least two (2) weeks in advance of conducting tests. The Contractor shall have qualified personnel present during all testing.

E. All tests shall be completely documented with the time of day, date, temperature, and all other pertinent test information. All required documentation of readings indicated shall be submitted to the Architect/Engineer prior to, and as one of the prerequisites for, final acceptance of the project.

F. Electrical Distribution System Tests: All current carrying phase conductors and neutrals shall be tested as installed, and before load connections are made, for insulation resistance and accidental grounds. This shall be done with a 500 volt cable insulation tester. The following procedures shall be as follows:
1. Minimum readings shall be one million (1,000,000) ohms or more for #6 AWG wire and smaller; 250,000 ohms or more for #4 AWG wire or larger. Measurement to be taken between conductors and between conductor and the grounded metal raceway.

2. After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take a cable insulation tester reading between the neutral bar and grounded enclosure. If this reading is less than 250,000 ohms, the Contractor shall disconnect the branch circuit neutral wires from this neutral bar. The Contractor shall then test each one separately to the panel until the low reading ones are found. The Contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
3. The Contractor shall send a letter to the Architect/Engineer certifying that the above has been done and tabulating the cable insulation tester readings for each panel. This shall be done at least four (4) days prior to final inspection.
4. At inspection, the Contractor shall furnish a cable insulation tester and show Architect/Engineer's representative that the panels comply with the above requirements. The Contractor shall also furnish a clamp type ammeter and a voltmeter and take current and voltage readings as directed by the representatives.
5. At inspection, the Contractor shall furnish ladders, required tools, and mechanics to open fixtures, boxes, panels, or any other equipment to enable the Architect/Engineer's representatives to see into any parts of the installation that may be requested.

G. Electrical Grounding System Tests: Provide documentation showing values of earth ground impedance for the system ground. See Specifications Section 260526 for testing requirements.

1.16 SLEEVES AND FORMS FOR OPENINGS

A. Anchor bolts, sleeves, inserts, supports, etc., that may be required for electrical work shall be furnished, located and installed by the Electrical Contractor. The Electrical Contractor shall give sufficient information (marked and located) to the General Contractor in time for proper placement in the construction schedule. Should the Electrical Contractor delay or fail to provide sufficient information in time, then the Electrical Contractor shall cut and patch construction as necessary and required to install electrical work. Such cutting and patching will be done by the General Contractor but paid for by the Electrical Contractor.

B. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

C. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, request shop drawings, equipment location drawings, foundation drawings, and any other data required to locate the concealed conduit before the floor slab is poured.

D. Where such data is not available in time to avoid delay in scheduled floor slab pours, the Architect/Engineer may elect to allow the installations of such conduits to be exposed. No additional compensation for such change will be allowed and written approval must be obtained from the Architect/Engineer.

E. Seal all openings, sleeves, penetration, and slots as specified and as shown on the Contract Drawings.

1.17 CUTTING AND PATCHING

A. For the purposes of the Electrical Contract, “cutting and patching” shall be defined as that work required to introduce new electrical work into existing construction. Work required to install or fit electrical boxes, conduit, enclosures, equipment, etc. into new construction is not “cutting and patching”.

B. The Electrical Contractor shall perform all cutting and patching necessary to install all equipment as required under his contract and shall re-establish all finishes to their original condition where cutting and patching occur.

C. All cutting and patching shall be done in a thoroughly workmanlike manner.

D. Core drill holes in existing concrete floors and walls as required.

E. Install work at such time as to require the minimum amount of cutting and patching.

F. Do not cut joists, beams, girders, columns or any other structural members without first obtaining written permission from the Architect/Engineer.

G. Cut opening only large enough to allow easy installation of the conduit.

H. Patching shall be of the same kind of material as was removed.

I. The completed patching work shall restore the surface to its original appearance.

J. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

K. Remove rubble and excess patching materials from the premises.

L. Raceways and ducts penetrating rated floor, ceiling or wall assemblies shall be properly sealed in accordance with the corresponding Underwriters Laboratories approved method utilizing approved and listed materials.

1.18 INTERPRETATION OF DRAWINGS

A. The Electrical drawings and specifications are complementary each to the other and what may be called for by one shall be as binding as if called for by both. The drawings are diagrammatic and indicate generally the location of outlets, devices, equipment, wiring, etc. Drawings shall be followed as closely as possible; however, all work shall suit the finished surroundings and/or trim.

B. Do not scale electrical drawings. Refer to the architectural drawings for dimensions.

C. Where the words “furnish and install” or “provide” are used, it is intended that this contractor shall purchase the equipment or material and install it completely with any and/or all material necessary and required for this particular item, system, equipment, etc.

D. Where the words “the Contractor” or “this Contractor” appear in either the Electrical Drawings or Division 26, 27 and 28 Specifications, it shall mean the Electrical Contractor.

E. Any omission from either the drawings or these specifications are unintentional, and it shall be the responsibility of this Contractor to call to the attention of the Architect/Engineer any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.

F. Where no specific material or equipment type is mentioned, a high quality product of a reputable manufacturer may be used provided it conforms to the requirements of these specifications. These materials shall be listed or labeled by a Third Party Testing Agency accredited by the NCBCC to label electrical equipment.

G. The electrical drawings show the general arrangement of raceways, equipment, fixtures, and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. Some adjustment of routings and installation of raceways, ducts, wireway, cable tray, equipment, components and devices should be expected. The electrical work shall conform to the requirements shown on all of the Drawings. General and Structural drawings shall take precedence over Electrical Drawings. Because of small scale of the electrical drawings, it is not possible to indicate offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings and accessories as may be required to meet such conditions, without additional cost to the Owner and as directed by the Architect/Engineer.

H. Each 3-phase circuit shall be run in a separate conduit unless otherwise shown on the Drawings.

I. Unless otherwise approved by the Architect/Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.

J. Where circuits are shown as “home runs” all necessary fittings and boxes shall be provided for a complete raceway installation.

K. Verify with the Architect/Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

L. Any work installed contrary to or without approval by the Architect/Engineer shall be subject to change as directed by the Architect/Engineer, and no extra compensation will be allowed for making these changes.

M. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Architect/Engineer during construction. Obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Architect/Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

N. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

O. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all

power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of equipment.

P. All connections to the equipment shall be made as required, and in accordance with the approved shop and setting drawings.

Q. Redesign of electrical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at the Contractor's expense. Redesign and detailed plans shall be submitted to the Architect/Engineer for approval. No additional compensation will be provided for changes in the work, either the Electrical Contractor's or others, caused by such redesign.

R. All floor mounted electrical equipment shall be placed on 4-inch thick concrete housekeeping pads. Edges shall be chamfered.

1.19 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his materials in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to suitably brace the equipment, to insure that the tilting does not impair the functional integrity of the equipment.

1.20 EXISTING BUILDINGS AND CONSTRUCTION

A. The Contractor is cautioned that some of the work to be performed under this contract is to be accomplished adjacent to and in an existing occupied building. All such work shall be scheduled and arranged to be done at the convenience of the Owner so as not to interfere with, disrupt, or disturb normal operations in the building. The Contractor shall obtain approval from the Owner before proceeding with work in existing buildings and shall work in existing buildings on schedule as agreed upon with the Owner. This is not to be necessarily construed to mean that the Contractor is expected to perform work on buildings on holidays, weekends, etc., but that the Contractor must schedule work with the Owner for the Owner's beneficial and normal usage of the buildings, and that the Contractor will be required to maintain the schedule as approved by the Owner.

B. The Contractor shall, at all times, provide safety barriers, protective devices, screening, dust barriers, etc., as required to maintain the safety and comfort of the building's personnel and/or occupants in or near the work area.

C. The Contractor shall be responsible for cleanup in connection with work in existing buildings. At the end of each working day, all debris, boxes, waste, etc., shall be removed from the buildings and properly disposed of. Equipment, materials, etc., may be left inside the buildings, but such must be properly stored, stacked and located as approved by the Owner.

D. The Contractor shall do all cutting, patching, finishing, repairing, painting, etc., necessary for electrical work to be installed in existing buildings. All finishes shall be left to equal finish

and condition prior to cutting. No cutting of structural members will be allowed. All cutting of walls, floors, roofs, etc., shall be repaired and/or replaced to equal finish prior to cutting. The Contractor shall route conduits and locate equipment as approved by the Owner and Architect/Engineer. Routings and locations shall be firmly established and approved before proceeding with any phase of the work.

E. The Contractor shall be responsible for any and all damage to the existing buildings, grounds, walkways, paving, etc., caused by the work, the Contractor and/or Contractor's personnel, and/or Contractor's equipment in the accomplishment of this work. Such damages shall be repaired and/or replaced by the Contractor at no additional cost to the Owner, to finish equal to that finish prior to damage. The Architect/Engineer shall be the judge as to equal finishes, etc.

1.21 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on one set of project contract drawings, herein after called the "record drawings".

B. Record drawings shall accurately show the installed condition of the following items:
1. Power distribution one-line diagram(s).
2. Panel schedule(s).
3. Control wiring diagram(s).
4. Lighting fixture schedule(s).
5. Service, feeder, branch circuit conduit and conductor sizes.
6. Lighting fixture, receptacle, and switch outlets, interconnections and homeruns with circuit identification.
7. Underground raceway routing.
8. Plan view, sizes and locations of panelboards.
9. Fire alarm system.
10. Telecommunications system.
11. Cable tray system.

1.22 CORROSION PROTECTION

All equipment, raceways, hardware, etc., furnished under the electrical contract shall be protected from corrosion by factory applied coatings, paint and galvanizing, or shall be fabricated of high quality 300 series stainless steel. All exposed hardware shall be hot dip galvanized. The requirements of preceding section entitled "Delivery and Storage" shall be strictly followed. Touch up any scratched metallic surfaces immediately to prevent corrosion. Apply cold galvanizing compound to all galvanized surfaces damaged during installation, i.e., cutting, etc. Rusted or corroded materials shall be replaced before final acceptance of the work.

1.23 SEISMIC REQUIREMENTS

A. All equipment furnished under the electrical contract shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code (NCSBC). The Contractor shall provide any and all seismic restraint details and calculations that may be required by the NCSBC and/or the Authority Having Jurisdiction.

B. Requirements for restraints are detailed in the NCSBC. All tables and references shall conform to building's location. Restraints shall be per Seismic Performance Category stated on Architectural Drawings.

C. The Contractor shall retain the services of a Professional Engineer registered in the State of North Carolina to design seismic restraint elements required for this project. The Engineer's calculations, bearing his professional seal, shall accompany shop drawings and shall demonstrate Code compliance including certification that the seismic system components comply with the testing requirements of NCSBC Section 1708.5. Calculations and shop drawings shall be submitted for review prior to the purchasing of materials, equipment, systems and assemblies. Internal seismic restraint elements of manufactured equipment shall be certified by a professional engineer retained by the manufacturer. Such certificate applies only to internal elements of the equipment. All equipment anchorage requirements shall be coordinated with the building structure and shall be compatible thereto. All such anchorages shall be subject to the review and approval of the project's structural engineer.

D. The Professional Engineer retained for seismic restraint calculations shall visit the job site upon completion of the seismic restraint installation to comply with the Special Inspections requirement of the Code. This engineer shall provide written verification of compliance of the installation with the approved seismic submittal. This verification shall be submitted as a Special Inspections Report and shall bear the Engineer's professional seal. Job site inspections by other than this engineer are not acceptable.

E. Review of the seismic design computations and shop drawings by the Architect/Engineer or his agent shall not relieve the Contractor of his responsibility to comply with the seismic or any other requirements of the North Carolina State Building Code.

1.24 GUARANTEE

The Contractor shall guarantee the materials and workmanship covered by these drawings and specifications for a period of one year from the date of acceptance by the Owner. The Contractor shall repair and/or replace any parts of any system that may prove to be defective at no additional cost to the Owner within the guarantee period. All equipment warranties shall be as specified and included in the Contract Documents.

1.25 PHASING OF THE WORK

The Electrical Contractor shall schedule his work as described in the relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

1.26 ALTERNATE BIDS

Alternate bid items are described in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

PART 2 - PRODUCTS Not used.

PART 3 - EXECUTION Not used.

END OF SECTION 260500

SECTION 260510 - SELECTIVE ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

Selective electrical demolition shall be provided by the Electrical Contractor as described herein and as shown on the contract drawings. Gross demolition will be provided by the General Contractor. Identify active utilities, and at the appropriate time, disconnect and cap off such utilities and provide experienced personnel on site during General Contractor demolition operations to perform such operations and resolve issues. Remove materials noted for salvage and reuse.

1.2 RELATED SECTIONS

Division 2 - Demolition

1.3 REFERENCES

NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Survey the affected areas before submitting bid proposal.

B. These Drawings have been compiled by the Architect/Engineer from the Owner's record drawings and limited field verification of existing conditions for the purpose of indicating the work required and are believed to be correct. Notwithstanding, the contractor shall verify all circuits, wiring, conduit, dimensions, points of access and all field conditions affecting his work. Report discrepancies to the Architect/Engineer before disturbing the existing installation.

C. Verify dimensions and circuiting arrangements are as shown on Drawings.

D. Verify that abandoned wiring and equipment serve only abandoned facilities.

E. Beginning of demolition means the Contractor accepts existing conditions.

3.2 PREPARATION

A. Identify and mark wiring to remain for the General Contractor.

B. Disconnect and/or de-energize electrical systems in walls, floors, and ceilings scheduled for removal.

C. Coordinate power outages with the Owner and Utility Company.

D. Continuous service is required on many circuits and outlets affected by these changes, except where the Owner will permit an outage for a specific time. Obtain Owner's consent before removing any circuit from continuous service.

E. Protect existing circuits to remain and extend as required utilizing matching conductors and conduit size and type.

F. Protect all existing active utility and standby power, communications, data, life safety, security, fire alarm, paging and emergency call systems and maintain them in operation throughout the progress of the work. Notify the Owner and Architect/Engineer if shutdowns are required prior to any outage of service. Where the duration of a proposed outage cannot be tolerated by the Owner, provide temporary connections as required to maintain service.

G. Trace out existing wiring that is to be relocated or removed and perform the relocation or removal work as required for a complete operating and safe system. Provide temporary and/or permanent wiring and connections as shown and/or as required by conditions to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, and when such work is specifically approved by the Owner, use personnel experienced in such operations.

H. Existing Electrical Service: Maintain existing systems in service. Disable systems only to make switchovers and connections. Obtain permission from the Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

I. Existing 12 kW Standby Power Generator: Remove the existing 12 kW standby generator system as shown on the Drawings. All work shall be done after facility normal business hours and on weekends. Disable systems only to make switchovers and connections. Obtain written permission from the Owner at least 72 hours before partially or completely disabling systems. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

J. Existing Fire Alarm System: Coordinate work with the Owner's fire alarm system vendor and maintain the existing system in service until the new system is accepted. Disable system only to make switchovers and connections. Notify the Owner and local fire service at least 24 hours before partially or completely disabling system. Limit outages to normal business hours only and minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. See Specifications Section 283111.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of relevant sections of the General and Supplemental General Conditions, Division 1 Specifications Sections, Section 260500 and this Section.

B. The Contractor shall review the architectural, mechanical, plumbing and electrical drawings and specifications for demolition requirements and carry out his work in a compatible and complementary manner.

C. Remove, relocate, and extend existing installations to accommodate new construction.

D. Remove all electrical equipment, wiring devices, raceways, boxes, fixtures, hangars, supports, etc., and those made obsolete by these alterations and as shown on the Contract Documents. All items to be removed or modified may not be shown, however, this contractor shall remove any electrical work as required by the construction or as directed by the Owner or Architect/Engineer. Survey the affected areas before submitting a bid as all existing conditions cannot be completely depicted on the drawings and some unusual conditions may exist.

E. Coordinate with the other trades, prior to bid, and include in the base bid the electrical disconnection of any equipment being demolished, even if not explicitly shown. Unless noted otherwise, remove all demolished equipment from the property and identified in the electrical drawings.

F. Remove materials and equipment designated for salvage and reuse. Store in protected, dry locations.

G. Secure all circuits, raceways, cable and conductors that, as a result from this construction, are abandoned or unused. Blank abandoned knockouts in remaining boxes. Install blank plates for all unused outlets that will remain as a result of this construction.

H. Remove disconnected, abandoned and unused exposed conduit and wiring back to source of supply, or to point of concealment, including abandoned conduit above accessible ceilings. Remove unused wiring in concealed conduits back to source or nearest point of usage. Cut conduit flush with walls and floors, and patch surfaces.

I. The accessible portions of abandoned free run cables (voice, data, video, alarm, etc.) shall be removed. Verify that abandoned wiring and equipment serve only abandoned facilities.

J. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.

K. Ends of all conduits to remain shall be tightly plugged to exclude dust and moisture while the building is under renovation.

L. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation. Coordinate outages in systems with the Owner. Where duration of proposed outage cannot be allowed by the Owner, provide temporary connections as required to maintain service.

M. Repair adjacent construction and finishes damaged during electrical demolition and extension work.

N. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

O. Disconnect and remove electrical devices serving utilization equipment that has been removed.

P. Disconnect and remove abandoned panelboards and distribution equipment.

Q. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide stainless steel blank cover for abandoned outlets which are not removed.

R. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

S. Protect existing circuits feeding lighting fixtures for extension to new and relocated lighting fixtures.

T. Extend existing switch legs to new switch locations as shown and/or required.

U. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

V. Reconnect existing circuits separated as a result of this construction.

3.4 DISPOSAL, CLEANING AND REPAIR

In general, it is intended that material and equipment indicated to be removed and disposed of by the Contractor. Removed materials shall become the Contractor's property and shall be disposed of, off the site, by the Contractor unless otherwise directed by the Owner. A receipt showing acceptable disposal of any legally regulated materials or equipment shall be given to the Owner. Fees associated with disposal shall be included in the contractor's base bid.

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness. Provide new typed circuit directories showing revised circuiting arrangement.

C. All salvageable materials shall be properly stored by the Electrical Contractor until installed in new construction.

D. The contractor is responsible for disposal of all lamps containing mercury in a lined landfill in accordance with NC General Statute 309.10M.

3.5 INSTALLATION

Install relocated materials and equipment under the provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

END OF SECTION 260510

SECTION 260519 - BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire and cable.

B. Metal clad cable.

C. Lighting Control Cable.

D. Wiring connectors and connections.

1.2 RELATED SECTIONS

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

B. Section 260526 - Grounding and Bonding.

C. Section 260533 - Conduit.

D. Section 260534 - Boxes.

E. Section 260553 - Identification.

1.3 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. NECA Standard of Installation (National Electrical Contractors Association).

1.4 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide manufacturer's catalog information showing dimensions, ratings, colors, and configurations.

C. Test Reports: Indicate procedures and values obtained.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.7 PROJECT CONDITIONS

A. All wire and cable shall be installed in conduit, except where MC Cable and/or free run lighting control cable is specifically permitted. This includes all power wiring; fire alarm, emergency systems control conductors, sound and communications wire and cable (unless noted otherwise); lighting control cable; HVAC control cable; etc. and other electrical systems required by Codes to be installed raceways. Lighting control cable is permitted above accessible ceilings and in conduit to the switch location.

B. Verify that field measurements are as shown on Drawings.

C. Conductor sizes are based on 75° C. copper.

D. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

E. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.8 COORDINATION

A. Coordinate Work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

PART 2 - PRODUCTS

2.1 BUILDING WIRE AND CABLE

A. Description: Single conductor insulated building wire.

B. Conductor: Copper. Solid and stranded as specified below. Minimum #12 AWG, maximum 500 KCMil.

C. Insulation/Voltage Rating: 600 volts.

D. Insulation: Dual-rated THHN/THWN or XHHW.

E. Color Coding:

	120/240 volts and 208/120 volts
Phase A -	Black
Phase B -	Red
Phase C -	Blue
Neutral -	White*
Ground -	Green

*Provide neutral conductors with factory color coded markings or stripes identified for their associated phase conductor (white-black, white-blue, white-red) where individual neutral conductors are required.

2.2 METAL CLAD (MC) CABLE

A. Description: Metal clad (MC) cable with aluminum interlocked armor, copper conductors and an internal green insulated equipment grounding conductor may be used for branch circuits 30 amperes and less. Use cable with individual neutral conductors where specified and/or required. Cable with individual neutral per phase design neutral conductors shall be provided with factory color coded neutral markings or stripes identifed for their associated phase conductor (white-black, white-red, white-blue).

B. Conductors: Copper. Solid and stranded as specified below. Minimum #12 AWG, maximum #10 AWG.

C. Insulation/Voltage Rating: 600 volts.

D. Insulation: Dual-rated THHN/THWN or XHHW.

E. Conductor Color Coding: Same as Building Wire above.

E. Interlocked armor color coding: Consistent with Section 260553 requirements for raceways.

F. MC cable with integral power and low voltage cable for lighting control is permitted.

G. Connectors shall be zinc plated malleable iron or steel body with locknut, dual cable gripping saddle design with set screw and insulated throat. Pressure cast (pot metal) connectors are not permitted.

2.3 ALUMINUM FEEDER CONDUCTOR OPTION

The Contractor may provide aluminum conductors for service entrance and large feeders. Such conductors shall result in equal ampacity to the copper service entrance and feeders they replace. The contractor is responsible for obtaining written approval from the Architect/Engineer for all proposed changes prior to installation. Raceways shall be upsized and quantities increased as required to maintain service entrance and feeder ampacity. Installation shall conform to conductor and connector manufacturer's recommendations including oxide inhibitor use and properly torqued connections. Maintain all NEC required spacing inside cabinets at terminations.

A. AA-8000 series aluminum conductors may be substituted for copper service entrance and feeder conductors in size #4/0 AWG and larger (i.e.; #2/0 AWG copper replaced with #4/0 AWG aluminum. Copper conductors in size #1/0 and smaller shall remain copper.).

B. The maximum aluminum conductor size shall be 500 KCMil.

C. All aluminum conductor terminations shall be made with machine applied compression connectors and individually field verified and certified in writing by the contractor to be installed per the conductor and equipment manufacturer's recommendations. Insulation shall be removed by "penciling" or using a manufacturer-approved insulation removal

tool that does not nick the underlying conductor. Do not "ring cut" insulation. Wire brush the conductor and apply conductor manufacturer approved oxide inhibitor prior to terminating, unless the compression connector is prefilled with inhibitor, all as recommended by the manufacturer.

2.4 LIGHTING CONTROL CABLE

Lighting control cable for dimming and occupancy sensor control shall be provided as required. Lighting control cable may be provided integral to MC cable, or discrete, as approved by the lighting controls manufacturer and as required by NEC Article 725. If discrete, cable shall be NEC Type CMP, in raceway from the switch outlet box to the accessible ceiling cavity, then free run to follow the lighting power system raceways to the fixtures controlled, be secured to the structure to the plane of the lighting power raceway system, then supported by the lighting power raceway system using NEC approved cable ties installed on no more than six foot intervals, or less if required by Codes and the AHJ. Lighting control cable shall be plenum rated and be approved by the lighting controls manufacturer. It shall consist of a 2#18 AWG solid, violet and gray insulated conductors minimum with an outer jacket rating of 300V minimum. Cable outer jacket shall not be red. Cable shall be daisy chain connected to lighting fixtures or be taped in junction boxes installed at the same plane of the lighting power raceway system. Do not support cable with ceiling grid supports wires. Do not drape cable over ceilings, lighting fixtures, conduit, ductwork, piping or equipment. Daisy chaining cable at the ceiling level is not permitted.

2.5 WIRING CONNECTORS AND CONNECTIONS

A. Conductors shall be installed continuous from outlet to outlet with no splicing except within outlet or junction boxes, troughs and gutters. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

B. Use mechanical connectors for copper conductor splices and taps, 8 AWG and larger, except main grounding conductors, which shall be terminated with compression lugs. Tape un-insulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor or use third party testing agency-approved insulating covers.

C. Use insulated spring wire connectors with plastic caps for copper conductors, 10 AWG and smaller, splices and taps in junction boxes, outlet boxes and lighting fixtures, Ideal "Wire-Nut" or "Wing-Nut", 3M Company "Scotchlock" series or NSI "Easy-Twist". "Push wire" type connectors are not acceptable.

D. "Sta-Kon" or other permanent type crimp connectors shall not be used for branch circuit connections.

E. Joints in stranded conductors shall be spliced by approved mechanical connectors and insulated with vinyl mastic tape and covered with vinyl electrical tape, 3M Scotch Vinyl Mastic Tape 2210 and Scotch Vinyl Electrical Tape Super 88, respectively, or approved equal. Solderless mechanical connectors for splices and taps, provided with U.L approved insulating covers, may be used instead of mechanical connectors plus tape.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire has been completed.

C. Verify that raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRING METHODS

A. Service: Use only building wire in raceway.

B. Panelboard and Equipment Feeders: Use building wire in metallic raceway.

C. Exposed Branch Circuits in Unfinished Dry Interior Locations: Use only building wire in metallic raceway.

D. Branch Circuits in Concealed Dry Interior Locations:
   1. Use building wire in metallic raceway or metal clad cable.
   2. MC cable may be used exposed in electrical equipment rooms where branch circuits originate at panelboards, but cable shall be supported and neatly arranged above panelboards on steel ladder rack, width as required. Cable shall be strapped to ladder rack using approved, UV resistant plastic cable ties. Alternately, MC cable shall be transitioned to building wire and metallic raceway outside of the electrical equipment rooms in a junction box or wiring trough concealed above an accessible ceiling. If this method is utilized to convert MC cable to building wire and metallic raceway, provide screw connection, feed-through, modular type DIN rail terminal blocks for termination and extension of circuit conductors. Terminal blocks shall be rated 30A, 300VAC minimum, and higher as required by circuit ampacity and voltage, quantity as required for phase, neutral and equipment ground conductors. Wirenut and similar terminations are not permitted in splice boxes or panelboard interiors. All splices shall be clearly labeled and neatly trained as judged acceptable by the Engineer.
   3. Where panelboards are installed on the surface, building wire in raceway shall be extended to the source panel from the last outlet box. MC cable shall not be installed exposed.

E. Branch Circuits in Wet or Damp Interior Locations: Use only building wire in metallic raceway.

F. Underground Installations: Use only building wire in non-metallic raceway.

G. Wet or Damp Interior Locations: Use only building wire in metallic raceway.

H. Exterior Locations: Use only building wire in metallic raceway or Schedule 40 PVC where noted.

3.4 INSTALLATION

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

B. Route wire and cable as required to meet Project Conditions.

C. Install cable in accordance with the NECA "Standard of Installation".

D. Use solid conductor for feeders and branch circuits 10 AWG and smaller, and Class B stranded for larger conductors.

E. Use conductor not smaller than 12 AWG for power and lighting circuits.

F. Use conductor not smaller than 14 AWG for fire alarm and control circuits.

G. Pull all conductors into raceway at same time.

H. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

I. Neatly train and lace wiring inside boxes, equipment, and panelboards. Do not tightly bundle conductors.

J. Clean conductor surfaces before installing lugs and connectors.

K. Identify wire and cable under provisions of Section 260553.

L. Identify each conductor with its circuit number or other designation indicated on Drawings.

M. Common neutral multiwire receptacle branch circuits are not permitted. Provide separate, individual neutral conductors for receptacle circuits.

N. Do not bundle metal clad cable in a manner that requires the conductors be derated.

M. MC cable shall be supported in straight lines using approved supporting means and in compliance with the NEC. Dedicated support wires may be used above finished ceilings and shall be painted red prior to installation. Do not support cable with ceiling grid supports wires. Do not drape cable over ceilings, lighting fixtures, conduit, ductwork, piping or equipment. Do not "daisy-chain" connect lighting fixtures with MC cable.

3.5 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect wire for physical damage and proper connection.

C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

D. Verify continuity of each branch circuit conductor.

E. 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 retained on site as part of the project record documents for review at time of final project inspection. A copy of these tests shall be sent to the Architect.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grounding electrodes and conductors.

B. Equipment grounding conductors.

C. Grounding well components.

D. Ground Bars.

1.2 RELATED SECTIONS

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

B. Section 260519 – Building Wire and Cable.

C. Section 260533 - Conduit.

D. Section 260534 - Boxes.

E. Section 260553 – Electrical Identification.

1.3 REFERENCES

A. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

B. NFPA 70 - National Electrical Code.

1.4 GROUNDING SYSTEM DESCRIPTION

A. The neutral of each secondary electrical distribution system shall be grounded at one point only which shall be at the main disconnecting device. From the main disconnecting device, a copper grounding conductor sized in accordance with the NEC shall be extended to the earth electrode. Main grounding conductors #8 AWG through and including #4 AWG shall be insulated and identified by a green colored insulation. All grounding conductors shall be installed in conduit sized in accordance with the NEC. Conduit carrying a grounding conductor shall also be grounded at the earth electrode.

B. The earth electrode shall be:

1. The metallic domestic water piping system of the building. Connection of the grounding conductor shall be made by an approved grounding clamp. The point of connection to the water system shall be within 6 inches of the entrance of the pipe inside the building or structure. Where dielectric unions are used in the water piping system, the grounding connection shall be made on the “street side” of the first such union in the system. A bonding jumper the same wire size as the grounding

conductor shall be installed across the water piping connection such that the water meter may be removed without interrupting the grounding system continuity. Where no metallic domestic water piping system exists, the earth electrode shall be a ground rod with supplemental ground electrodes as defined below.

2. Ground Rods: Size as specified below driven 11 feet into the earth where shown on the contract drawings or as required. The rods shall be connected to the system ground point as shown on the Drawings by an insulated, green copper jumper in conduit. The connection at the rods shall be brazed or exothermically welded. The points of connection to the earth electrode system shall be visible and accessible upon completion of construction. Sectional rods of the same size and length shall be used in multiple rod installations, if required by soil conditions.
3. The building steel and slab reinforcing steel as shown and as required by the NEC. Connection points shall be as directed by the Architect/Engineer.

1.5 PERFORMANCE REQUIREMENTS

The ground resistance of the earth electrode shall not exceed 25 ohms. The Electrical Contractor shall test the earth electrode using a standard three point ground resistance tester and shall advise the Architect/Engineer of the results of such tests in writing. Where tests show the resistance to ground exceeds 25 ohms, appropriate action shall be taken to reduce the resistance to 25 ohms, or less, by driving additional ground rods or other approved methods. Compliance shall be demonstrated by retesting.

1.6 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide for grounding electrodes and connections.

1.7 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Test Reports: Indicates overall resistance to ground and resistance of each electrode.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.8 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Procedures for submittals as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Project Record Documents: Record actual locations of components and grounding electrodes.

C. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.9 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

1.10 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Material: Copper-clad steel.

B. Diameter: 3/4 inch (19mm)

C. Length: 10 feet (3000 mm).

2.2 MECHANICAL CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. Ground clamps shall not be fabricated from aluminum or any aluminum alloy.

2.3 WIRE

A. Material: Copper. Use solid conductor for 10 AWG and smaller, and Class B stranded for larger conductors, all sized per NEC requirements. Conductors shall be tinned bare copper for direct buried installations.

2.4 BONDING BUSHINGS

Bonding bushings shall be steel or malleable iron, insulated, threaded type, zinc plated for interior use and galvanized for exterior use. Provide with dual rated tin plated saddle for use with bonding conductors and resilient plastic insulation throat liner with 150°C rating molded on over the metallic stop. All bushings shall be third party testing agency approved and listed. Die cast zinc bushings are not acceptable.

2.5 GROUND ROD INSPECTION WELLS

A. Pedestrian Traffic Rated
1. Well Housing: 9 inch diameter High Density Polyethylene (HDPE), 10" minimum length. Static vertical load rating of 300 PSF minimum. Two knock out mouse holes for conductor entrance. Harger GAW910, nVent Erico T416B or approved equal.
2. Well cover: HDPE twist lock with locking bolt and the legend "GROUND" embossed on cover.

B. Vehicle Traffic Rated
1. Well Housing: 10 inch diameter reinforced concrete, 12" minimum length. Static vertical load rating of 20,000 PSF minimum. Two knock out mouse holes for conductor entrance.
2. Well cover: Bolt down cast iron with the legend "GROUND" embossed on cover.

2.5 GROUNDING BUSBARS

A. Electrical Power Grounding Busbars: Third party testing agency listed and labelled. Grounding busbars shall be provided for single point termination of power distribution system grounding and bonding conductors as shown on the Drawings. Grounding busbars shall be tin plated solid copper factory drilled with a NEMA hole size and pattern for termination of two hole lugs, quantity as required with 25% spare, and be of the minimum dimensions shown on the Drawings. Provide with 600V standoff insulators, stainless steel mounting brackets and stainless steel hardware. Provide clear Lexan cover over connections.

B. Telecommunications Grounding Busbars: Comply with TIA-607-C and BISCI Standards. Grounding busbars shall be provided for single point termination of telecommunications system grounding and bonding conductors as shown on the Drawings. Grounding busbars shall be tin plated solid copper factory drilled with a BISCI hole size and pattern for termination of two hole lugs, quantity as required with 25% spare, and be of the minimum dimensions shown on the Drawings. Provide with 600V standoff insulators, stainless steel mounting brackets and stainless steel hardware. Provide clear Lexan cover over connections.

PART 3 - EXECUTION

3.1 EXAMINATION

Coordination and Meetings: Verify existing conditions prior to beginning work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

3.2 INSTALLATION

A. Quality Control: Manufacturer's instructions shall be followed as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Provide bonding to meet Regulatory Requirements.

C. Provide separate, insulated conductor within each feeder and branch circuit raceway.

D. Equipment Grounding Conductor: 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. Terminate each end on suitable lug, bus, or bushing. Exceptions are as follows:
1. Raceways for telecommunications.
2. Raceways for data.
3. Raceways for audio conductors.
4. Services.

E. Equipment grounding continuity shall be maintained through flexible conduit as required in previous sections.

F. Grounding conductors shall be installed as to permit the shortest and most direct path from equipment to ground. All connections to ground conductors shall be accessible for inspection and made with approved solderless connectors, brazed or bolted to the equipment or structure to be grounded. All contact surfaces shall be thoroughly cleaned before connections are made to insure good metal to metal contact.

G. All equipment housings and/or enclosures, and all non-current carrying metallic parts of electrical equipment, raceway systems, etc., shall be effectively and adequately bonded to ground.

H. Grounding type insulated bonding bushings and jumpers shall be provided where concentric, eccentric or over-sized knockouts are encountered. The jumpers shall be sized per the NEC.

I. All metallic raceways entering or leaving panelboards (branch circuits less than 30 amperes in branch circuit panelboards excepted), switchboards, transfer switches, enclosed circuit breakers, safety switches, transformers, pull boxes, splice boxes, etc. shall be provided with insulated grounding and bonding bushings and each separate piece of raceway shall be individually bonded to the equipment ground bus or metallic enclosure, as applicable, by means of copper conductor sized in accordance with the NEC.

J. Bond the above ground portion of the gas piping system upstream from equipment shutoff valve to the building electrical service ground. The bonding jumper shall be sized per the NEC.

K. An equipment ground bus shall be installed in each panelboard for terminating equipment grounding conductors.

L. All wiring devices equipped with grounding connections shall be permanently and securely connected to the enclosure in which they are mounted with a copper grounding jumper.

M. The frame of all lighting fixtures shall be securely grounded to the equipment ground system with grounding conductors.

N. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing where indicated. Bond reinforcing steel together.

O. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

P. Provide ground rod inspection well with cover at each rod location. Install well top flush with finished grade.

3.3 EXISTING WORK

If the work includes renovation and/or addition to existing conditions:

1. Modify existing grounding system to maintain continuity and to accommodate renovations.
2. Extend existing grounding system using materials and methods specified.

3.4 FIELD QUALITY CONTROL

A. Quality Assurance: Field inspection, testing and adjusting as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

1.2 REFERENCES

A. NECA - National Electrical Contractors Association.

B. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide manufacturer's catalog data for fastening systems.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide adequate corrosion resistance.

B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

C. Anchors and Fasteners:
1. Concrete Structural Elements: Use expansion anchors.
2. Steel Structural Elements: Use beam clamps.
3. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
5. Solid Masonry Walls: Use expansion anchors.
6. Sheet Metal: Use sheet metal screws or bolts

7. Wood Elements: Use wood screws.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Do not use powder-actuated anchors.

E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

F. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch (25 mm) off wall.

I. Conduits installed on the interior of exterior building walls shall be spaced away from the wall surface a minimum of 1/4 inch (65mm) using "clamp-backs" or struts.

J. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

END OF SECTION 260529

SECTION 260533 - CONDUIT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Metal conduit.

B. Flexible metal conduit.

C. Liquidtight flexible metal conduit.

D. Electrical metallic tubing.

E. Nonmetallic conduit.

1.2 RELATED SECTIONS

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

B. Division 7: Fire Stopping.

C. Division 7: Roofing penetrations.

D. Section 260534 - Boxes.

E. Section 260526 - Grounding and Bonding.

F. Section 260529 - Supporting Devices.

G. Section 260553 - Electrical Identification.

1.3 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.

C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

D. ANSI/NFPA 70 - National Electrical Code.

E. NECA “Standard of Installation”.

F. NEMA TC2 - Schedule 40 PVC

G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.4 DESIGN REQUIREMENTS

Conduit Size: ANSI/NFPA 70.

1.5 SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, fittings and conduit bodies.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Accurately record actual routing of conduits larger than 2 inches (51 mm).

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown. “Third party agencies shall be amongst those accredited by the NCBCC (North Carolina Building Code Council) to Label Equipment”.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle Products to site under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

1.9 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Size: Conduit shall be sized in accordance with the latest edition of the NEC unless shown otherwise, with minimum conduit size of ½ inch, except homeruns minimum size shall be 3/4". Flexible metal and watertight ("sealtite") conduit in size ½ inch and larger are acceptable for motor, appliance and fixture connections provided green ground wire is installed (see Section 260526) and NEC is followed.

B. Underground Installations:
1. More than Five Feet from Foundation Wall: Use rigid steel conduit, intermediate metal conduit, plastic coated conduit, thickwall nonmetallic conduit and thinwall nonmetallic conduit.
2. Within Five Feet from Foundation Wall: Use rigid steel conduit.
3. In or Under Slab on Grade: Use rigid steel conduit, intermediate metal conduit, plastic coated conduit, thickwall nonmetallic conduit and thinwall nonmetallic conduit.
4. Minimum Size: 1 inch (25 mm).

C. Outdoor Locations, Above Grade: Use rigid steel conduit.

D. In Slab Above Grade:
1. Use rigid steel conduit.
2. Maximum Size Conduit in Slab: 3/4 inch (19 mm).

E. Wet and Damp Locations: Use rigid steel conduit.

F. Dry Locations:
1. Concealed: Use rigid steel conduit, intermediate metal conduit or electrical metallic tubing. EMT may be utilized as permitted by the NEC, with the following restrictions. EMT shall not be installed:
   a. Any location outdoors, in direct contact with earth, or underground (in/below slab- on grade or in earth.
   b. Indoors in wet or damp locations, or in concrete, cinderblocks or bricks.
   c. Where exposed to severe corrosive influence and/or severe physical damage.
   d. Encased in concrete.
   e. For transition between EMT and rigid conduits, use JB.

2.2 METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1.

B. Plastic-Coated Rigid Steel Conduit: ANSI C80.1, 40 mil PVC coating.

C. Intermediate Metal Conduit (IMC): Rigid steel.

D. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit with zinc-plated steel or malleable iron fittings.

2.3 FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction.

B. Fittings: ANSI/NEMA FB 1, steel.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Description: Interlocked steel construction with PVC jacket.

B. Fittings: ANSI/NEMA FB 1, steel or nonmetallic type.

2.5 ELECTRICAL METALLIC TUBING (EMT)

A. Description: ANSI C80.3; galvanized tubing.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel or malleable iron, compression type, insulated throat.

2.6 NONMETALLIC CONDUIT

A. Description: NEMA TC 2; Schedule 40 PVC.

B. Fittings and Conduit Bodies: NEMA TC 3.

2.7 ONE PIECE SURFACE METAL RACEWAY

A. The raceway shall be dual channel (one side for power and one side for data) with a base and cover factory assembled.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5.

C. A hand operated cutting tool shall be available for the base and cover to ensure clean, square cuts.

D. A full complement of fittings shall be available including but not limited to mounting clips and straps, couplings, flat, internal and external elbows, cover clips, tees, entrance fittings, conduit connectors and bushings. The covers shall be painted with an enamel finish, in to match the raceway. They shall overlap the raceway to hide uneven cuts. All fittings shall be supplied with a base where applicable.

E. Device boxes shall be available for mounting standard devices and faceplates. A device box shall be available in single- and multiple-gang configurations up to six-gang. They shall range in depth from 0.94" to 2.75" [23.88mm to 69.85mm]. Single-gang boxes shall allow for snap-on and fastener application. Extension boxes shall be available to adapt to existing standard flush switch and receptacle boxes. All device and fixture box covers shall be painted with an enamel finish, ivory in color to match the raceway cover.

F. The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available.

G. Raceway shall be paintable to match adjacent colors.

H. Raceway shall be painted by Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Circuiting is shown schematically. Exact routing of branch circuits may be varied to suit building construction; however, the combination of circuits within raceways and panelboard connections shall not be changed from those shown on the drawings.

B. Raceways shall be installed concealed in finished areas. Where construction does not permit concealed raceways and where indicated on the drawings, raceways shall be run exposed. Exposed raceways shall be run parallel to, or at a right angle with the building walls. Route conduit installed above accessible ceilings parallel and perpendicular to walls.

C. Where any run of rigid conduit may change to a run of EMT or vice-versa, each change shall be made in a junction or outlet box with each conduit terminated separately therein. Rigid conduit to EMT (or vice-versa) adapters shall not be permitted.

D. Install conduit in accordance with NECA “Standard of Installation”.

E. Arrange conduit to maintain headroom and present neat appearance.

F. Maintain adequate clearance between conduit and piping.

G. Maintain 12 inch (300 mm) clearance between conduit and surfaces with temperatures exceeding 104 degrees F (40 degrees C).

H. Cut conduit square using saw or pipecutter and de-burr cut ends.

I. Bring conduit to shoulder of fittings; fasten securely.

J. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

K. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows, or hydraulic one-shot bender, to fabricate bends in metal conduit larger than 2 inch size.

L. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

M. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.

N. Provide suitable pull string in each empty conduit except sleeves and nipples.

O. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

P. The raceway system shall not be relied on for grounding continuity. Ground and bond conduit under provisions of Section 260526.

Q. Identify conduit under provisions of Section 260553.

R. 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.

S. Grounding type insulated bonding bushings and jumpers shall be provided where concentric, eccentric or over-sized knockouts are encountered. The jumpers shall be sized per the NEC.

T. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.

U. Arrange supports to prevent misalignment during wiring installation.

V. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

W. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

X. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

Y. Do not attach conduit to ceiling support wires.

Z. All metallic raceways entering or leaving panelboards (branch circuits less than 30 amperes in branch circuit panelboards excepted), switchboards, transfer switches, enclosed circuit breakers, safety switches, transformers, pull boxes, splice boxes, etc. shall be provided with insulated grounding and bonding bushings and each separate piece of raceway shall be individually bonded to the equipment ground bus or metallic enclosure, as applicable, by means of copper conductor sized in accordance with the National Electrical Code.

AA. The term "fittings" includes couplings, connectors, offsets, LBs, conduit bodies, hubs, bushings, bonding bushings, etc.

BB. No pressure cast (pot metal) fittings or conduit bodies shall be allowed.

CC. Outlets, junction, taps, etc., on exposed rigid metal conduit shall be cast malleable iron conduit fittings or cast malleable metal boxes of the type and size appropriate for the location. Sheet steel outlet boxes shall not be permitted on exposed raceway runs except at or near a ceiling for interior construction.

1. Interior exposed raceway junction, switch, receptacle and outlet boxes installed at or below 8 feet AFF/AFG shall be cast malleable type with hubs and cast, gasketed plates.
2. Exterior exposed raceway junction, switch, receptacle and outlet boxes shall be cast malleable type with hubs and cast, gasketed plates.

DD. EMT couplings and terminations shall be made utilizing zinc-plated, steel hexagonal compression connectors. No set screw or indented type fittings shall be utilized.

EE. EMT couplings and terminations shall be "concrete tight" where buried in masonry or concrete. EMT fittings, where installed in damp locations, shall be of the "raintight" type.

FF. Install nonmetallic conduit in accordance with manufacturer's instructions.

GG. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

HH. PVC schedule 40 shall not be used exposed or concealed in gypsum walls, but may be used in CMU walls.

II. IMC and GRC shall terminate with either a double locknut / bushing set, or in a threaded hub.

JJ. Conduit couplings for IMC, GRC and PVC shall be in accordance with the NEC.

KK. The placement of conduit in floor slabs shall be thoroughly coordinated with the General Contractor to avoid conflicts with steel reinforcing bars, reductions in net concrete sections and floor penetrations.

LL. Route conduit in and under slab from point-to-point.

MM. Do not cross conduits in slab.

NN. Schedule 40 PVC may be used in elevated floor slabs and in foundation slabs. Minimum concrete cover shall be 3/4 inch at finished or formed surface and shall be 3 inches at concrete surface cast against earth or for slabs placed on-grade. Greater amounts of concrete cover shall be used in areas subject to damage.

OO. Where underground or underslab [service and feeder] raceways are required to turn up into cabinets, equipment, etc., and on to poles, the elbow required and the stub-up out of the slab or earth shall be of 40 mil plastic-coated rigid steel. Alternately, field applied corrosion protection wrap systems utilizing a primer, putty tape and all-weather corrosion protection tape may be used, in equivalent thickness to factory applied materials, with the specific approval of the Architect/Engineer.

PP. Raceways run external to building foundation walls, with the exception of branch circuit raceways, shall be encased with a minimum of three (3) inches of concrete on all sides.

QQ. Service entrance raceways run inside building foundation walls shall be buried at least eighteen (18) inches below grade or encased with a minimum of three (3) inches of concrete on all sides. Concrete encasement shall extend to the service equipment for raceways exposed above grade in crawl spaces.

RR. Encased raceways shall be of a type approved by the NEC as “suitable for concrete encasement”.

SS. Encased raceways shall have a minimum cover of eighteen (18) inches, except for raceways containing circuits with voltages above 600 volts, which shall have a minimum cover of thirty (30) inches.

TT. Branch circuit raceways run underground external to building foundation walls shall be run in raceways installed in accordance with the NEC, and shall be of a type approved by the NEC as “suitable for direct burial.” Minimum raceway size shall be 1 inch.

UU. Raceways run underground, internal to building foundation walls shall be of a type, and installed by a method approved by the NEC.

VV. Raceways that penetrate outside walls, ceilings from conditioned space or other similar condition shall be effectively sealed to prevent condensation from infiltrating humid air.

WW. Where raceways pass through a below grade wall, from a conditioned interior building space, the raceway shall be sealed utilizing fittings similar and equal to OZ/GEDNEY type “FSK” thru-wall fitting with “FSKA” membrane clamp adapter if required.

XX. All underground raceways shall be identified by underground line marking tape within the provisions of Section 260553. The tape to be located directly above the raceway and 6 to 8 inches below finished grade.

YY. EMT conduit provided below roof deck shall be installed 11/2 inches away from the deck to allow for screws not to penetrate the EMT conduit during reroofing.

ZZ. Conduits, JBs, Troughs, any enclosure when mounted outside on the walls, shall be off the walls by one inch.

AAA. Surface metal raceways shall be used only where indicated on the drawings. All hardware and supports shall be per NEC and supplied by with raceway.

BBB. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.

2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified under Division 7.

END OF SECTION 260533

SECTION 260534 - BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall and ceiling outlet boxes.

B. Pull and junction boxes.

C. Floor boxes.

1.2 RELATED SECTIONS

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

B. Division 7: Firestopping.

C. Division 8: Access Doors.

D. Section 260526 - Grounding and Bonding.

E. Section 260553 - Electrical Identification.

F. Section 262726 - Wiring Devices.

G. Section 260529 – Supporting Devices.

1.3 REFERENCES

A. NECA - Standard of Installation.

B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide manufacturer’s catalog information showing dimensions and configurations.

1.5 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Submittals for Project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Junction, switch, receptacle and outlet boxes for interior use in dry locations shall be zinc coated or cadmium plated sheet steel, 4" square and 2-1/8" deep, unless otherwise indicated on the contract drawings. Smaller and shallower outlet boxes will be permitted only by special permission of the Architect/Engineer where such boxes are necessary due to structural conditions encountered. Where larger junction boxes are required, they shall be fabricated from No. 10, 12, 14 or 16 gauge sheet steel as required by the Underwriters Laboratories, Inc., and galvanized after fabrication. All junction boxes shall have screw fastened covers. Outlet boxes shall be provided with extension plaster rings where required by structural and finish conditions. Sheet steel boxes shall be as manufactured by Appleton, Raco, Steel City or Spring City.
2. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 2 inch (13 mm) male fixture studs where required.
3. Concrete Ceiling Boxes: Concrete type.

B. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Provide gasketed cover by box manufacturer. Provide threaded hubs. Cast boxes shall be by Crouse-Hinds, Appleton, O. Z. Gedney or Killark.

C. Wall Plates for Finished Areas: As specified in Section 262726.

2.2 FLOOR BOXES

A. Floor Boxes: NEMA OS 1, fully adjustable, oversize, reach-in, concealed service, multi-compartment, two and three gang type (one and two duplex receptacles and one telecommunications outlet as shown), 3-3/4 inches deep, minimum. See Drawings for raceway connection requirements.

B. Material: Cast metal or non-metallic. Do not use plastic boxes in rated assemblies.

C. Shape: Rectangular.

D. Service Fittings Covers and Trims: As specified in Section 262726.

E. Boxes shall be Hubbell SystemOne or approved equal.

F. Boxes shall be as specified on the Drawings.

2.3 PULL AND JUNCTION BOXES

Sheet Metal Boxes: NEMA OS 1, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

Verify locations of outlets, floor boxes and poke-throughs prior to rough-in.

3.2 INSTALLATION

A. Install boxes in accordance with NECA “Standard of Installation”.

B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

C. Set wall mounted boxes at elevations to accommodate mounting heights indicated and specified in section for outlet device. Boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box location up to 10 feet if required to accommodate intended purpose. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes. Use flush mounting outlet box in finished areas. Use Erico Caddy RBS series, Raco 9001 or Cooper B-Line BB8-16 box mounting brackets to support flush mounting outlet boxes between studs.

3.3 ADJUSTING

A. Contract Closeout: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust floor box and poke-throughs flush with finish flooring material.

C. Adjust flush-mounting outlets to make front flush with finished wall material.

D. Install knockout closures in unused box openings.

3.4 CLEANING

A. Contract Closeout: Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION 260534

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates and labels.

B. Wire and cable markers.

C. Conduit markers.

D. Wiring device plates marking.

E. Underground warning tape.

1.2 RELATED SECTIONS

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

B. Division 9: Painting.

1.3 REFERENCES

ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide catalog data for nameplates, labels, and markers.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic as follows:

Furnish and install engraved laminated phenolic nameplates for all electrical equipment supplied under this contract for identification of system, equipment controlled or served, phase, voltage, ampacity, fault current, etc. Nameplates shall be securely attached to equipment with stainless steel screws, and shall identify by name the equipment controlled, attached, etc. Embossed, self adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:

1. Blue surface with white core for all 120/208 volt equipment.
2. Bright red surface with white core for all equipment related to fire alarm system.
3. Dark red (burgundy) surface with white core for all equipment related to Security.
4. Green surface with white core for all equipment related to “emergency” systems.
5. Orange surface with white core for all equipment related to telephone systems.
6. Brown surface with white core for all equipment related to data systems.
7. White surface with black core for all equipment related to paging systems.
8. Purple surface with white core for all equipment related to TV systems.

A. Locations:

1. Each electrical distribution and control equipment enclosure (safety switches, panelboards, transformers, etc.)
2. Communication cabinets.
3. Pull and splice boxes.

B. See details on the Drawings for additional requirements.

C. Provide nameplates as specified above for all existing electrical equipment to remain.

1.2 WIRE MARKERS

A. Description: Split sleeve type wire markers or approved equivalent.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

C. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on drawings.
2. Control Circuits: Control wire number as indicated on schematic and interconnection diagrams on drawings.

1.3 CONDUIT, RACEWAY AND BOX MARKING

Paint visible surfaces of exposed junction and outlet boxes and covers of raceway systems above lay-in and other accessible ceilings. Paint all boxes and covers before installation. Paint conduit and raceways above accessible ceilings at ten foot minimum intervals with a 6 inch wide band in accordance with the color scheme outlined above. Legibly mark conduits at junction boxes above accessible ceilings with the panelboard and circuit numbers of the circuits contained in the raceway

using a permanent black, bold marking pen.

1.4 WIRING DEVICE PLATES MARKING

A. Description: Adhesive backed, laminated plastic receptacle device plate labels identifying the circuit feeding the device. Labels shall be label machine printed, **black lettering on a clear background**, to indicate panel and circuit number and shall be Casio, Brother, T&B or approved equal.

B. Locations: Each receptacle device plate. Apply centered on the lower portion below the receptacle, parallel to the lower surface.

C. Legend: Typed labels to indicate panel and circuit number feeding the device (i.e., RPA-24).

1.5 UNDERGROUND WARNING TAPE

6 inch wide, 4 mils thick, minimum, permanent plastic tape compounded for direct burial, detectable type, colored bright yellow with suitable continuous warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.1 PREPARATION

Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using stainless steel rivets or stainless steel machine screws, lockwashers and acorn nuts as shown on the Drawings. Stainless steel screws and nylon locknuts may be used in lieu of lockwashers and acorn nuts if the screw threads are not exposed.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Install receptacle circuit identification labels.

E. Identify conduit using field painting under provisions of Division 9.

F. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.

G. Update all existing panelboard directories where changes are made. Provide new panel schedule cards as required to maintain legibility.

H. Identify underground conduits using one underground warning tape per trench at 6 - 8 inches below finished grade.

I. Install adhesive backed labels only when ambient temperature and humidity conditions for adhesive use are within range recommended by manufacturer.

END OF SECTION 260553

SECTION 260580 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Electrical power supply for, and connections to, equipment specified under other Divisions and/or provided by the Owner or Owner's vendors.

1.2 RELATED DIVISIONS AND SECTIONS

NOTE: Work specified to be accomplished by Division 26 in Related Divisions and Sections shall be as binding as work specified in Division 26.

A. Division 1: Owner-furnished equipment.

B. Division 11: Equipment.

C. Division 13: Special Construction.

D. Division 21: Fire Suppression.

E. Division 22: Plumbing.

F. Division 23: Heating, Ventilating and Air Conditioning.

G. Section 260533 – Conduit.

H. Section 260519 - Building Wire and Cable.

I. Section 260534 – Boxes.

J. Section 260526 - Grounding and Bonding.

K. Section 260553 - Electrical Identification.

1.3 REFERENCES

A. NEMA WD 1 - General Purpose Wiring Devices.

B. NEMA WD 6 - Wiring Device Configurations.

C. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

C. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26.

1.6 COORDINATION

A. Coordinate work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements.

D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

E. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Attachment Plug Construction: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

C. Cord Construction: ANSI/NFPA 70, Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL WORK IN CONNECTION WITH OTHERS

A. Division 26 shall provide a source of power, and final connections, for mechanical, plumbing, sprinkler, elevator, General Contractor-furnished and Owner-furnished equipment shown on the Drawings. Provide pigtails, flexible connections, conductors, raceways, circuit breakers, safety switches, receptacles, junction boxes, panelboards, wiring troughs, etc. as detailed in this section and/or as shown on the Drawings.

B. The locations of safety switches and other electrical equipment and devices shown on the Electrical Drawings are approximate only and some adjustment of their locations should be anticipated. Coordinate exact locations with the entity (contractor or Owner) providing the equipment. See other specifications divisions for further explanation of contractor responsibility. Do not apply power to equipment without the permission of the entity providing the equipment.

C. Division 26 shall coordinate with the mechanical, plumbing, sprinkler, elevator, and general contractors, and the Owner, prior to ordering or installation of any equipment, to verify equipment requirements are provided in the electrical design. Coordinate and verify all electrical requirements, final connections, phasing and rotation, overcurrent and overload protective device sizes with the entity providing the equipment. The contractor will not be compensated for costs associated with changing the electrical systems to match utilization equipment, even if the electrical work is installed per the electrical drawings.

D. Fuses, variable speed drives, magnetic motor starters, magnetic motor starter overload elements, control devices and sensors and control wiring and control raceways for such equipment will be provided and installed by the entity providing the equipment. The locations of local disconnecting means furnished by other divisions are shown on the respective division's Drawings. Coordinate exact locations with the entity providing the equipment.

E. Division 23 (Mechanical) Equipment.

1. Division 26 shall furnish and install power wiring, and final connections, to equipment provided by Division 23. If the equipment is provided with an external motor starter, variable frequency drive, etc., Division 23 will install the starter, VFD, etc. and Division 26 shall wire complete. If the equipment has built-in disconnects, Division 26 shall make final connections to the disconnects. If shown on the Drawings, Division 26 shall provide circuit breakers in adjacent panelboards, where allowed by Code and equipment requirements, in lieu of safety switches, to serve local mechanical equipment. Circuit breaker ratings shall be coordinated with Division 23. Division 26 shall make final connections to the equipment.

3. HVAC Control Panels, Control Equipment and Computers:

a. Division 26 shall provide and install 120V power wiring to the control panel(s) terminals or to receptacle(s), as required. Division 26 shall provide sufficient electrical circuits from the fire alarm control panel to enable all required mechanical equipment operations during fire mode. See Division 23 Specifications for further definition of the required fire alarm/mechanical control system interface and operation sequence and coordinate with Division 23.

b. HVAC Control and Miscellaneous Power: Division 26 shall provide branch circuit power sources (designated "HVAC Control Power" 20A circuit breakers in selected branch circuit panelboards) as indicated in the panel schedules on the Drawings. Division 23 shall extend power from these circuit breakers as required for control power, damper power, and power for unscheduled HVAC equipment. If additional circuits are required, the contractor may use circuit breakers designated as "Spare".

c. All control and similar equipment less than 120VAC including fuses, relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float and flow sensors, pneumatic-electric and low voltage thermostats, thermal overloads, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, etc. and other appurtenances associated with equipment in Division 23, shall be furnished, installed and wired under Division 23. All wiring required for controls and instrumentation, not indicated on the Drawings, shall be furnished and installed by Division 23.

2. Heat Tape: Division 26 shall provide junction boxes or weatherproof, ground fault interrupting type duplex receptacles for heat tapes. See the Drawings for locations and confirm exact locations and termination requirements with Division 23.

3. Duct Mounted Smoke Detectors: Duct mounted smoke detectors shall be provided and wired by Division 26, but installed by Division 23. Fire Alarm Air Handling Units (AHU) shut down circuits shall be wired, by Division 26, from the fire alarm control panel to a termination point, adjacent to the AHU. Division 26 shall leave sufficient marked conductor tails in a junction box adjacent to each unit for final connection by Division 23 to the equipment. Duct mounted smoke detectors are shown on the mechanical floor plans only.

6. Smoke Dampers: Division 26 shall provide 120VAC power for smoke dampers provided by Division 23. Circuits are not shown on the Electrical Drawings. Division 26 shall extend power circuits to dampers from circuit breakers designated as "HVAC Control Power". Leave sufficient marked conductor tails in a junction box adjacent to each damper for final connection by Division 23. Smoke dampers are shown on the mechanical floor plans only. The branch circuit breaker(s) supplying smoke dampers shall be physically protected by a panelboard lock and circuit breaker handle lock and each circuit breaker shall be identified with a 1/4" permanent red dot applied to its handle.

7. Refer to Division 23 for additional detail concerning electrical connections to Division 23 equipment.

F. Division 22 (Plumbing) Equipment:

1. Division 26 shall furnish and install a properly sized fused safety switch, and make final power connections for each item of equipment specified in Division 22 and as shown on the Drawings.

2. All control and similar equipment less than 120VAC including fuses, relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float and flow

sensors, pneumatic-electric and low voltage thermostats, thermal overloads, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, etc. and other appurtenances associated with equipment in Division 22, shall be furnished, installed and wired under Division 22. All wiring required for controls and instrumentation, not indicated on the Drawings, shall be furnished and installed by Division 23.

3. Electric and Gas-Fired Water Heaters: Division 26 shall furnish and install a fusible safety switch (for electric water heaters) or snap switch (for gas water heaters) adjacent to each water heater and shall make final power connections to the water heater.
4. Hot Water Circulation Pump: Division 22 will furnish and install a manual motor starter for circulator pump. Division 26 shall wire the system complete.
5. Electric Water Coolers: Division 26shall provide grounding type 120VAC GFCI receptacle(s), quantity as required by the equipment, for 120VAC power supply at each electric water cooler and shall consult with Division 22 and determine the exact location and type service required for each type installed before roughing in. All outlets and cords shall be concealed within the cabinet.
6. Refer to Division 22 for additional detail concerning electrical connections to Division 22 equipment.

G. Division 14 (Elevator) Equipment:

1. Division 26 shall provide a power source for all elevator equipment including elevator controllers and elevator cab lighting. Furnish and install a properly sized fusible safety switch, adjacent to the respective equipment or in locations as required by the elevator manufacturer, and make final power connections for each item of equipment specified in Division 14 and as shown on the Drawings. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the elevator vendor.
2. Division 26 shall also provide raceways for telephone connections, and telephone cable to the telephone backboard if specified, to each elevator controller.
3. The electrical design for the elevator(s) is based on the elevator specified in Division 14. The Contractor shall compensate the electrical engineer for any and all required modifications to the electrical design required by alternate elevator electrical requirements. Modifications to the electrical requirements shall be provided by the Contractor at no additional cost to the Owner.
4. Provide fire alarm system connections to the elevator controllers and provide appropriate signals to the controllers during fire mode, including recall and fire hat signals. Coordinate requirements with the Division 14. See Specs Section 283111 for additional requirements.
5. Provide power for elevator sump pumps, control panels and alarm systems as required. Provide connections as required and coordinate exact locations and configurations with the General Contractor and Division 14.
6. Provide accessory power and lighting as required by Division 14.
7. Provide shunt trip accessory for all feeder circuit breakers supplying elevator controllers, if required. Coordinate shut trip coil voltage. Provide electrical supervision for shunt trip circuits as indicated and as required by Codes. See Drawings and Specifications Section 283111 for control requirements and details.

H. Division 21 (Fire Protection) System: Division 26 shall connect fire alarm system conductors to sprinkler flow and tamper switches, provided and installed by Division 21. Final connections shall be made by Division 26 under the direct supervision of Division 21.

See Fire Alarm System Drawings and Specifications Section 283111 for interface requirements and details.

I. General Contractor Provided Equipment: Division 26 shall provide a power source adjacent to equipment provided by the General Contractor. Final connections to this equipment shall be provided by Division 26. Coordinate exact locations and requirements with the General Contractor.

1. Door Hold-Open Devices: Division 26 shall furnish and install electrical connections from the fire alarm system to each door hold-open device, furnished by the General Contractor, at locations as shown and as directed by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the door hardware vendor. Final connections to the equipment shall be by Division 26 in cooperation with the General Contractor.
2. Electrically-Operated Doors: Division 26 shall furnish and install a power supply to each electrically-operated door at locations as shown and as directed by the General Contractor. Division 26 shall also install and wire door activation switches provided by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the door hardware vendor. Final connections to the equipment shall be by Division 26 in cooperation with the General Contractor.
3. Projection Screens: Division 26 shall furnish and install a junction box and disconnect switch adjacent to each projection screen and make power connections to the screen power terminals. Division 26 shall also install and wire screen position switches provided by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the projection screen vendor. Final connections to the equipment shall be by Division 26 in cooperation with the General Contractor.

J. Owner Provided Equipment: Division 26 shall provide a power source adjacent to equipment provided by the Owner. Coordinate exact locations and requirements with the General Contractor. Final connection to the equipment will be provided by Division 26. Provide receptacle configurations and/or provide direct connection as required by equipment and coordinate exact locations and configurations with the Owner. Do not apply power to equipment without the permission of the Owner.

K. A/V Systems Equipment: Division 26 shall provide boxes, raceways and power for A/V equipment. Coordinate exact locations and requirements with the Owner. Final connection to the equipment will be provided by Division 26 in coordination with the A/V Systems contractor. Provide receptacle configurations as required and coordinate exact locations and configurations with the A/V Systems contractor. Do not apply power to equipment without the permission of the A/V Systems contractor.

3.3 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer’s instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Provide interconnecting conduit and wiring between devices and equipment where indicated.

END OF SECTION 260580

SECTION 260923 - ENCLOSED CONTACTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General purpose contactors.

B. Lighting contactors.

C. Time switches.

D. Photocells.

1.2 REFERENCES

A. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

C. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide dimensions, size, voltage ratings and current ratings.

1.4 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer’s installation instructions.

1.5 PROJECT CLOSEOUT SUBMITTALS

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of each contactor and indicate circuits controlled on project record documents.

C. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.6 QUALIFICATIONS

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

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 LIGHTING CONTACTORS

A. Manufacturers:
1. Eaton.
2. ABB/General Electric.
3. Siemens.
4. Schneider/Square D.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA ICS 2, magnetic lighting contactor.

C. Configuration: Mechanically held, 3 wire control.

D. Coil Voltage: As indicated/required.

E. Poles: As indicated, with 2 spares minimum.

F. Contact Rating: As indicated, 30 amperes minimum.

G. Enclosure: ANSI/NEMA ICS 6, as indicated.

H. Accessories:
1. Pushbutton: ON/OFF.
2. Selector Switch: ON/OFF/AUTOMATIC.
3. Indicating Light: RED.
4. Auxiliary Contacts: Two, field convertible.
5. Astronomical time switch with momentary contact output.
6. Photocell.

2.2 ACCESSORIES

A. Pushbuttons and Selector Switches: NEMA ICS 2, heavy duty type.

B. Indicating Lights: NEMA ICS 2, transformer type.

C. Auxiliary Contacts: NEMA ICS 2, Class A300.

D. Time Switch: Astronomic, two channel, electronic type with 48 hour capacitor or battery reserve, digital display, 30 ampere output contact rating, two, single pole output contacts, voltage compatible with load served, NEMA-1 enclosure.

E. Photocell: Weatherproof, enclosed, single pole, 1800 VA, 120VAC, twist lock plug-in type with base.

PART 3 - EXECUTION

A. Connect time switch(es) and/or photocell(s) to contactor(s) and program per Owner's requirements to control loads.

B. Install photocell where shown or as required and adjust to provide proper operation.

END OF SECTION 260923

SECTION 262416 – PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Distribution panelboards.

B. Branch circuit panelboards.

1.2 RELATED SECTIONS

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

B. Division 3: Concrete for supporting foundations and pads.

C. Section 260526 - Grounding and Bonding.

D. Section 260553 - Electrical Identification.

E. Section 262421 - Utility Service Entrance.

F. Section 262813 - Fuses.

G. Section 264313 – Surge Protection Devices for Low-Voltage Electrical Power Circuits.

1.3 REFERENCES

A. NECA Standard of Installation (published by the National Electrical Contractors Association).

B. NEMA AB1 - Molded Case Circuit Breakers.

C. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies.

D. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

E. NEMA PB 1 - Panelboards.

F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

G. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide manufacturer's catalog information showing dimensions, ratings, features, colors, and configurations.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

D. Arrange panelboard branch circuit breakers as shown on the Drawings. Agreement of circuit breaker (pole) numbers with the Drawings panel schedules and floor plans is required in order to avoid confusion during construction, redrawing the circuitry for record drawing purposes and accurate documentation of the as-built conditions.

1.5 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

C. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALIFICATIONS

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

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 MAINTENANCE MATERIALS

A. Contract Closeout. As required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Furnish two of each panelboard key.

PART 2 - PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

A. Manufacturers:
1. Eaton.
2. General Electric/ABB.
3. Siemens.
4. Square D Schneider.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA PB 1, circuit breaker type.

C. Service Conditions:
1. Temperature: 104º F. (40º C.).
2. Altitude: N/A.
3. Terminal Rating: 75º C. minimum.

D. Panelboard Bus: Copper, ratings as indicated. Provide 100% copper ground and neutrals buses in each panelboard. Provide insulated ground bus where scheduled. Provide 200% copper neutral bus in each panelboard fed by a K rated transformer.

E. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 208 volt panelboards, or as indicated.

F. Circuit Breakers: NEMA AB 1, bolt-on or plug-on (Square D I-Line and similar only) type.
1. Circuit breakers in distribution panelboards shall be fully rated.
2. Solid-state Trip Molded Case Main and Branch Circuit Breakers (100A and larger): Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
a. Adjustable instantaneous trip.
b. Adjustable long time pickup and delay.
c. Adjustable short time pickup and delay.
d. Ground fault pickup and delay.
e. Arc flash reduction mode with external switch and indicator (1,200A and larger).
f. Include shunt trip, undervoltage release, and other accessories where indicated.
g. Display line currents and cause of trip.

3. Conventional Thermal Magnetic Molded Case Branch Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
4. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

G. Enclosure: NEMA PB 1, Type 1 or Type 3R, cabinet box.

H. Cabinet Front: Flush and Surface cabinet front door-in-door type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Distribution panelboards larger than 400 amperes are not required to have door-in-door trims.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:
1. Eaton.
2. General Electric/ABB.
3. Siemens.
4. Square D Schneider.
5. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Service Conditions:
1. Temperature: 104º F. (40º C.).
2. Altitude: N/A.
3. Terminal Rating: 75º C. minimum.

A. Panelboard Bus: Copper, ratings as indicated. Provide 100% copper ground and neutrals buses in each panelboard. Provide 200% copper neutral bus where indicated. Provide insulated ground bus where scheduled. Provide 200% copper neutral bus in each panelboard fed by a K rated transformer.

B. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 208 volt panelboards; 14,000 amperes rms symmetrical for 480 volt panelboards, or as indicated.

C. Circuit Breakers: NEMA AB 1, bolt-on type.
1. Circuit breakers in branch circuit panelboards shall be fully rated.
2. Solid-state Trip Molded Case Main Circuit Breakers (100A and larger): Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
a. Adjustable instantaneous trip.
b. Adjustable long time pickup and delay.
c. Adjustable short time pickup and delay.
d. Ground fault pickup and delay.
e. Arc flash reduction mode with external switch and indicator.
f. Include shunt trip, undervoltage release, and other accessories where indicated.

g. Display line currents and cause of trip.

3. Conventional Thermal Magnetic Molded Case Branch Circuit Breakers: Thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits and Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.
4. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

D. Enclosure: NEMA PB 1, Type 1 or Type 3R.

E. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards.

F. Cabinet Front: Flush and Surface cabinet front door-in-door type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.3 METERING

A. The main distribution panelboard shall be provided with a front mounted, digital power quality meter / analyzer package. The metering shall include simultaneous display of six (6) parameters including voltage, current, power, kVA, kVAR, power factor, frequency, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. Provide all voltage and current transformers required to provide the above data.

B. Manufacturers: The power quality meter / analyzer package shall be:
1. Eaton IQ 260.
2. General Electric/ABB.
3. Siemens.
4. Square D/Schneider.
5. Substitutions: refer to provisions of the General and supplemental General Conditions and Division 1 specification sections.

C. Install at 60" AFF to bottom of the meter case or, if the meter is to be installed above 60" AFF but no more than 78"AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

2.4 METERING TRANSFORMERS

A. Current Transformers: ANSI C57.13, 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

B. Potential Transformers: ANSI C57.13, 120 volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation."

B. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

C. Panelboards shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260500, Paragraph 1.23 for additional requirements.

D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

E. Provide filler plates for unused spaces in panelboards.

F. Provide typed circuit directory for each branch circuit panelboard. Final typed panelboard directories installed in the panelboard door pocket shall include final actual room names and numbers in addition to the general description shown on the panel schedules on the drawings. Revise directory to reflect circuiting changes required to balance phase loads.

G. Provide engraved plastic nameplates under the provisions of Section 260553.

H. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling and below floor. Minimum spare conduits: 5 empty 1 inch. Identify each as SPARE.

I. Ground and bond panelboard enclosure according to Section 260526.

3.2 FIELD QUALITY CONTROL

A. Quality Control: Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

3.3 ADJUSTING

A. Contract Closeout: Adjust installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Cleaning: Vacuum dirt and debris from panelboard tubs; do not use compressed air to assist in cleaning.

C. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

D. Adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

END OF SECTION 262416

SECTION 262421 - UTILITY SERVICE ENTRANCE

PART 1 - GENERAL

1.1 SECTION INCLUDES

Coordination with the serving electrical utility company.

1.2 RELATED SECTIONS

Not used.

1.3 REFERENCES

A. NECA Standard of Installation (National Electrical Contractors Association).

B. NFPA 70 - National Electrical Code.

1.4 SYSTEM DESCRIPTION

System Characteristics: 208Y/120 volts, three phase, four-wire, 60 Hertz.

1.5 SUBMITTALS FOR REVIEW

Not used.

1.6 SUBMITTALS FOR INFORMATION

Not used.

1.7 QUALITY ASSURANCE

A. Utility Company: Duke Energy Progress.

B. Perform Work in accordance with Utility Company requirements.

1.8 REGULATORY REQUIREMENTS

Conform to requirements of NFPA 70.

1.9 PRE-INSTALLATION MEETING

Convene one week prior to commencing work of this section. Review service entrance requirements and details with Utility Company representative. Notify the Architect/Engineer at least seven days prior to the scheduled meeting. Provide written meeting minutes to the Architect/Engineer.

PART 2 - PRODUCTS

Not used.

Provide transformer pad and accessories as required by Duke Energy "THREE-PHASE PAD-MOUNTED TRANSFORMER CONCRETE FOUNDATION SPECIFICATIONS - JANUARY 2019", at https://www.duke-energy.com/_/media/pdfs/partner-with-us/padtransformerconcretefoundspecs.pdf. Install as directed by Duke Energy.

PART 3 - EXECUTION

3.1 PREPARATION

Coordinate with Utility Company and assist the Owner in obtaining permanent electric service to the Project. Utility Company fees will be paid by the Owner.

3.2 INSTALLATION

Install transformer pad, service conductors and raceways and metering equipment as required by Utility Company.

END OF SECTION 262421

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall switches.

B. Wall box dimmers.

C. Receptacles.

D. Wall plates.

E. Floor box service fittings.

1.2 DESCRIPTION

Provide wiring devices in types, characteristics, grades, colors and electrical ratings for applications indicated which are third party testing agency listed and which comply with NEMA WD 1 and other applicable third party testing agency, NEMA and DSCC (Fed Spec) standards. All devices shall be produced by the same manufacturer.

1.3 RELATED SECTIONS

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

B. Section 260526 - Grounding and Bonding.

C. Section 260534 - Boxes.

D. Section 260553 - Electrical Identification.

1.4 REFERENCES

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device - Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories (UL) 498.

F. DSCC (Fed Spec) W-C-596G

1.5 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.6 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's installation instructions.

1.7 QUALIFICATIONS

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

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
1. Hubbell Model 1221/2/3/4 Series.
2. Leviton 1221/2/3/4.
3. Pass and Seymour PS20AC1/2/3/4.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency listed, DSCC, heavy-duty, AC only, general-use, grounding type, back and side wired, single pole, three-way and four-way as indicated, snap switch with hex-head equipment grounding screw. Switches shall have a steel, nickel plated bridge with integral ground, one piece rivetless copper alloy spring contact arm and terminal plate and large silver cadmium oxide contacts. All switches shall have quiet operating mechanisms without the use of mercury switches. All switches shall be approved by a third party agency, approved for the voltage and current indicated.

C. Body and Handle: Gray plastic with toggle handle.

D. Indicator Light: Neon lighted handle type switch; red color handle. Voltage per system rating.

E. Locator Light: Neon lighted handle type switch; green color handle. Voltage per system rating.

F. Ratings:
1. Voltage: 120-277 volts AC.
2. Current: 20 amperes.

2.2 WALL BOX LED 0-10V DIMMERS

A. Manufacturers:
1. Lutron DVSTV and DVTV.
2. Sensor Switch.
3. Wattstopper.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC Type I semiconductor dimmer for LED drivers. Provide line voltage or 0-10V to match lighting fixtures specified.

C. Body and Handle: Gray plastic with preset slider.

D. Switch Ratings:
1. Voltage: 120-277 volts AC.
2. Current: 8A minimum. Provide with 16A power pack for loads greater than 8A.

E. Power Rating: Match load shown on drawings.

2.3 RECEPTACLES

A. Manufacturers:
1. Hubbell Model HBL 5362 and HBL 5362TR.
2. Leviton 5362 and 5363-SGW.
3. Pass and Seymour 5362A and TR63.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC, heavy-duty, 20 ampere, 120 volt, general use, duplex, straight blade, grounding type receptacle arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall have a full wrap around brass bridge with integral ground and standup double wipe contacts. 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.

C. Device Face and Body: Gray nylon or reinforced thermoplastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20R.

F. Provide tamper resistant devices where required by Codes.

2.4 USB RECEPTACLES

A. Manufacturers:
1. Hubbell Model USB20AC5.
2. Leviton T5833.
3. Pass and Seymour TR20USBAC6.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC, heavy-duty, 20 ampere, 120 volt, general use, duplex, straight blade, grounding type receptacle with Type A and C, 5A, 5V USB charging ports, arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall have a full wrap around brass bridge with integral ground and standup double wipe contacts. 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.

C. Device Face and Body: Gray nylon or reinforced thermoplastic. Provide red devices and plates where noted.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20R.

F. Provide tamper resistant devices where required by Codes.

2.5 GROUND FAULT CIRCUIT INTERRUPTERS (GFI)

A. Manufacturers:
1. Hubbell Model GFR5362S.
2. Leviton G5362.
3. Pass and Seymour 2097TRWR.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Description: NEMA WD 1, third party testing agency, DSCC, heavy-duty, 20 ampere, 120 volt, general use, duplex, straight blade, grounding type receptacle arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall have a full wrap around brass bridge with integral ground and standup double wipe contacts. 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.

C. Device Face and Body: Gray nylon or reinforced thermoplastic.

D. Configuration: NEMA WD 6, type as specified and indicated.

E. Convenience Receptacle: Type 5-20R.

F. Provide tamper resistant devices where required by Codes.

2.6 WALL PLATES

A. Manufacturers:
   1. Hubbell.
   2. Leviton.
   3. Pass and Seymour.
   4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Decorative Cover Plate: Single and combination, of types, sizes and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Material shall be smooth, 0.04" thick, type 302 Stainless Steel as manufactured by the device vendor.

C. Weatherproof Cover Plate: Exterior mounted receptacles, and those noted to be weatherproof, shall be provided with weatherproof PVC transparent cover plates, standard size, and shall be single or ganged as indicated on the contract drawings. Weatherproof plates shall be "approved" third party listed as "raintight while in use".

D. Provide a minimum of 2% (not less than 2) spare cover plates of each type at project close-out.

2.7 FLOOR MOUNTED SERVICE FITTINGS

A. Pedestal Convenience Receptacle:
   1. Housing: Satin aluminum.
   2. Device Plate: Stainless steel.
   3. Configuration: As shown.

B. Flush Cover Convenience Receptacle:
   1. Material: Brass.
   2. Configuration: Duplex threaded opening.

C. Pedestal Communication Outlet:
   1. Housing: Satin aluminum.
   2. Device Plate: By Owner.
   3. Configuration: N/A.

D. Flush Cover Communication Outlet:
   1. Material: Brass.
   2. Configuration: 2-1/8 x 1 inch combination threaded opening.

E. Pedestal Combination Fitting:
   1. Housing: Satin aluminum.
   2. Device Plate: Stainless steel.
   3. Configuration: One duplex convenience receptacle with one bushed opening, 1 inch inside diameter.

F. Flush Cover Combination Fitting:
   1. Material: Brass.
   2. Configuration: Duplex threaded opening with 2-1/8 x 1 inch combination threaded opening.

G. Protective Ring: Brass finish.

H. Split Nozzle: Brass finish.

I. Carpet Ring: Brass.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure that outlet boxes are installed at proper height.

B. Ensure that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA “Standard of Installation”.

B. Install devices vertically, plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top. Install horizontally oriented receptacles with the grounding pole on the left.

E. Receptacles installed over counters, backsplashes, etc., shall be mounted horizontally.

F. Install line voltage wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.

G. Do not share neutral conductor on load side of line voltage dimmers.

H. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

I. Install decorative plates on switch, receptacle, and blank outlets in finished areas. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

J. Connect switches by wrapping conductor around screw terminal.

K. Connect receptacles by utilizing back wiring provisions only. Do not use side wire terminals.

L. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets. Use cast box covers and plates on cast boxes.

M. Install protective rings on active flush cover service fittings.

N. Provide adhesive backed, laminated plastic receptacle device plate labels identifying the circuit feeding the device. Labels shall be label machine printed to indicate panel and circuit number and shall be Casio, Brother, T&B or approved equal. See Section 260553 for additional requirements

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 260534 to obtain mounting heights specified and indicated on drawings.

B. All wiring devices shall be installed at heights as required by the ADA

C. Install wall switch 48 inches above finished floor, measured to top of device plate.

D. Install convenience receptacle 18 inches above finished floor, measured to bottom of device plate, unless noted otherwise on the Drawings.

E. Install convenience receptacle horizontally 6 inches above backsplash of counter, unless noted otherwise on the Drawings.

F. Install dimmer 48 inches (1.2 m) above finished floor, measured to top of device of plate.

G. Install telecommunications jack 18 inches (450 mm) above finished floor, measured to bottom of device plate, unless noted otherwise on the Drawings.

H. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches (1.4 m) above finished floor, unless noted otherwise on the Drawings.

I. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 (1.2 m) above finished floor, unless noted otherwise on the Drawings.

3.5 FIELD QUALITY CONTROL

A. Quality Control. As required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify that each receptacle device is energized.

E. Test each receptacle device for correct polarity and for ground continuity.

F. Test each GFCI receptacle device for correct operation.

3.6 ADJUSTING

A. Contract Closeout: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Contract Closeout: Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

SECTION 262727 - OCCUPANCY SENSORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Wall box and ceiling type occupancy sensors and accessories.

1.2 RELATED SECTIONS

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

B. Section 260534 - Boxes.

C. Section 260553 - Electrical Identification.

D. Section 262726 - Wiring Devices.

E. Section 260526 - Grounding.

1.3 REFERENCES

A. NECA - Standard of Installation.

B. NEMA WD 1 - General Requirements for Wiring Devices.

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements.

D. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, ratings and configurations.

1.5 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's installation instructions.

1.6 QUALIFICATIONS

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

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Provide Products listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Occupancy Sensor system shall sense the presence of human activity within the spaces indicated and fully control the “On” / “Off” function of the lighting loads automatically. Sensors shall turn “On” the load upon entrance into the room and shall not initiate “On” outside of entrance.

B. Acceptable technology is Passive Infrared (PIR), Ultrasonic and Microphonic. Dual Technology is required utilizing PIR and one of the other technologies.

C. Occupancy sensors shall be field convertible to operate in either the occupancy or vacancy mode.

D. Sensors shall automatically adjust time delays and sensitivity based on the activity level in the space.

E. All line voltage devices shall be approved third party testing agency listed under Energy Management Equipment, or Industrial Control Equipment. Listing under Appliance Control shall not be accepted.

F. All line voltage devices shall be UL Listed under Energy Management Equipment, or Industrial Control Equipment. UL Listing under Appliance Control shall not be accepted.

G. Product shall be manufactured in the USA and be warranted for 5 years.

2.2 WALL BOX LINE VOLTAGE SENSORS FOR SMALL AREAS

A. Description: Line voltage, single gang, wall mounted occupancy sensor switch with one override or two (as shown) switch(es). Switch shall recess into single gang switch box and fit a standard GFI receptacle plate opening. Switches shall be compatible with standard three and four-way toggle switches. All switches shall be approved by a third party agency, approved for the voltage and current indicated. Provide hard lens switches in storage rooms and other location subject to abuse.

B. Manufacturers
   1. Lutron.
   2. Sensor Switch.
   3. Wattstopper.
   4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

C. Body and Handle: Match device colors specified in Section 262726.

D. Ratings:
   Voltage: 120-277 volts AC.
   Minimum Load Rating: 800 watts at 120 VAC, 1200 watts at 277 VAC. Sensors shall be compatible with all load types, including LED, electronic and compact fluorescent ballasts, incandescent or fluorescent and require no minimum load.

2.3 WALL BOX LOW VOLTAGE SENSOR/DIMMER SWITCHES FOR SMALL AREAS

A. Description: Low voltage, single gang, wall mounted occupancy sensor switch 0-10v dimmer with one override or two (as shown) switch(es). Switch shall recess into single gang switch box and fit a standard GFI receptacle plate opening. Switches shall be compatible with standard three and four-way toggle switches. All switches shall be approved by a third party agency, approved for the voltage and current indicated. Provide hard lens switches in storage rooms and other location subject to abuse.

B. Manufacturers
   1. Lutron.
   2. Sensor Switch.
   3. Wattstopper.
   4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

C. Body and Handle: Match device colors specified in Section 262726.

2.4 CEILING MOUNTED LOW VOLTAGE SENSORS FOR LARGE AREAS

A. Sensor Switches: Low voltage, recess ceiling mounted occupancy sensor switch. Sensors shall be adjustable to accommodate the room geometry as shown or the contractor shall provide multiple sensors as required for complete coverage. The device shall operate in conjunction with a line voltage power pack to control the connected lighting loads. Sensors shall operate on a Class 2, three-conductor system. Multiple sensors shall be connectable to a single power pack. Sensor shall recess into a two gang outlet box. All devices shall be approved by a third party agency, approved for the voltage and current indicated.
   Manufacturers:
   1. Lutron.
   2. Sensor Switch.
   3. Wattstopper.
   4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Control units/Power packs: Devices shall be rated 20A at 120-277 volts and shall be compatible with all load types, including LED. They shall have the capacity to power additional remote heads or additional relays. Control relays may be paralleled to accommodate extra load or more than three heads or additional relays. Additional relay shall be used where there is more than one circuit being controlled or where there is a need to control multiple voltages.
Manufacturers:
1. Lutron.
2. Sensor Switch.
3. Wattstopper.
4. Substitutions: Refer to provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

C. Sensor Body: White plastic, or match device colors specified in Section 262726.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Ensure that outlet boxes are installed at the proper location.

B. Ensure that ceiling openings are neatly cut and will be completely covered by devices.

C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA "Standard of Installation."

B. Install in locations in accordance with manufacturers recommendation.

C. Install devices vertically, plumb and level.

D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 260534 to obtain mounting heights specified and indicated on drawings.

B. All wiring devices shall be installed at heights as required by the A.D.A.

C. Install wall switch 48 inches (1.2 m) above finished floor, measured to bottom of outlet box.

3.5 FIELD QUALITY CONTROL

A. Quality Control. As required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect each wiring device for defects.

C. Operate each system with circuit energized and verify proper operation.

3.6 ADJUSTING

A. Contract Closeout: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

A. Contract Closeout: Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262727

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fuses.

B. Spare fuse cabinet.

1.2 RELATED SECTIONS

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

B. Section 262816 – Enclosed Switches.

1.3 REFERENCES

A. NFPA 70 - National Electric Code.

B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.4 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual fuse sizes.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.8 EXTRA MATERIALS

A. Provide no less than 10% of each fuse size and type installed, with a minimum of at least one set of three of each.

B. Provide one fuse puller.

PART 2 - PRODUCTS

2.3 FUSE REQUIREMENTS

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Third party testing agency Listed.

	Circuit Type	Fuse type
1.	Service Entrance and Feeder Circuits over 600Amp 200K Amp interrupting rating.	Class L
2.	Service Entrance and Feeder Circuits 600Amp or less 200K Amp interrupting rating.	Class RK1 or J
3.	Motor, Motor Controller and Transformer Circuits 200K Amp interrupting rating.	RK5

D. For individual equipment where fault current does not exceed 50KA use Class K5 fuses with 50KA interrupting rating.

E. Fusible safety switches with short-circuit withstand ratings of 100KA or 200KA require Class R or Class J rejection fuse block feature.

2.4 SPARE FUSE CABINET

A. Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse puller specified.

B. Doors: Hinged, with hasp for Owner’s padlock.

C. Finish: Beige enamel.

PART 3 - EXECUTION

3.3 INSTALLATION

A. Install fuses in accordance with manufacturer’s instructions.

B. Install fuse with label oriented such that manufacturer, type, and size are easily read.

C. Install spare fuse cabinet in main electrical equipment room or adjacent to the main service equipment.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fusible switches.

B. Nonfusible switches.

1.2 RELATED SECTIONS

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

B. Section 260526 - Grounding and Bonding.

C. Section 260529 – Supporting Devices.

D. Section 260553 – Electrical Identification.

E. Section 262813 – Fuses.

1.3 REFERENCES

A. NECA - Standard of Installation (published by the National Electrical Contractors Association).

B. NEMA FU1 - Low Voltage Cartridge Fuses.

C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

E. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide switch ratings and enclosure dimensions.

1.5 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of enclosed switches in project record documents.

1.6 QUALIFICATIONS

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

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton.
B. General Electric/ABB.
C. Siemens.
D. Square D Schneider.
E. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

2.2 RATINGS

A. Service Conditions:
   1. Temperature: 104°F. (40°C.).
   2. Altitude: N/A.
   3. Terminal Rating: 75°C. minimum.

B. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical, or as indicated.

2.3 FUSIBLE SWITCH ASSEMBLIES

A. Description: NEMA KS 1, heavy duty type with externally operable handle interlocked (defeatable) to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch. Mechanisms shall be non-teasible, positive, quick make-quick break type. Handle lockable in ON or OFF position. Switches shall have handles whose positions are easily recognizable in the ON or OFF position.

B. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

C. Provide accessories required by their installation. Provide auxiliary switch contacts as required by other systems. Coordinate with other Divisions as required.

2.4 NONFUSIBLE SWITCH ASSEMBLIES

A. Description: NEMA KS 1, heavy duty type with externally operable handle interlocked (defeatable) to prevent opening front cover with switch in ON position, enclosed load

interrupter knife switch. Mechanisms shall be non-teasible, positive, quick make-quick break type. Handle lockable in ON or OFF position. Switches shall have handles whose positions are easily recognizable in the ON or OFF position.

B. Provide accessories required by their installation. Provide auxiliary switch contacts as required by other systems. Coordinate with other Divisions as required.

2.5 ACCESSORIES

A. Provide neutral assemblies and equipment grounding kits as required.

B. For safety switches installed in elevator controller feeders, provide electrical interlock kit(s) with sufficient contacts for elevator control interlock as required by the elevator vendor.

2.6 ENCLOSURES

A. Fabrication: NEMA KS 1.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with NECA “Standard of Installation”.

B. Switches shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260500, Paragraph 1.23 for additional requirements.

C. Install fuses in fusible disconnect switches serving Division 26 equipment.

D. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

A. Quality Control: Field inspection, testing and adjusting as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

END OF SECTION 262816

SECTION 262817 - ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Enclosed circuit breakers.

1.2 RELATED WORK

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

B. Section 260526 - Grounding and Bonding.

C. Section 260529 Supporting Devices.

D. Section 260553 - Electrical Identification.

E. Section 260573 - Short Circuit, Arc Flash and Coordination Study.

F. Section 262813 - Fuses.

1.3 REFERENCES

A. NECA (National Electrical Contractors Association) “Standard of Installation”.

B. NEMA AB 1 - Molded Case Circuit Breakers

C. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Provide catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.

C. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

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

1.7 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

1.8 Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.9 EXTRA MATERIALS

A. Furnish under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Provide three of each size and type current limiter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton.
B. General Electric/ABB.
C. Siemens.
D. Square D Schneider.
E. Substitutions: As permitted in relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

2.2 MOLDED CASE CIRCUIT BREAKER

A. Circuit Breakers: NEMA AB 1.
   1. Circuit breakers shall be fully rated.
   2. Solid-state Trip Molded Case Circuit Breakers (100A and larger): NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
      a. Adjustable instantaneous trip.
      b. Adjustable long time pickup and delay.
      c. Adjustable short time pickup and delay.
      d. Ground fault pickup and delay.
      e. Arc flash reduction mode with external switch and indicator (1,200A and larger).
      f. Include shunt trip, undervoltage release, and other accessories where indicated.

g. Display line currents and cause of trip.

3. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

B. Service Conditions:
   1. Temperature: 104º F. (40º C.).
   2. Altitude: N/A.
   3. Terminal Rating: 75º C. minimum.

C. Minimum Integrated Short Circuit Rating: 30,000 amperes rms symmetrical, or as indicated.

2.3 PRODUCT OPTIONS AND FEATURES (as specified and as applicable)

B. Provide accessories as scheduled, to NEMA AB 1.

C. Shunt Trip Device: 120 volts AC.

D. Undervoltage Trip Device: 120 volts AC.

E. Auxiliary Switch: 120 volts AC.

F. Alarm Switch: 120 volts AC.

G. Electrical Operator: 120 volts AC.

H. Handle Lock: Include provisions for padlocking.

I. Provide mechanical trip device.

J. Provide insulated grounding lug in each enclosure.

2.4 ENCLOSURE

B. Enclosure: NEMA AB 1, Type 1 and 3R, as indicated.

C. Fabricate enclosure from steel.

D. Finish using manufacturer's standard enamel finish, gray color.

PART 3 EXECUTION

3.2 INSTALLATION

B. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.

C. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 260529.

D. Equipment shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260500, Paragraph 1.23 for additional requirements.

E. Height: 5 feet AFF to operating handle.

F. Provide engraved plastic nameplates under the provisions of Section 260553.

3.3 FIELD QUALITY CONTROL

B. Field inspection and testing shall be performed under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

C. Inspect and test each circuit breaker to NEMA AB 1.

D. Inspect each circuit breaker visually.

E. Perform several mechanical ON-OFF operations on each circuit breaker.

F. Verify circuit continuity on each pole in closed position.

G. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.

H. Include description of testing and results in test report.

3.4 ADJUSTING

B. Adjust work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

C. Adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

END OF SECTION 262817

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors, furnished and installed by Division 23.

1.3 RELATED SECTIONS

A. Section 262813 - Fuses.

B. Section 260553 – Electrical Identification.

C. Section 260526 - Grounding and Bonding.

D. Section 260529 - Supports.

1.4 DEFINITIONS

A. BAS: Building automation system.

B. EMI: Electromagnetic interference.

C. LAN: Local area network.

D. LED: Light-emitting diode.

E. MCP: Motor-circuit protector.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PCC: Point of common coupling.

J. PWM: Pulse-width modulated.

K. RFI: Radio-frequency interference.

L. TDD: Total demand (harmonic current) distortion.

M. THD(V): Total harmonic voltage demand.

N. VFC: Variable-frequency motor controller.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs 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 and the unit will be fully operational after the seismic event."

1.6 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. LEED Submittals:
   1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of enclosed unit.
      f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
      g. Specified modifications.
   2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Qualification Data: For qualified testing agency.

F. Seismic Qualification Certificates: For VFCs, 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.

G. Product Certificates: For each VFC, from manufacturer.

H. Source quality-control reports.

I. Field quality-control reports.

J. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

K. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

L. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NRTL [or NETA .
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.][delete for SCO projects]

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

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
   2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
   3. Humidity: Less than 95 percent (noncondensing).
   4. Altitude: Not exceeding 3300 feet (1005 m).
   5. Provide sealed and gasketed NEMA 4X enclosures in outdoor locations.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.10 COORDINATION

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

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five (5) years from date of final acceptance of the work.

1.12 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.
   1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Indicating Lights: Two of each type and color installed.
   4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
   5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Rockwell Automation, Inc.; Allen-Bradley Brand.
4. Siemens Energy & Automation, Inc.
5. Square D; a brand of Schneider Electric.

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2.

C. Application: Variable torque for compressors, fans and pumps.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter), 12 pulse drive factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:
1. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
2. Minimum Efficiency: 96 percent at 60 Hz, full load.
3. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
4. Vibration Withstand: Comply with IEC 60068-2-6.
5. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
6. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
7. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
8. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical.

J. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   3. Under- and overvoltage trips.
   4. Inverter overcurrent trips.
   5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
   6. Critical frequency rejection, with three selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
   8. Loss-of-phase protection.
   9. Reverse-phase protection.
   10. Short-circuit protection.
   11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

B. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

C. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Fault or alarming status (code).
   6. Set point frequency (Hz).

D. Control Signal Interfaces:
   1. Electric Input Signal Interface:
      a. A minimum of six multifunction programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
      a. 0- to 10-V dc.
      b. 4- to 20-mA dc.
   3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc, which can be configured for any of the following:
      a. Output frequency (Hz).
      b. Motor speed (rpm).
   4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      a. Motor running.
      b. Fault and warning indication (overtemperature or overcurrent).

2.3 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit manually. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller, with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
   1. Bypass Contactor: Load-break, NEMA-rated contactor.
   2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
   3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized

and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
   1. NORMAL/BYPASS selector switch.
   2. HAND/OFF/AUTO selector switch.
   3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
      b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
      a. CPT Spare Capacity: 50 VA.
   6. Overload Relays: NEMA ICS 2.
      a. Solid-State Overload Relays:
         1) Switch or dial selectable for motor-running overload protection.
         2) Sensors in each phase.
         3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
         4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
         5) Analog communication module.
      b. NO isolated overload alarm contact.
      c. External overload reset push button.

2.4 LINE CONDITIONING

A. Input Line Conditioning: Provide input filtering, as required, to limit TDD at input terminals of all VFCs to less than 8 percent and THD(V) to 5 percent.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA ICS 6, Type 1 and 4X as required to meet conditions of installation. See Section 260500 for enclosure requirements.

2.6 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, type.
      a. Push Buttons: Shielded types; momentary.
      b. Pilot Lights: LED types; push to test.

B. Bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
   1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Equipment shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and

hardware, bracing, fittings, etc. as required for seismic restraint. See Section 260500, Paragraph 1.22 for additional requirements.

D. Install fuses in each fusible-switch VFC.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Comply with NECA 1.

H. Install wiring from VFC to motor in conduit and locate the VFC within ten (10) feet and within sight of the motor.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices[and facility's central-control system]. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

E. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. [Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.][dlete for SCO projects]
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

F. Set field-adjustable pressure switches.

3.8 PROTECTION

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

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 263213- PACKAGED ENGINE-GENERATOR SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged engine-generator set.

B. Exhaust silencer and fittings.

C. Battery.

D. Remote annunciator.

E. Weather-protective, sound-attenuating enclosure.

F. Access stairs and platforms, if required.

1.2 RELATED SECTIONS

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

B. Section 260526 - Grounding and Bonding.

C. Section 260529 Supporting Devices.

D. Section 260553 - Electrical Identification.

E. Section 263600 - Automatic Transfer Switches.

1.3 REFERENCES

A. NEMA AB1 - Molded Case Circuit Breakers.

B. NEMA MG1 - Motors and Generators.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum.)

D. NFPA 30 - Flammable and Combustible Liquids Code.

E. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.

F. NFPA 70 - National Electrical Code.

G. NFPA 101 - Life Safety Code.

H. NFPA 110 - Emergency and Standby Power Systems.

1.4 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.

C. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, exhaust silencer, vibration isolators, weather resistant housing, remote annunciator, etc.
Provide:
1. A complete Bill of Materials for all components.
2. Dimensioned plan and elevation drawings of the engine-generator set.
3. Dimensioned plan and elevation drawings of the gen set enclosure. Provide dimensions from the centerline of the top control panel switch and the output circuit breaker handle(s).
4. Dimensioned plan, details and elevation drawings and proposed materials of the access platform and stairs, if required.

D. Test Reports: Indicate results of performance testing.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

F. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate procedures and findings.

1.5 OPERATION AND MAINTENANCE DATA

A. Provide three (3) bound copies.

B. Operation Data: Include instructions for normal operation.

C. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

D. Maintain one copy of document on site.

1.6 QUALITY ASSURANCE

Perform Work in accordance with NFPA 110.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70 and NFPA 110.

B. Equipment shall be UL 2200 listed.

C. Furnish Products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Accept unit on site on skids. Inspect for damage.

B. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.10 MAINTENANCE SERVICE

Furnish service and maintenance, at manufacturer-recommended intervals, of engine-generator set for one year from Date of Final Acceptance.

1.11 MAINTENANCE MATERIALS

Furnish one set of tools required for preventative maintenance of the engine-generator system. Package tools in adequately sized metal tool box.

1.12 EXTRA MATERIALS

Provide two of each fuel oil and air filter element.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Caterpillar.
B. Cummins.
C. MTU.
D. Generac.
E. Substitutions: Under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

2.2 PACKAGED ENGINE-GENERATOR SYSTEM

A. Description: NFPA 110, standby rated, engine-generator system conforming to NFPA 70 and 110.

B. Engine-generator set shall provide back-up power for the emergency power distribution system during utility power outage. Power outage sensing, generator starting, transfer of load, re-transfer to normal power and engine cool-down running time shall be completely automated and shall not require attended operation.

C. Minimum System Capacity: 200 kW, 250 kVA at elevation of 100 feet above sea level, standby rating using engine-mounted radiator. See Specifications Paragraph 2.4 G. below for additional load information.

2.3 ENGINE

A. Type: Water-cooled inline or V-type, two or four stroke natural gas engine.

B. Rating: Sufficient to operate under 10 percent overload for one hour in an ambient of 105° F at elevation of 1,000 feet.

C. Fuel System: Natural gas.

D. Engine speed: Not to exceed 1800 rpm.

E. Governor: Isochronous type to maintain engine speed within 0.25 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

G. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

H. Engine Jacket Heater: Thermal circulation immersion type water heater with integral thermostatic control, contactor in a NEMA rated enclosure, sized to maintain engine jacket water at 120°F, and suitable for operation on 120 or 208 volts AC as shown. Heater shall be disconnected while the engine is running.

I. Radiator: Provide a closed recovery cooling system with sufficient capacity to cool the engine when the generator set is delivering full rated load at a minimum ambient temperature of 110°F (43°C). Radiator, fan, engine driven centrifugal water pump and thermostatic valve shall be provided and the system protected against freezing and corrosion. Radiator air flow restriction 0.5 inches of water (1.25Pa) maximum.

J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel shut-off solenoid, gear-driven water pump, and a replaceable fuel filter element conveniently located for servicing. Include fuel pressure gauge, water temperature gauge, and lube oil pressure

gauge on engine/generator control panel.

K. Lubricating System: The engine shall have a lubricating oil pump for supplying oil under pressure to the main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings and valve rocker mechanism. Full flow oil filters, conveniently located for servicing shall be provided. Lube oil drain extension and valve terminated on the outside of the generator base shall be provided.

L. Mounting: Provide unit with suitable spring-type vibration isolators and mount on structural steel base, which shall allow mounting to a raised concrete pad. Anchor bolts and vibration isolators shall be used to mount the steel base to the concrete pad. Vibration isolators shall be one piece units, resistant to corrosion and environmental degradation.

2.4 GENERATOR

A. Generator: NEMA MG1, three phase, four wire, reconnectible brushless synchronous generator with brushless exciter. Generator shall be revolving field type, close coupled or directly coupled to the engine flywheel. The generator shall have a single ball bearing support for the rotor and the rotor shall be dynamically balanced up to 25% overspeed.

B. Standby rating: No less than 200 kW, 250 kVA, at 0.8 power factor, 208/120 volts, 60 Hz at 1800 rpm. See Specifications Paragraph 2.4 G. below for additional load information.

C. Insulation Class: F.

D. Temperature Rise: 105°C Standby.

E. Enclosure: NEMA MG1, open drip proof.

F. Voltage Regulator: Shall be of solid state design and provide voltage-per-hertz operation to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Steady state voltage modulation shall not exceed one cycle per second. For any addition of load up to and including 90% of rated, the voltage shall recover to and remain within the steady band in not more than 1.5 seconds. Frequency regulation from no load to rated load shall conform with engine governor performance. For any addition of load up to 90% of rated load, the frequency shall recover to the steady state frequency within 5 seconds. Include manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain. Regulator to be mounted on top or side of the generator and enclosed in a NEMA rated enclosure. An isolation transformer in the voltage regulator circuit shall be provided.

G. The minimum rating of the engine-generator set specified in previous paragraphs is estimated. The Contractor shall provide an engine-generator set capable of simultaneous starting and continuous operation, with less than twenty (20) percent voltage dip and without set overload, of the loads detailed on the Drawings.

2.5 ACCESSORIES

A. Vibration Isolation Devices
   1. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-

steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
    1) Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
    2) Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
    3) Minimum Additional Travel: 50 percent of required deflection at rated load.
    4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
    5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

B. Exhaust Silencer: Super critical grade silencer to reduce engine exhaust noise in accordance with dBA requirements listed above, with muffler companion flanges and seamless flexible stainless steel exhaust connector, sized in accordance with engine manufacturer's instructions. The silencer shall be all-welded heavy duty carbon steel construction and shall include a compressed thermal/acoustical insulation packed shell. In addition to its acoustical values, the two (2) inch minimum thick packed shell shall be provided to reduce the outer surface temperature.

C. Exhaust Piping: Schedule 40 black steel. Piping inside the enclosure shall be insulated.

D. Batteries: Heavy duty, starting type lead-acid storage batteries capable of four 15 second cranks followed by a 15 second rest period at 0°F. Match battery voltage to starting system. Include necessary cables and clamps.

E. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

F. Battery Charger: Automatic solid state, current limiting, float equalizing type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Minimum continuous output of 10 amperes DC. Charger shall be capable of recharging a completely discharged battery in a maximum of 8 hours. Include overload protection, voltage surge suppressors, full wave rectifier, DC voltmeter and ammeter, low DC voltage alarm relay, malfunction alarm contact, and 120 volt AC fused input. Provide in NEMA-1 wall mounted enclosure.

H. Remote Emergency Stop Switch: Weatherproof, surface wall mounted, unless otherwise indicated, adjacent to the engine-generator set and labeled with an engraved, three layer, laminated plastic nameplate “GENERATOR EMERGENCY STOP”. Push button shall be protected from accidental operation. See Drawings for location.

I. Line Circuit Breaker: A NEMA AB 1, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole, sized in accordance with NFPA 70. Include battery-voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements.

J. Engine-Generator Control Panel: NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:
   1. Frequency Meter: Digital, 45-65 Hz. range.
   2. AC Output Voltmeter: Digital, 2 percent accuracy, with phase selector switch.
   3. AC Output Ammeter: Digital, 2 percent accuracy, with phase selector switch.
   4. AC wattmeter, digital.
   5. Output voltage adjustment.
   6. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, over-speed, and over-crank.
   7. Engine start/stop selector switch.
   8. Engine running time meter.
   9. Oil pressure gauge.
   10. Water temperature gauge.
   11. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
   12. Additional visual indicators and alarms as required by NFPA 110.

K. Remote Annunciator Panel: NFPA 110 compliant, surface [flush] mounted panel with painted finish and silk screened lettering, in manufacturer's standard color. Provide alarm horn, indicators and alarms and switching as follows:
   1. High battery voltage (alarm).
   2. Low battery voltage (alarm).
   3. Low fuel pressure (alarm).
   4. Intertank leakage.
   5. Battery charger malfunction.
   6. System ready.
   7. Anticipatory-high water temperature.
   8. Anticipatory-low oil pressure.
   9. Low coolant temperature.
   10. Mode switch not in auto position (alarm).
   11. Over-crank (alarm).
   12. Emergency stop (alarm).
   13. High water temperature (alarm).
   14. Over-speed (alarm).
   15. Low oil pressure (alarm).
   16. Line power available.
   17. Generator power available.
   18. Lamp test and horn silence switch.
   19. Emergency stop switch.

L. Sound attenuated, weather-protective enclosure: UL2200 listed, non walk-in, reinforced, 14 gauge minimum aluminum powder painted housing allowing access to control panel and service points, with tamper resistant, lockable side and rear doors and panels.
   1. Include fixed louvers, battery rack, and internally-mounted silencer. Provide non-hydroscopic sound insulated interior panels with metal perforated skin. Provide thermal Insulation, manufacturer's standard materials and thickness selected in coordination with block heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
   2. Enclosures shall be primed and finish painted in a color as selected by the Architect. Hardware, latches and hinges shall be stainless steel. Roof shall be peaked to allow

drainage of rain water. Unit shall have sufficient guards to prevent entrance by rodents and small animals.

3. Sound attenuation shall be Level II (maximum of 73 dbA maximum at 7 meters). Exhaust gasses and cooling air shall be discharged vertically.
4. Enclosure housing shall be suitably constructed to withstand 150 mph wind loads.
5. Provide exterior emergency stop pushbutton (per Para. 2.5 H. above) and exterior oil and coolant drains with interior valves.
6. Provide a minimum of three watertight, impact-resistant, general illumination, LED lighting fixtures with a minimum 5,000 lumens output each, a weatherproof GFCI convenience receptacle and a weatherproof switch for the lighting. Position the lighting fixtures to illuminate the housing interior and controls. Power from the circuits indicated on the Drawings.
7. Provide a minimum of three watertight, impact-resistant, general illumination, LED lighting fixtures with a minimum 5,000 lumens output each and a weatherproof 30 minute timer switch. Position the lighting fixtures to illuminate the housing interior and controls. Power from the generator battery.
8. Provide an internal 120/208 volt, 100 ampere, three phase, circuit breaker loadcenter supplying lighting, convenience receptacle, block heater, battery charger and other generator set accessories required for generator performance.
9. Provide permanent access platform, stairs and handrails for access to controls and circuit breakers to maintain no greater than 6’-7” to top of any control device or circuit breaker handle, and for maintenance access via enclosure access panels. Stair and platform shall be hot dip galvanized, aluminum and/or fiberglass and shall comply with OSHA and all local jurisdiction requirements. Platform shall provide for 180 degree "full swing opening" of all side (and end, if required) service doors and at least 135 degree opening of the control panel door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install raceways as prescribed by NEC Article 700.

C. Systems shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Specifications Section 260500, Paragraph 1.23 for additional requirements.

D. Commission the system as detailed below.

3.2 FIELD QUALITY CONTROL

A. Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.3 ADJUSTING

A. Testing, Adjusting, and Balancing: Adjust installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Adjust all operating mechanisms for free mechanical movement.

C. Adjust all control parameters and settings to values as recommended by the manufacturer and as instructed by Architect/Engineer.

D. Adjust generator output voltage and engine speed.

3.4 MANUFACTURER'S FIELD SERVICES

Furnish manufacturer's field representative to supervise final connections and system adjustments.

3.5 COMMISSIONING

The term "commission" and "commissioning" as used in this document includes, but is not limited to:

1. Static and operational testing and start-up of the electrical equipment.
2. Providing qualified and manufacturer trained and certified personnel to conduct/assist in tests.
3. Providing equipment, materials and test instrumentation necessary to conduct testing.
4. Providing equipment, materials, test instrumentation and labor necessary to correct deficiencies found during the commissioning process which fulfills contract and warranty requirements.
5. Providing operation and maintenance information and as-built drawings to the Architect/Engineer for review verification and organization, prior to distribution.
6. Providing Owner training for the systems specified.

3.6 TESTING AND DEMONSTRATION

A. Load Bank Test:
Provide a full load test utilizing a portable test bank for four hours minimum for each engine-generator set. Each test shall be performed at the job site in the presence of the Owner and Architect. Each test shall include one hour at 50% load, one hour at 75% load and two hours at 100% load. Upon completion of the load test, the generators shall be shut down after the cool down period. The generators shall then be started and immediately upon reaching rated rpm, 100% load shall be applied to demonstrate one step full load capability. The capability of the system to pick up full standby service load within 10 seconds of power outage shall also be demonstrated. After testing is complete:

1. A copy of the generators test report shall be submitted to the Engineer of Record, the Owner, the Architect and the State Construction Office.
2. Test results shall record the following parameters in 20 minute intervals during four hour test:
   a. Kilowatts.
   b. Amperes.
   c. Voltage.

d. Coolant temperature.
e. Room temperature.
f. Frequency.
g. Oil pressure.
h. Fuel flow.

B. Building Loads Test: Following the load bank test, start the buildings load test. Simulate power outage, including operation of the distribution equipment, automatic starting cycle, and automatic shutdown and return to normal, by interrupting normal source, and demonstrate that system operates with actual building loads to provide standby power. The test shall demonstrate the capability of the engine-generator set to operate the loads stated in Paragraph 2.4 G. Test all alarm and shutdown circuits by simulating conditions. Test duration shall be one hour minimum.

3.7 TRAINING

Prior to final acceptance, the manufacturer's authorized representative shall provide comprehensive training and thoroughly and competently instruct the Owner's designated personnel in proper operation of the system and in all required periodic maintenance. Training shall include, but not be limited to, operation (all aspects including normal and emergency modes), maintenance and troubleshooting of the equipment. A minimum of eight (8) hours on-site time, in addition to load bank testing, shall be allocated for this purpose.

3.8 DOCUMENTATION

Upon final completion of the system, a documentation package shall be provided and shall include three (3) bound (in three ring binders with index tabs) copies of complete manufacturer’s operation and instruction manuals. Provide one bound original (no photocopies) and two additional bound copies (photocopies are acceptable) of the total documentation package. The manuals shall include operation and maintenance procedures, complete parts lists, dimensional drawings, unit wiring diagrams and schematics, and interconnection wiring drawings. Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures. The following shall also be provided:

A. System record drawings.

B. Instruction manuals as supplied by the manufacturer for all components and electronics.

C. Product specification sheets for all equipment without instruction manuals.

3.9 CLEANING

A. Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Touch up scratched or marred surfaces to match original finish.

C. Clean engine and generator surfaces. Replace oil and fuel filters.

3.10 WARRANTY

The Contractor shall provide the following minimum manufacturers factory warranty for each engine-generator set and associated equipment:

A. All equipment shall be new and warranted free of faulty workmanship and damage.

B. The warranty shall include all parts, labor (including travel with no travel time or distance limitations), expenses and equipment necessary to perform replacement and/or repairs.

C. The total system (parts and labor) shall be warranted free of defects for a period of one (1) year from date of final acceptance.

D. Replacement of defective materials and repair of faulty workmanship shall take place within 48 hours of notification by Owner and shall be guaranteed at no cost to the Owner during the warranty period.

E. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturer's warranties.

F. The printed warranty shall be included in the contract documents.

3.11 FINAL ACCEPTANCE

The installation shall be supervised, checked and tested by a qualified representative of the engine-generator set manufacturer. Written certification, by the qualified manufacturer's representative, verifying manufacturer's startup procedures were followed and full system functionality was achieved shall be submitted to the Architect and Owner prior to final acceptance.

END OF SECTION 263213

SECTION 263600 - TRANSFER SWITCHES

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 **automatic** transfer switches rated 600 V and less.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
   2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

   1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   2. Include material lists for each switch specified.
   3. Single-Line Diagram: Show connections between transfer switch, power sources, and load.
   4. Riser Diagram: Show interconnection wiring between transfer switches, engine-generator set, etc.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for transfer switches, 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.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.

a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD 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:

1. Notify the Owner no fewer than five days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the Owner**'s** written permission.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **Five years** from date of Substantial Completion.

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. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for **30** cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Terminal: Solid and fully rated unless otherwise indicated.

K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable **with printed** markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via **front** access.

M. Enclosures: General-purpose NEMA 250, **Type 1**, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Shall be provided by the generator vendor as part of a package system.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: **Hard-drawn copper, 98 percent conductivity**.
6. Main and Neutral Lugs: **Mechanical** type.
7. Ground Lugs and Bus-Configured Terminators: **Mechanical** type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

F. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

G. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

H. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

I. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

J. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.

2. Undervoltage Sensing for Each Phase of Normal **and Alternate** Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is unavailable.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for **emergency** systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.
g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.
m. Receptacle withstand capability.
n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identify components according to Section 260553 "Identification for Electrical Systems."

B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

C. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Route and brace conductors according to manufacturer's written instructions**.** Do not obscure manufacturer's markings and labels.

G. Brace and support equipment according to Section 260500, Para. 1.22.

H. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

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

1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.

3. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.

g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264313 - SURGE SUPPRESSION DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

Section includes field-mounted surge suppression devices (SPD) for low-voltage (120VAC to 480VAC) power distribution and control equipment.

1.2 RELATED DOCUMENTS

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

B. Section 260526 - Grounding and Bonding.

C. Section 260529 Supporting Devices.

D. Section 260553 - Electrical Identification.

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. SVR: Suppressed voltage rating.

C. SPD: Surge Suppression Device.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

B. Qualification Data: For qualified testing agency.

C. Product Certificates: For SPD, from manufacturer.

D. Field quality-control reports.

E. Operation and Maintenance Data: For SPD to include in emergency, operation, and maintenance manuals.

F. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

D. Comply with NEMA LS 1.

E. Comply with UL 1283 and UL 1449.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Service Conditions: SPDs shall be rated for continuous operation under the following conditions unless otherwise indicated:
1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.7 COORDINATION

Coordinate location of SPDs to allow adequate clearances for maintenance.

1.8 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB.
2. Current Technology.
3. Eaton.
4. Siemens.
5. Square D.

B. Surge Protection Devices:
   1. Comply with UL 1449, 5th Edition.
   2. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
   3. Fuses, rated at 200-kA interrupting capacity.
   4. Fabrication using bolted compression lugs for internal wiring.
   5. Redundant suppression circuits.
   6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
   7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   8. LED indicator lights for power and protection status of each phase and neutral.
   9. Audible alarm, with silencing switch, to indicate when protection has failed.
   10. Form-C contacts rated at 5A and 250VAC, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   11. Six-digit transient event counter with reset button and nonvolitile memory to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 320 kA per mode/640 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
   1. Line to Neutral: 70,000 A.
   2. Line to Ground: 70,000 A.
   3. Neutral to Ground: 50,000 A.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277VAC and 208Y/120VAC, 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: 800 V for 480Y/277VAC and 400 V for 208Y/120VAC.
   2. Line to Ground: 800 V for 480Y/277VAC and 400 V for 208Y/120VAC.
   3. Neutral to Ground: 800 V for 480Y/277VAC and 400 V for 208Y/120VAC.

2.2 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
   1. ABB.
   2. Current Technology.
   3. Eaton.
   4. Siemens.
   5. Square D.

B. Surge Protection Devices:
   1. Comply with UL 1449, 5th Edition.
   2. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
   3. Fuses, rated at 200-kA interrupting capacity.
   4. Fabrication using bolted compression lugs for internal wiring.

5. Redundant suppression circuits.
6. Redundant replaceable modules.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status of each phase and neutral.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. Form-C contacts rated at 5A and 250VAC, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
11. Six-digit transient event counter with reset button and nonvolitile memory to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
1. Line to Neutral: 70,000 A.
2. Line to Ground: 70,000 A.
3. Neutral to Ground: 50,000 A.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277VAC and 208Y/120VAC, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 800 V for 480Y/277VAC and 400 V for 208Y/120VAC.
2. Line to Ground: 800 V for 480Y/277VAC and 400 V for 208Y/120VC.
3. Neutral to Ground: 800 V for 480Y/277VAC and 400 V for 208Y/120VC.

2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install SPD at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install SPD with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

C. SPD circuit breaker and feeder conductors shall be as recommended by the device manufacturer, or #8 AWG copper, whichever is greater. Install in metallic raceway.

D. Coordinate SPD circuit breaker rating with actual SPD provided.

3.2 FIELD QUALITY CONTROL

A. Inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
   2. After installing SPDs, but before electrical circuitry has been energized, test for compliance with requirements.
   3. Complete startup checks according to manufacturer's written instructions.

C. SPD will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Do not energize or connect electrical equipment to their sources until SPDs are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SDP installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

END OF SECTION 264313

SECTION 265100 - INTERIOR LUMINAIRES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires and accessories.

B. Drivers.

C. Lamps and LED Light Engines/Sources.

D. Luminaire accessories.

1.2 RELATED SECTIONS

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

B. Section 260533 - Conduit.

C. Section 260519 - Building Wire and Cable.

D. Section 260534 - Boxes.

E. Section 260526 - Grounding and Bonding.

F. Section 260553 - Electrical Identification.

1.3 REFERENCES

A. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

B. NFPA 70 - National Electrical Code.

C. NFPA 101 - Life Safety Code.

1.4 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

D. Submittal information must include IES and Photometric files with the fixture specifications. IES Photometric and LM79 data for the submitted LED fixtures, IES file must been from an NVLAP (National Voluntary Laboratory Accreditation Program) accredited laboratory. Submittal information will also include a referenced location for a current installation of the proposed products where the operational performance of these proposed products can be observed and evaluated by the Owner. Provide photometric calculation for the following:

1. Typical office space.
2. Typical classroom space.
3. Typical meeting room.
4. Typical other spaces.
5. Each interior floor plan with emergency lighting fixtures only.
6. Exterior plan with emergency lighting fixtures only.

1.5 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's operation and maintenance instructions for each product.

1.7 QUALIFICATIONS

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

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. [Lighting systems shall comply with the 2009 North Carolina State Energy Code and North Carolina Senate Bill 668.] [SCO]

D. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.9 EXTRA PRODUCTS

A. Furnish one replacement LED lighting module for each type. Furnish one replacement LED lighting module for each 24 of each module type, but no less than one.

B. Furnish one replacement LED driver type for each 24 of each type, but no less than one.

C. Furnish one replacement exit lighting fixture for each 24 of each type, but no less than one.

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. Furnish Products as scheduled. Refer to relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections for substitutions and product options.

B. All lighting fixtures shall be approved by third party testing agencies and NFPA and shall bear their label.

C. All fixtures shall be listed on one or more of the following websites: LED Lighting Facts website (www.lightingfacts.com), Energy Star website (www.energystar.gov), or the Design Light Consortium website www.designlights.org.

D. Power supplies/drivers/ballasts, LED arrays, boards or light engines shall be easily field replaceable using common hand tools (e.g., screwdrivers, pliers, etc.) and without uninstalling the luminaire.

E. All fixtures shall have a stock, or standard finish unless otherwise specified. Fixtures subject to corrosive or damp environments shall have corrosion resistant hardware and finishes.

F. No visible welding, no plane-protruding screws, latches, springs, hooks, rivets or plastic supports viewed from the occupied (room) side are allowed.

G. All fixtures shall be installed complete with lamps or LED sources as specified.

H. Lighting fixture types shall be furnished as required by the Lighting Fixture Schedule as indicated on the drawings. Catalog numbers are provided as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers listed will be acceptable upon approval of the Architect/Engineer. The Contractor shall verify from the contract drawings the type ceilings or walls the fixture is to be used with and shall provide compatible mounting attachments and trim. Provide all accessories or additional materials required to maintain the ceiling fire rating as required by regulatory authorities.

I. Luminaires shall be designed to operate at an average operating temperature of 25°C. The operating temperature range shall be 0°C to 25°C.

J. Interior Area LED Fixtures/Lamps:
   1. Kelvin temperature of in the range of 3500k to 4000k unless otherwise indicated in schedule.
   2. 75 plus lumens per watt minimum.
   3. CRI 85 or greater.
   4. 5-year warranty minimum with L70 of 50,000 hours or greater.
   5. Modular design for field replacement of parts.
   6. Series parallel matrix for prevention of LED string outages (not applicable to exit lights and recessed can fixtures).
   7. Tool less access to driver and LED modules.
   8. UL certified up to 90F degrees operating temperature.

K. Manufacturers shall be firms regularly engaged in the manufacture of lighting fixtures of types and ratings required, who have a service organization in the continental US, and whose products have been satisfactorily used in similar service for not less than 5 years. Fixtures shall comply with the provisions of all applicable code and standards. All fixtures shall be tested before shipping.

L. Warranty: 10 years from the date of Final Acceptance non-prorated on complete fixture including driver including premature failure, discoloration and defects. The contractor shall provide a written warranty against defects in material and workmanship, including replacement for ten years from the date of final acceptance.

2.2 LED SOURCES

LED sources shall be high intensity white, single color or as noted. Provide white LEDs in the color temperature(s) specified. The color temperature in all lamps of the same type shall be consistent and remain so over the life of the lamp. Color consistency between lamps shall conform to ANSI NEMA ANSLG standard C78.377-2008. The contractor shall replace lamps/fixtures exhibiting inconsistent lamp color. Minimum lumen maintenance shall be 70% of rated initial lumen output at 50,000 hours of operation. Measurement of lumen maintenance shall be in accordance with IES LM-80-08. The lamp and/or luminaire manufacturer shall provide a minimum of five year warranty from the date of Final Acceptance against premature failure, discoloration and defects. The color or color temperature of replacement LED lamps shall match those of the same lamp types that remain in operation. The minimum color rendering index of white LEDs shall be 80. Electrical and photometric performance of LED assemblies and luminaires shall conform to IES LM 79-08. LED arrays in the product(s) will be considered defective in material or workmanship if a total of 10% or more of the individual light-emitting diodes in the product(s) fail to illuminate during normal operation after installation.

2.3 LED DRIVERS

A. Provide high frequency electronic type with secondary voltages matching those required by the led source they operate. Drivers shall operate within a 0ºF – 140ºF ambient temperature range. Minimum driver specifications:
   1. Power factor ≥ 90% (at full luminaire output and across specified voltage range).
   2. Driver efficiency (at full load): ≥ 85% for drivers capable of ≥ 50 watts and ≥ 80% for drivers capable of < 50 watts
   3. Current crest factor – 1.5 minimum.
   4. Total harmonic distortion < 20% (at full luminaire output and across specified voltage range).
   5. Rated life – 50,000 hours.

6. Transient and surge protection: ANSI C62.41-2002 Category A surge protection standards up to and including 2.5 kv for interior fixtures.
7. Sound: Class A not to exceed a measured value of 24dB.
8. Maximum standby power: 1W.
9. For indoor and building mounted fixtures, provide minimum 2-kv surge suppression integral with the driver (5-kv preferred if available).
10. For outdoor fixtures, provide minimum 10.0-kv surge suppression integral with the driver.
11. Thermal management
    a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
    b. The LEDs manufacturer's maximum junction temperature for the expected life shall not be exceeded at the average operating ambient temperature.
    c. The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient temperature.
    d. The driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating temperature. Thermal management shall be passive by design. The use of fans or other mechanical cooling devices shall not be allowed.
12. Flicker: Comply with IESNA standards for flicker and IEEE PAR1789 Recommended Practice, including flicker at when fully powered and when dimmed.
13. EMI/RFI: The luminaire and associated on-board circuitry shall meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI Emissions.
14. Inrush Current: Comply with NEMA 410.

Manufacturers shall have been manufacturing LED drivers for at least ten years with a documentable low failure rate. The contractor shall provide a written warranty against defects in material and workmanship, including replacement for ten years from the date of final acceptance.

2.4 LENSES

Lenses shall be clear virgin acrylic material with uniform 3/16" square based female cone prisms aligned 45° to the length and width of the lens panel. Minimum prism depth shall be 0.080" with a nominal panel thickness of 0.156" and a minimum overall panel thickness of 0.150" to 0.160" inches.

2.8 CONTROLS

A. Time Switch: Astronomic, two channel, electronic type with 48 hour capacitor or battery reserve, digital display, 30 ampere output contact rating, two, single pole output contacts, voltage compatible with load served, NEMA-1 enclosure.

B. Photocell: Weatherproof, enclosed, single pole, 1800 VA, 120VAC, twist lock plug-in type with base.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

B. Lighting equipment shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Specifications Section 260500, Paragraph 1.23 for additional requirements.

C. Where a recessed or downlight fixture replaces a section or part of an acoustical ceiling tile, or a section or part of a suspended gypsum board ceiling, the fixture shall be supported at two (2) diagonal corners to the steel frame of the building. Supports shall be provided with the same type of wire as used to support the lay-in ceiling track or GWB ceiling system. Attach one end of the wire to one corner of the fixture and the other end to the building's structural system. The lay-in or flange fixture shall then be screwed to the main runners of the lay-in ceiling track or GWB ceiling system at all four (4) corners using sheet metal screws (parabolic type fixtures shall be attached to the ceiling grid with approved clips). The Electrical Contractor shall be responsible for coordination work with the ceiling contractor; however, the ceiling contractor will provide framed openings for reception of lighting fixtures. All recessed fixtures shall be furnished with all necessary mounting accessories.

D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

E. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

F. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling grid members using bolts or screws.

G. Install recessed luminaires to permit removal from below.

H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

I. Install wall mounted luminaires, emergency lighting units and exit signs at height as indicated on Drawings.

J. Install accessories furnished with each luminaire.

K. Connect luminaires, emergency lighting units and exit signs to branch circuit outlets provided under Section 260534 using flexible conduit.

L. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

M. Bond products and metal accessories to branch circuit equipment grounding conductor.

N. Install/provide specified lamps/LEDs in each emergency lighting unit, exit sign, and luminaire.

3.2 FIELD QUALITY CONTROL

A. Quality Assurance: Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Contract Closeout: Adjust installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Aim and adjust luminaires as directed.

3.4 CLEANING

A. Contract Closeout: Clean installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 DEMONSTRATION AND INSTRUCTIONS

A. Contract Closeout: Demonstrate installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Demonstrate luminaire operation for minimum of two hours.

3.6 PROTECTION OF FINISHED WORK

A. Contract Closeout: Protect installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Relamp luminaires that have failed lamps at Substantial Completion. Replace LED modules in which more than 5% of the LEDs have failed lamps at Final Acceptance of the Work.

END OF SECTION 265100

SECTION 265200 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

Section includes emergency exit lighting and emergency egress lighting units, LED emergency drivers, lighting inverters and transfer switching devices.

1.2 RELATED SECTIONS

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

B. Section 260533 - Conduit.

C. Section 260519 - Building Wire and Cable.

D. Section 260534 - Boxes.

E. Section 260526 - Grounding and Bonding.

F. Section 260553 - Electrical Identification.

1.3 STANDARDS

A. UL 924

B. NFPA 101 - Life Safety Code.

C. NFPA 70 - National Electrical Code.

D. North Carolina State Building Code including Energy Code Volume X.

E. NEMA - Standards

1.4 SUBMITTALS FOR REVIEW

A. Submittals: Procedures for submittals. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide dimensions, ratings, and performance data.

1.5 SUBMITTALS FOR INFORMATION

A. Submittals: Submittals for information. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 SUBMITTALS FOR CLOSEOUT

A. Contract Closeout: Submittals for project closeout. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Submit manufacturer's operation and maintenance instructions for each product.

1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Conform to requirements of NFPA 101.

C. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated. Products shall also meet or exceed the standards listed in Part 2.

PART 2 - PRODUCTS

2.1 GENERAL

A. All lighting fixtures shall be listed as emergency lighting equipment and approved by third party testing agencies and NFPA and shall bear their label.

B. All fixtures shall have a stock, or standard finish unless otherwise specified.

C. All fixtures shall be completely self-contained, provided with maintenance free battery, automatic charger and other features. They shall be installed complete with lamps, batteries, etc. which shall be new and unused at time of final inspection of the project for acceptance.

D. Lighting fixture types shall be furnished as required by the Lighting Fixture Schedule on the contract drawings and as herein specified. Catalog numbers are provided as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers listed will be acceptable upon approval of the Architect/Engineer. The Contractor shall verify from the contract drawings the type of ceilings or walls the fixture is to be used with and shall provide compatible mounting attachments and trim. Provide all accessories or additional materials required to maintain the ceiling fire rating as required by regulatory authorities.

E. Emergency lighting fixtures shall be as shown on the lighting fixture schedule on the contract drawings, and as herein specified.

F. Warranty: The entire unit shall be warranted for three years. The battery must have a additional two more years pro-rated warranty. Warranty shall date from the date of final project acceptance.

2.2 EMERGENCY LIGHTING (EGRESS) UNITS

A. Product Description: Self-contained LED emergency lighting unit automatically activated when the line voltage drops below 80%.

B. Battery: Ten year normal life expectancy, 6 or 12 volt, sealed, maintenance-free, lead calcium type, with 1.5 hour minimum capacity at full load. Battery shall be a high temperature type with an operating range of 0° C. to 60º C., contain a resealable pressure vent and sintered positive and negative terminals. A low voltage disconnect switch shall be included if a lead battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage.

C. Battery Charger: Automatic, solid state, full wave rectification, surge protected, current-limiting, dual-rate type, with filtered output of sufficient capacity to recharge discharged battery to full charge within twelve hours. Provide fused output circuit, low voltage battery disconnect, brownout and short circuit protection. Thermal protection shall sense circuitry temperature and adjust charge current to prevent overheating and charger failure. Thermal compensation shall adjust charger output to provide optimum charge voltage relative to ambient temperature. Regulated charge voltage shall maintain constant charge voltage over a wide range of line voltages. AC lockout circuit shall allow battery connection before AC power is applied and prevent battery damage due to deep discharge.

D. Lamps: LED. Heads shall rotate for aiming. Maximum LED failure rate shall be 25% within a seven (7) year period; otherwise, if exceeded, manufacturer shall replace the complete unit at no charge to the Owner.

E. Mounting: Surface wall or recessed ceiling as indicated by the drawings.

F. Housing: White polycarbonate, with steel backbox/housing or steel with white finish. Wall mount unit with hinged faceplate and adjustable mounting hardware. Ceiling mount unit with T bar hangar kit.

G. Self-Diagnostics: Electronics shall automatically, or manually upon demand, conduct self test on battery condition (including actual discharge), charger, lamps and internal wiring integrity per NEC and NFPA at prescribed intervals. A pilot light shall indicate the unit is

connect to AC power. Provide test switch and visual indicator(s) of unit operational condition including charger status, ready and service code. Test switch shall simulate operation of the unit upon loss of AC power by energizing lamps from the battery, and also exercise the transfer relay.

H. Electrical Connection: Conduit connection.

I. Input Voltage: Dual voltage input (120/277 volts).

2.3 LED EMERGENCY DRIVER

A. Product Description: Manufacturer-installed UL924 LED emergency battery power supply suitable for installation in LED luminaire wireway. When normal AC power fails, the unit shall immediately drive the LED load at a reduced light output for a minimum of 90 minutes. When AC power is present, the emergency LED driver shall operate in various charging modes to ensure the sealed, maintenance-free, high-temperature nickel-cadmium batteries are fully recharged within 24 hours after a full discharge and remain fully charged until the next loss of AC power.

B. Battery: Seven to ten year normal life expectancy, 9.6 volt, sealed, maintenance-free, nickel-cadmium type, with 1.5 hour minimum capacity at 10 watts output. Battery shall be a high temperature type with an operating range of 32° F. to 122º F.

C. Provide with self-diagnostics module with status indicator light and test switch. Self-diagnostics shall automatically, or manually upon demand, conduct self test on battery condition (including actual discharge), charger, LEDs and internal wiring integrity per NEC and NFPA at prescribed intervals. Status light shall indicate operational condition including charger status, ready and service code. Test switch shall simulate operation of the unit upon loss of AC power by energizing lamps from the battery.

D. Input Voltage: Dual voltage input (120/277 volts).

2.4 EXIT LIGHTING UNITS

A. Product Description: Self-contained exit lighting unit automatically activated when the line voltage drops below 80%.

B. Battery: Ten year normal life expectancy, 6 or 12 volt, sealed, maintenance-free, lead calcium type, with 1.5 hour minimum capacity. Battery shall be a high temperature type with an operating range of 0º C. to 60º C. and contain a resealable pressure vent and sintered positive and negative terminals. A low voltage disconnect switch shall be included if lead battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage.

C. Battery Charger: Automatic, solid state, surge protected, full wave rectification, current-limiting, dual-rate type, with filtered output of sufficient capacity to recharge discharged battery to full charge within twelve hours. Provide fused output circuit, low voltage battery disconnect, brownout and short circuit protection. Thermal protection shall sense circuitry temperature and adjust charge current to prevent overheating and charger failure. Thermal compensation shall adjust charger output to provide optimum charge voltage relative to ambient temperature. Regulated charge voltage shall maintain constant charge voltage over a wide range of line voltages. AC lockout circuit shall allow battery connection before AC power is applied and prevent battery damage due to deep discharge.

D. Lamps: LED, discrete or diffuse. Maximum failure rate shall be 25% within a seven year period, otherwise, if exceeded the manufacturer shall replace the entire unit at no cost to the Owner.

E. Face:
1. Standard Unit: Single or dual face as indicated or required. Translucent plastic face with red letters on white background.
2. Architectural/Edge Lit Unit: Clear transparent plastic panel with red letters on clear or mirrored background.

F. Directional Arrows: As indicated or universal type for field adjustment.

G. Mounting: Universal, surface wall, back or end mount, or ceiling, top or pendant mount.

H. Housing: White polycarbonate for standard unit, metallic enclosure with clear plexiglass signage panel for architectural/edge lit unit.

I. Self-Diagnostics: Electronics shall automatically, or manually upon demand, conduct self test on battery condition (including actual discharge), charger, lamps and internal wiring integrity per NEC and NFPA at prescribed intervals. Provide test switch and visual indicator(s) of unit operational condition including charger status, ready and service code. Test switch shall simulate operation of the unit upon loss of AC power by energizing lamps from the battery. This simulation shall also exercise the transfer relay.

J. Electrical Connection: Conduit connection.

K. Input Voltage: Dual voltage input (120/277 volts).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install suspended exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend sign at indicated height.

B. Install surface-mounted emergency lighting units and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install wall-mounted emergency lighting units and exit signs at height as indicated.

D. Install accessories furnished with each emergency lighting unit and exit sign.

E. Emergency and exit lighting fixtures shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code. Provide mounting devices and hardware, bracing, fittings, etc. as required for seismic restraint. See Specifications Section 260500, Paragraph 1.23 for additional requirements.

F. Connect emergency lighting units and exit signs to branch circuit outlets provided under this Division as indicated.

G. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling grid members using bolts or screws.

H. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.

I. Install specified lamps in each emergency lighting unit.

J. Ground and bond emergency lighting units and exit signs under the provisions of Section 260526.

K. Locate exit and emergency lighting fixtures as indicated on reflected ceiling plan.

L. Install recessed luminaires to permit removal from below.

M. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

N. Install screws to secure recessed grid-supported luminaires in place.

O. Install accessories furnished with each luminaire.

P. Paint a 3/8” diameter red dot on each emergency lighting fixture to provide ready identification of emergency fixtures. Exact location shall be coordinated with the Architect/Engineer.

3.2 FIELD QUALITY CONTROL

A. Quality Assurance: Field inspection, testing and adjusting shall be as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Contract Closeout: Adjust installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Aim and adjust emergency lighting fixture heads to illuminate paths of egress.

3.4 CLEANING

A. Contract Closeout: Clean installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosures.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 DEMONSTRATION AND INSTRUCTIONS

A. Contract Closeout: Demonstrate installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. The Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes, in accordance with NEC 700. If the battery is not user accessible, the test shall be done by measuring the light output using a light meter at a fixed position at the start and end of the 90 minute test. Battery voltage or light output shall be 87.5% minimum of the initial measurement after 90 minutes run time to pass the test. Any unit which fails the test shall be repaired or replaced, and tested again. A copy of the test report shall be presented at final inspection and included in the Owner's Operation and Maintenance Manual. Include starting voltage, ending voltage, and percent voltage drop in the test report. The Architect/Engineer will provide the testing form for contractor use.

3.6 PROTECTION OF FINISHED WORK

A. Contract Closeout: Protect installed work as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Relamp emergency lighting units and exit signs that have failed lamps at Substantial Completion. Replace exit signs in which more than 5% of the LEDs have failed lamps at Substantial Completion.

END OF SECTION 265200

DIVISION 27 – COMMUNICATIONS

Communications work shall be defined by drawings numbered with the prefix "E-", the general provision of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division-27 Communications Specifications.

Engineer of Record for Division 27 is Jason P. Famiglietti, PE, CBHF Engineers, PLLC, 2246 Yaupon Drive, Wilmington, NC 28401.

11/25/2024

END OF SECTION 270000

SECTION 270510 - TELECOMMUNICATIONS PATHWAYS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment and terminal backboards.

B. Premises wiring raceways and outlets.

1.2 REFERENCES

The State of North Carolina expects and enforces strict adherence to the latest published versions of the following codes and standards:

1. Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Final Guidelines (July 1991) – 36 CFR Part 1191
2. Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – TIA / EIA526 -7 (OFSTP-7)
3. Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – TIA / EIA-526 - 14 (OFSTP-14A)
4. Commercial Building Telecommunications Wiring Standard – TIA / EIA-568 - B.1
5. Commercial Building Telecommunications Wiring Standard – TIA / EIA-568 - B.2
6. Commercial Building Telecommunications Wiring Standard – TIA / EIA-568 - B.3
7. Telecommunications Pathways and Spaces – TIA / EIA - 569
8. Residential Telecommunications Cabling Standard – TIA / EIA - 570
9. Optical Fiber Cable Color Coding – TIA / EIA - 598
10. Administration Standard for the Telecommunications Infrastructure of Commercial Buildings – ANSI / TIA / EIA-606
11. Commercial Building Grounding and Bonding Requirements for Telecommunications – TIA / EIA - 607
12. Customer-Owned Outside Plant Telecommunications Standard – TIA / EIA -758
13. Detail Specification for 62.5-µm Core Diameter / 125-µm Class 1a Multimode Graded Index Optical Waveguide Fibers – TIA / EIA - 492AAAA
14. Generic Requirements for Optical Fiber and Optical Fiber Cable – Bellcore TR-TSY-000020
15. National Electrical Code (NEC) Articles 600, 700 & 800
16. National Fire Protection Association (NFPA) NFPA - 71, - 72, - 75, - 780.
17. BICSI - Telecommunications Distribution Methods Manual (Newest Edition) Building Industry Consulting Service International
18. BICSI - Customer-Owned Outside Plant Design Manual (Newest Edition) Building Industry Consulting Service International
19. Customer –Owned Outside Plant Telecommunications Cabling Standard TIA / EIA –758 – 1

1.3 SYSTEM DESCRIPTION

Individual and combination telecommunications/data outlets shall be installed where shown on the contract drawings. Raceways shall be installed as straight as possible and shall contain not more than the equivalent of three quarter bends.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations and sizes of pathways and outlets.

1.5 QUALITY ASSURANCE

A. Telephone Utility: Field verify.

B. Perform Work in accordance with telephone utility's rules and regulations.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish Products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

C. Shall conform to Coastal Carolina Community College Telecommunications Department Guidelines.

D. Shall conform to North Carolina STS-1000 Telecommunications Guidelines, which can be downloaded from the web site https://files.nc.gov/ncdoa/documents/files/STS1000_ITS.pdf /

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS OUTLETS

Outlets shall consist of standard, square cornered boxes 4-11/16” wide by 4-11/16“ high by 2-1/8” deep, minimum, flush mounted at the height indicated on the contract drawings. Provide a single gang plaster ring for the square cornered boxes 4-11/16” wide by 4-11/16“ high by 2-1/8” deep.

2.2 TELECOM WIRE AND CABLE

All telephone, data and fiber cable shall be furnished and installed by the contractor. See Section 271500.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Finish paint termination backboards with durable white enamel under the provisions of Division 9 prior to installation of equipment.

B. Support raceways and backboards under the provisions of Section 260529.

C. Install termination backboards plumb, and attach securely to building wall at each corner.

D. Install #14 gauge steel or approved, 200 lb. nylon cord pull wire in each empty conduit run. The maximum bends between pull points shall be 180 degrees.

E. The maximum distance between pull boxes shall be 100 feet.

END OF SECTION 270510

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Ladder cable trays.
2. Wire-basket cable trays.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

2.2 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. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.3 LADDER CABLE TRAYS

A. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 6 inches (150 mm) o.c.
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
7. Minimum Usable Load Depth: 6 inches (150 mm).
8. Straight Section Lengths: 10 feet (3 m except where shorter lengths are required to facilitate tray assembly.
9. 18 inches (450 mm), 24 inches (600 mm) unless otherwise indicated on Drawings.
10. Class Designation: Comply with NEMA VE 1, Class 12B.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
13. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.4 WIRE-BASKET CABLE TRAYS

A. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Materials: High-strength-steel longitudinal wires with no bends.
3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:

a. Straight sections shall be furnished in standard 118-inch (3000-mm) lengths.
b. Wire-Basket Depth: 6-inch (150-mm) usable loading depth by 18 inches (450 mm), 24 inches (600 mm) wide (See drawings for sizes and locations).

5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

2.5 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
4. Finish: Mill galvanized before fabrication.

a. Hardware: Chromium-zinc plated, ASTM F 1136.

2.6 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes 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.

2.7 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA FG 1.

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. Fasten cable tray supports to building structure.

D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

E. Support wire-basket cable trays with trapeze hangers.

F. Support trapeze hangers for wire-basket trays with 1/4-inch- (6-mm-) diameter rods.

G. 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.

H. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.

I. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

J. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

K. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

L. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

M. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, 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 the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, 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 missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

END OF SECTION 270526

SECTION 271500 - DATA COMMUNICATIONS CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

Section includes termination devices, racks, and premises wiring for telephone and data communication circuits by certified manufacturers and contract installers with certification and testing of all equipment and cabling.

A. Shall conform to Coastal Carolina Community College Telecommunications Department Guidelines.

B. Shall conform to North Carolina STS-1000 Telecommunications Guidelines, which can be downloaded from the web site https://files.nc.gov/ncdoa/documents/files/STS1000_ITS.pdf /

1.2 REFERENCES

The State of North Carolina expects and enforces strict adherence to the latest published versions of the following codes and standards:

1. Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Final Guidelines (July 1991) – 36 CFR Part 1191
2. Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – TIA / EIA526 -7 (OFSTP-7)
3. Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – TIA / EIA-526 - 14 (OFSTP-14A)
4. Commercial Building Telecommunications Wiring Standard – TIA / EIA-568 - B.1
5. Commercial Building Telecommunications Wiring Standard – TIA / EIA-568 - B.2
6. Commercial Building Telecommunications Wiring Standard – TIA / EIA-568 - B.3
7. Telecommunications Pathways and Spaces – TIA / EIA - 569
8. Residential Telecommunications Cabling Standard – TIA / EIA - 570
9. Optical Fiber Cable Color Coding – TIA / EIA - 598
10. Administration Standard for the Telecommunications Infrastructure of Commercial Buildings – ANSI / TIA / EIA-606
11. Commercial Building Grounding and Bonding Requirements for Telecommunications – TIA / EIA - 607
12. Customer-Owned Outside Plant Telecommunications Standard – TIA / EIA -758
13. Detail Specification for 62.5-µm Core Diameter / 125-µm Class 1a Multimode Graded Index Optical Waveguide Fibers – TIA / EIA - 492AAAA
14. Generic Requirements for Optical Fiber and Optical Fiber Cable – Bellcore TR-TSY-000020
15. National Electrical Code (NEC) Articles 600, 700 & 800
16. National Fire Protection Association (NFPA) NFPA - 71, - 72, - 75, - 780.
17. BICSI - Telecommunications Distribution Methods Manual (Newest Edition) Building Industry Consulting Service International
18. BICSI - Customer-Owned Outside Plant Design Manual (Newest Edition) Building Industry Consulting Service International
19. Customer –Owned Outside Plant Telecommunications Cabling Standard TIA / EIA –758 –

1.3 SYSTEM DESCRIPTION

A. Provide, ready for operation, a complete and operational communication network infrastructure system that is a manufacturer certified 250 MHz, Cat 6A system.

B. The system shall include, but not be limited to, cabling (copper and fiber optic), modules, patch panels, faceplates, connectors, hardware, accessories, connections, and all other material, labor and operations required for a complete system in this building.

C. Cabling shall be installed in raceways and/or on a cable support structure as shown on the Drawings. Raceways for cabling shall be installed in compliance with Section 260553. Cable support structure shall be as specified hereinafter.

D. The horizontal wiring shall consist of the wiring from the telecommunication room(s) to the information services outlet. (The horizontal wiring includes the wiring termination components in the telecommunication room(s), the horizontal wiring itself, and the termination components at the outlet).

E. Backbone cabling shall consist of fiber and copper cables to connect data services as required and shown on the Drawings.

F. Horizontal Wiring for Data and Telephone: Unless indicated otherwise on the Drawings, the normal connections requirements to a standard four position telecommunication outlet are two (2) data cables to each outlet. The two data cables shall terminate at the telecommunications room rack designated for data on the manufacturers end-to-end termination Cat 6A hardware.

G. The system shall be compliant with the Owner's long range strategic development plan to provide for current and future data requirements by a planned end-to-end manufacturer's system, while recognizing the need for future bandwidth and fault tolerance. The proposed system shall utilize a network of fiber optic and unshielded twisted pair (UTP), riser, tie and station cables. Fiber cables shall terminate on Fiber Distribution Centers and/or modular patch panels as shown on the Drawings. Cables and terminations shall be identified at all locations and cables shall terminate in an alphanumeric sequence at all termination locations. The complete system shall be fully standards compliant. Copper and Fiber Optic drops shall be warranted to the link performance as defined by ANSI/TIA-568-C standards. All UTP end-to-end Channel Configurations as defined by ANSI/TIA 568B-1,2,3 shall be provided by a single manufacturer.

1.4 SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Product Data: Submit catalog data for each termination device, cable, rack, etc.

C. Test Reports: Indicate procedures and results for specified field testing and inspection.

D. Reference paragraph 1.7 B below, submit copies of all BICSI RCDD certifications together with picture identification and itemized list of technicians and installers.

1.5 CLOSEOUT SUBMITTALS

A. Submit under provisions of relevant sections of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Project Record Documents: Record actual locations and sizes of pathways and outlets.

C. Provide a certificate of completion of the installation with verifications that each copper cable pair has been tested to a minimum of 250 MHz.

D. Provide a certificate of completion of the installation with verifications that each fiber optic cable has been tested to industry standards.

E. Provide a Certified Installation Warranty Certificate.

F. Provide Test results for each cable and outlet.

G. Provide marked up Drawings showing additions, deletions, and modifications also identifying cable routings.

H. Provide electronic copies of marked up final Drawings.

I. Provide wall mounted copies of the final system Drawings in each telecommunications room.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer: Company specializing in installing products specified in this section with minimum five years documented experience on projects utilizing infrastructure work similar to that required for this project, and with service facilities within 150 miles of project.

1. The Installer shall be an experienced firm regularly engaged in the layout and the installation of cabling infrastructure systems. Documentation shall be provided to show that the Contractor has successfully completed projects of similar size and scope within the previous twelve months.
2. The Installer shall be manufacturer certified and shall have a current valid certification card.
3. The Telecommunication Project Manager shall:

a. be certified as BICSI RCDD
b. be experienced in this type of project and provide technical support.
c. attend monthly progress meetings and additional meetings as scheduled or required.
d. In addition to having the appropriate manufacturer certifications, the installing work force shall wear visible identification badges at the project site showing name, current photograph and company name.

C. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

D. The Manufacturer and Installation Contractor shall also note the requirements of Paragraph 2.1 below.

1.7 PRE-INSTALLATION MEETING

Convene minimum one week prior to commencing Work of this section.

1.8 REGULATORY REQUIREMENTS

C. Conform to requirements of NFPA 70.

D. Furnish Products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

E. Shall conform to CCCC Campus Telecommunications Department Guidelines.

F. Shall conform to North Carolina STS-1000 Telecommunications Guidelines, which can be downloaded from the web site http://www.its.state.nc.us/

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. AMP NETCONNECT CAT 6A AND THE CORNING CABLE SYSTEMS LANscape.: Contractor shall be a registered and certified designer and installer.

Note: The Corning solution requires the installers to be a current EWP.

2.2 DATA RELAY RACK FRAMES

A. Product Description: Standard 19" equipment and cable management rack assembly, floor mounted, aluminum, and having double sided wide vertical cabling section. Racks by Chatsworth and Middle Atlantic or equal are acceptable. Secure to floor and wall with manufacturer's recommended hardware and accessories, racks shall be connected to the electrical ground system in compliance with ANSI/TIA 607. Horizontal and vertical cable management panels shall be provided installed above and below each data patch panel to provide neat and orderly routing of patch cables. Cable management panels shall be sized to accommodate the maximum number of patch cables for the patch panels.

B. Data cables shall be terminated on AMP Cat 6A solution, mounted in 7' x 19" aluminum racks. A double sided vertical cable management unit with cover shall separate each rack. Reverse direction patch cords or NORDX solution patch cords shall be used to connect communication equipment.

C. Each rack shall have one electrical power strip mounted on the rear of one of the vertical organizers. The power strip shall have a minimum of six outlets and shall not be equipped with an on/off switch.

D. Each rack will also house a minimum of one (1) rack-mounted 20A rated, power strip with 6" stand-offs (black in color) equal to Chatsworth MOD. 66-16620-3MS.

2.3 DATA OUTLET JACKS, PATCH PANELS AND PATCH CABLES

A. Product Description: ANSI/TIA 568B Cat 6A compliant rack-mounted assembly or terminals and accessory patch cords, with adequate capacity for all active and 25% spare circuits.

B. PATCH CORDS

1. The provision of Patch cords shall be included in the project and provided by the data contractor for the rack end and the work area outlet(s).
2. The patch cords shall be provided to the networking communications department.
3. Installation of the patch cords shall be by CCCC Network Communications when the communications rooms have been accepted by the University and secured.
4. Work Area Outlet - Patch cords shall be provided for the work area outlet. The patch cord lengths shall be 50% 6 feet, 30% 10 feet, 20% 14 feet. Unless otherwise designated by the Network Communications Department, the quantity for the Work area outlets shall be for all Network communications data outlets throughout the facility.
5. Data Racks - Patch cords shall be provided for each data cable in the data rack(s) of all communications rooms. At the rack end the patch cords will be 100% 1 foot.
6. Wireless Access Point - Patch cords shall be provided for each wireless access point. The length shall be a minimum of 5 feet and the quantity is for each wireless access point. The patch cord for the rack end shall be included in the data cable count quantity at the rack.
7. Patch cords shall be from one supplier and match the end to end solution being installed for the project.
8. Patch cords shall be submitted for review.

C. Product Description: 8 pin modular jack (RJ45), Cat 6A compliant and conforming to ANSI/TIA 568 requirements for cable connectors for specific cable types. Wire per ANSI/TIA 568B pinout. Provide single gang plates with four (4) jack locations, configured for two (2) data. Each faceplate shall have designated label strips for the top and bottom at each face plate.

D. Jacks shall be as specified. All installers must be properly trained and certified by the manufacturer to install jacks according to manufacturer specifications.

Circuit	Jack	Color
Data	Cat 6A	White

Outlet Faceplates shall match those specified in Section 262726 and shall provide for four jacks.

2.4 INTERIOR CABLES

A. Network Data Cable shall be Cat 6A installed to the strict ANSI/TIA 568B-1,2,3/569 BICSI and NEC guidelines for the installation of Cat 6A cable, blue in color unless otherwise designated or required by environmental standards.

B. Cat 6 UTP, 4 Pair (High Performance) cables shall extend between station location and terminal consisting of 4 pair, 100 ohm, 24 or 23 AWG solid conductors, and terminating on 8 pin modular jacks provided at each outlet. Cable jacket shall comply with NEC Article 800 for use as a plenum or non-plenum cable. The 4 pair UTP cable shall be UL® and cUL® Listed Type CMP (plenum) or CMR (non-plenum), as required. The high performance Cat 6E UTP cable shall be of the traditional round design with or without flute. The high performance Cat 6 cable shall be shall be specified to 550 MHz and shall meet the guaranteed electrical performance and physical specifications as follows:

High Performance Category 6A cables Guaranteed electrical performance to 550 MHz:

Freq (MHz)	Attn DB/100m	Cat 6A Industry Standard (DB)	*Required* NEXT (DB)	Cat 6A Industry Standard (DB)	*Required* PS NEXT (DB)	CAT 6A Industry Standard (DB)	*Required* ELFEXT (DB)	CAT 6A Industry Standard (DB)	*Required* PS ELFEXT	CAT 6A Industry Standard (DB)	*Required* Return Loss	CAT 6A Industry Standard (DB)
0.772	1.6	≤ 1.8	76.0	≤ 76.0	74.0	≤ 74.0	70.0	≤ 70.0	67.0	≤ 67.0	‡	‡
1	1.8	≤ 2.0	74.3	≤ 74.3	72.3	≤ 72.3	67.8	≤ 67.8	64.8	≤ 64.8	20	20
4	3.6	≤ 3.8	65.3	≤ 65.3	63.3	≤ 63.3	55.7	≤ 55.7	52.7	≤ 52.7	23	23
8	5.1	≤ 5.4	60.8	≤ 60.8	58.8	≤ 58.8	49.7	≤ 49.7	46.7	≤ 46.7	24.5	24.5
10	5.8	≤ 6.0	59.3	≤ 59.3	57.3	≤ 57.3	47.8	≤ 47.8	44.8	≤ 44.8	25	25
16	7.3	≤ 7.6	56.3	≤ 56.3	54.3	≤ 54.3	43.7	≤ 43.7	40.7	≤ 40.7	25	25
20	8.2	≤ 8.5	54.8	≤ 54.8	52.8	≤ 52.8	41.7	≤ 41.7	38.7	≤ 38.7	25	25
25	9.2	≤ 9.6	53.3	≤ 53.3	51.3	≤ 51.3	39.8	≤ 39.8	36.8	≤ 36.8	24	24
31.25	10.4	≤ 10.7	51.9	≤ 51.9	49.9	≤ 49.9	37.9	≤ 37.9	34.9	≤ 34.9	24	24
62.5	15.0	≤ 15.5	47.4	≤ 47.4	45.4	≤ 45.4	31.8	≤ 31.8	28.8	≤ 28.8	22	22
100	19.3	≤ 19.9	44.3	≤ 44.3	42.3	≤ 42.3	27.8	≤ 27.8	24.8	≤ 24.8	20	20
200	28.3	≤ 29.2	39.8	≤ 39.8	37.8	≤ 37.8	21.7	≤ 21.7	18.7	≤ 18.7	18	18
250	32.1	≤ 33.0	38.3	≤ 38.3	36.3	≤ 36.3	19.8	≤ 19.8	16.8	≤ 16.8	17	17
300	35.6	‡	37.2	‡	35.2	‡	18.2	‡	15.2	‡	17	‡
350	38.9	‡	36.2	‡	34.2	‡	16.9	‡	13.9	‡	16	‡
400	42.0	‡	35.3	‡	33.3	‡	15.7	‡	12.7	‡	16	‡
450	45.0	‡	34.5	‡	32.5	‡	14.7	‡	11.7	‡	16	‡
500	47.9	‡	33.8	‡	31.8	‡	13.8	‡	10.8	‡	15	‡
550	50.6	‡	33.2	‡	31.2	‡	12.9	‡	9.9	‡	15	‡

‡ Not Specified

Testing is specified to 550 MHz. Cable manufacturer will have to provide the performance chart for their cable. Existing Systimax cable XL 7 series on campus meets the performance category listed.

2.5 EQUIPMENT ROOM (ER) AND TELECOMMUNICATION ROOM (TR)

A. The ER/TR(s) for each building shall provide for a transition between the horizontal and backbone pathways, and provide space for telecommunications components including cable terminations (horizontal and backbone), active and passive equipment, cross-connections cabling, and hardware, and any other materials or equipment associated with the building telecommunications, data and technology systems.

B. The walls of the ER/TR(s) for each building shall be covered in ¾ inch non- fire rated plywood void free and finished on one side, mounted horizontally 4 inches AFF. The non-fire rated plywood shall be painted, on all 6 sides, with at least two coats of fire resistant white paint. The final paint finish shall be clear of footprints, markings, etc and shall be a smooth finished product.

C. All ER/TR(s) shall be equipped with a grounding bus bar. A solid copper grounding bus bar, ¼ inch thick by 4 inches high, with compression fittings and stand off brackets with insulators will be required on the Telecommunications backboard. Bus bars will be connected by a backbone of insulated, solid copper. This backbone shall be connected to the main grounding bus bar in the electrical entrance facility that is tied back to the building's grounding system.

D. Data cables shall be routed into the ER/TR(s) through overhead ladder racking. The ladder racking shall be 18" minimum width. The data cables shall be terminated on the Amp Cat 6a solution; mounted in 7' x 19" aluminum racks. A doubled-sided vertical cable management unit with cover shall separate each rack. Reverse direction patch cords shall be used to connect communications equipment. Cat 6a cross connect is not permitted. Racks and ladder racking shall be properly anchored to the floor and grounded.

E. No electrical conduits, refrigerant pipes, water pipes or any type of wiring for non-related Network communications devices may be installed thru the overhead ceiling or the flooring of the MDF, IDF or Entrance Facility.

F. AV cabling shall not use the communications rooms: MDF, IDF, and entrance Facilities as a pathway due to legal and auditing problems. The AV cable for riser pathways shall use an AV dedicated pathway.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The project manager and crew shall be consistent through out the project. The project manager shall be present when any work is being performed. The project manager shall contact the Owner designated contact at the beginning and end of each day that work is to be performed.

B. Cable shall be installed and terminated per manufacturer's specifications. The installer will observe the cabling practices described in ANSI/TIA 568-B. Standard industry practices guided by the ANSI/NECA/BICSI568-2001 BICSI TDMM and BICSI installation manual shall be employed for cable installation, handling, grooming, etc. All cabling will be installed in a manner that will protect the cable from damage during installation, facilitate cable management and identification, and provide a neat and groomed appearance.

C. Install wire and cable in accordance with ANSI/TIA 568B.1,2,3 and ANSI/TIA 569A.

D. The maximum bends between pull points shall be 180 degrees.

E. The maximum distance between pull boxes shall be 100 feet.

F. If a continuous raceway system is not shown on the Drawings, all cabling not shown in raceway shall be supported with a cable support structure.

1. Cabling shall be installed in straight paths and exit pathways at ninety-degree angles. Diagonal, beeline and or non-supported cabling are unacceptable. Cabling shall be routed as high as possible and above other building facilities in the path with the least obstructions in the ceiling space while maintaining the separation requirements of ANSI/TIA 568B1,2,3, ANSI/TIA 569A and NFPA 70 (NEC). There shall be a minimum distance of 3 inches between the cable and ceiling grid and cable pathways shall be clear of all possible EMF and RFI interference. Specifically cables shall be at least 2 feet away from all fluorescent lights and other potential EMF sources. Any violations of this shall be corrected at the contractor's expense. Cables shall not be run parallel with electrical conduits or strapped to them. The placing of cable ties shall not deform the cables.
2. The cable support structure shall utilize Cat 6a approved cable supports and be sized to accommodate change. J hook type cable supports shall be securely fastened to the building structure and be spaced at a maximum distance of four (4) feet so that sag between supports does not exceed 12 inches. J hooks shall be sized as follows: two inch J hooks rated for 75 cables and shall be used to support cable paths of 50 or less cables, four inch J hooks rated for 150 cables and shall be used to support cable paths of 51 to 100 cables. All cable paths shall be sized with 20% spare capacity. All attachment hardware shall be approved for the type of installation and maximum load rating of the products to be installed.

G. All penetrations through walls and floors shall be sleeved. All sleeves shall have permanently attached bushings. Sleeves shall be sized to accept 50% growth. All sleeves shall be fire-stopped using UL® approved methods and shall maintain assembly fire ratings. All sleeves between floors shall be supported with a conduit riser clamp installed per the manufacturer direction and shall be installed tight to the ceiling with enough sleeve to attach the bushing and rise up three inches above the floor on the opposite end.

H. Existing sleeves and wall penetrations may be used provided no sleeve exceeds a 40 percent fill ratio. If using an existing sleeve, it shall have a permanently attached bushing, the contractor shall protect all existing cables and be responsible for any damage to existing cables. All existing sleeves and penetrations shall be firestopped and meet state and local codes at the completion of the installation.

I. The horizontal cables shall be bundled in the ladder tray using Velcro cable ties. Plastic ty-wraps are not permitted. All cable shall be installed according to ANSI/TIA 568B-1, 2, 3 /569A standards.

J. Cross-connect fields: 110 type IDC connecting clips shall be installed for every installed cable pair. Horizontal station cable shall have 12 inches spare cable at the station outlet and 10 feet of spare at each rack. Cat 6a power sum cables and fiber riser cable shall have 10 feet spare at each rack. Outside plant Cat 3 cables shall have 8 feet spare at each protector block. Cat 6a power sum cables from building protector blocks shall have 10 feet spare at protector blocks. Fiber cables terminating into the building shall have a 20-feet service loop at the data rack. For inter-building cable ducts a slack loop of one full circle shall be arranged in each manhole

K. All cable shall be installed in a complete, neat and orderly fashion. Install cable with sufficient bending radius as not to kink, shear or damage binders. Bend radius shall meet manufacturer=s specifications for horizontal cable, fiber-optic cable, inter- and intra-building cable and copper inter- and intra- building cable. Cables shall be groomed, such that cables to be terminated on the left side of the patch panels are routed down the left side of the rack, and cables to be terminated on the right side of the patch panels are to be routed down the right side of the rack.

L. Terminate all data and telephone cables at outlet devices. Terminate data cables on specified rack designated by the manufacturer's end-to-end solution equipment. Terminate telephone cables on specified rack using manufacturer's end-to-end solution for Cat 6a.

M. Rigid conduit or surface mounted raceway as indicated on the plans and specifications shall be used for all drops, flex hose shall not be used. If conditions DO NOT provide for conduit or surface mounted raceway to be used, the Contractor shall coordinate with the Owner's Connectivity Department for permission to use alternate raceway.

N. Install pullwire in each empty telephone or data conduit.

O. Ground and bond pathways, cable shields, racks and equipment under the provisions of ANSI/TIA - 607 - Commercial Building Grounding/Bonding Requirements.

P. Each end of all Cat 6a cable shall be labeled at approximately 3 to 6 inches from the Network Data jack, CATV, and campus wide systems with a printed cable label. Labeling for the faceplate and block terminations shall be provided by the contractor with consultation from the Owner. All labeling shall comply with the ANSI/TIA–606A standard. The ER/TR labeling nomenclature shall match that of the station outlet (SO) identifier as listed below:

1. Rack- mounted 110-block labeling: Each 110 block position (each 4-pair connector clip) shall be labeled as follows: Standard SO's/ wall phones outlets FVXX- where FVXX is the SO identifier where the Cat 6a cable on that connector clip terminates.
2. Modular patch panel labeling: Each panel shall be labeled. Each modular jack panel position shall be labeled as XXX where XXX matches the SO identifier. The patch panel shall have a label placed on the upper left hand corner of the panel face identifying the panel.

Q. All labels for the labeling shall be printed using a computer, printer or Brother P-Touch labeler with TZ tape or equivalent. Labels shall not be hand written. Labels shall be different colors as detailed for identification per the 606A standard. The contractor shall meet with the Owner and verify the numbering schemes and label coloring.

R. The general numbering sequence shall conform to a sequential numbering pattern common to all floors of the facility. All cables shall be numbered sequentially from room to room as closely as possible. The final numbering scheme shall be agreed upon between the selected vendor and the building owner prior to the start of the physical installation.

S. Station outlet labeling shall follow Patch panel Letter followed by patch number. EX: A1-48, B1-48, C1-48. Patch panel A, port 1; Patch panel B, port 1, etc.

T. ANSI/TIA 606 Administration standards for the Telecommunications Infrastructure of

Commercial Buildings is incorporated by reference. Compliance shall be maintained. Each cable record shall indicate the cable type by manufacturer and manufacturer's designation and shall document every pair/conductor in the cable. The cable identifier shall be linked to all pathways in which it runs.

U. Each piece of termination hardware such as a patch panel or wiring block shall have an unique named and label. Termination positions on cross-connect shall be identified by type (the pair /conductor terminated and a user code). For each element in the route, identification labels shall be completed and attached. Labels shall meet the requirements of UL969® Standard for Marking and Labeling Systems. A final report shall record system configuration, unique identifier, fiber labels, pathways and as-built details and as-built drawings. Loss Measurements and OTDR traces shall also be included with the records. Color coding to match UL606® requirements.

Cable numbering shall follow the example:

Example: CABLE D.5.2.013
D=DATA
5=TELECOMMUNICATIONS ROOM NUMBER
2=FLOOR NUMBER
013=13TH CABLE TO BE INSTALLED

V. All WAPS locations shall be labeled utilizing above methods. All concealed locations shall have a green dot with label. Coordinate green dot and labeling with owner.

W. All cables shall be installed according to ANSI/TIA 568B-1,2,3 /569A standards. Care shall be taken during the installation to prevent nicks, abrasions, burning and scuffing of the cable. Cables found to be damaged will be replaced at the contractor's expense regardless of whether the cable passes Cat 6a Level III testing standards.

3.2 TESTING

A. Horizontal Cable Testing:

1. Each equipment telecommunications room patch cord, patch panel, horizontal cable, RJ 45 jack, station patch cord shall be tested end-to-end for compliance with Cat 6a level III parameters as stated in the ANSI/TIA 568 B1, 2, 3/ 569 standards. Only certified Cat 6a cable testing shall be used. The Test equipment used for horizontal Cat 6 cable tests shall be in compliance with the industry standard Cat 6a cable testers level III, and comply with ANSI/TIA test procedures. Each link shall be tested to ANSI/TIA 568-B.
2. Testing of all copper wiring shall be performed prior to system cutover. 100 percent of the horizontal and riser wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage. Data horizontal wiring pairs shall be tested from the information outlet to the TR. Cat 6a cable runs shall be tested for conformance to the specifications of EIA/TIA 568B Annex D.
3. Testing shall be accomplished using a ANSI/TIA TSB-67 UL® Certified Level II-E test set. Test shall include length, mutual capacitance, characteristic impedance, attenuation, and near-end and far-end cross talk and ELFEXT.
4. The contractor, at no charge to the Owner, shall bring any pairs not meeting the requirements of the standard into compliance.
5. Complete, end-to-end test results shall be submitted to the Owner. AMP testing shall follow the same procedure and use the Permanent link test to meet AMP

requirements.

6. All cable pairs must be tested for the following conditions in conjunction with or in addition to all ANSI/TIA 568b Cat 6a testing requirements: Polarity, Reversal of pairs, Wire transpositions, Continuity, Opens, Shorts.

B. Fiber Optic Testing:

1. Each 62.5 OR 50/125-micron fiber shall be tested patch panel to patch panel at the 850 and 1300 nm wavelength in both directions using a light meter. Each single mode fiber shall be tested patch panel to patch panel at the 1310 and 1550 nm wavelength using a light meter. The maximum total attenuation for any single fiber between patch panels shall not exceed 3.0 dB.
2. Power meter tests, for building risers, shall be accomplished for length, attenuation, and micro bends, and for each individual fiber. Test results shall be provided for each individual fiber and maintained for inclusion into the documentation package.
3. Link attenuation does not include any active devices or passive devices other than cable connectors and splices.
4. A final report shall be complied that records system configuration, fiber labels, cable routes, and as-built details and as-built drawings.

C. A Certified Cat 6a cable tester, Level III, shall perform the certification test on all Cat 6a cables and adhere to ANSI/TIA-568B.

D. All test equipment shall be consistent throughout the installation. All test equipment shall be available for inspection by the Owner at any time. A valid and current calibration certificate traceable to the National Institute of Standards and Technology for any test equipment to be used shall be provided to the Owner.

E. Provide electronic copies only of the computer generated reports of the test results.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Inspect, test and certify all cabling and equipment and terminations as specified and in accordance with ANSI/TIA 568 B.

3.4 MANUFACTURER WARRANTY

A. Contractor shall provide a minimum Twenty Year cabling Extended Product Warranty and Application Assurance. The warranty shall support any performance claims the manufacturer makes over and above the Cat 6a standards stated herein.

B. A Warranty Statement shall be provided by the Manufacturer stating the period of the Warranty for all the products specified for the project, the name and address of the authorized manufacturer’s agent and also state who shall honor any and all Warranty claims.

C. Extended Product Warranty shall cover product defects for all passive manufactured channel components. Passive components are defined as those exhibiting no gain or contributing no energy. As from the date of a Registration Certificate the Manufacturer shall Warrant:

1. That the passive products that comprise the registered Channel solution shall be free from manufacturing defects in material or workmanship under normal and proper use;
2. That all channel approved passive cabling products that comprise the registered Channel solution exceed the specification of ANSI/TIA 568-B and exceed ISO/IEC 11801 standards and shall be equal to or exceed the performance specifications of the associated Communication product data sheet in effect at the time the Registration Certificate is issued;
3. That the installation shall meet the insertion and return loss, attenuation and near-end cross talk (NEXT) requirements of ANSI/TIA 568-B and the ISO/IEC 11801 standards for cabling links/channel configurations specified in these standards;
4. That each channel is exclusively comprised of a single manufacturer's solution in accordance with application standards;
5. This extended Product Warranty is applicable to the channel cabling solution products only on the original site of installation. Under the Extended Product Warranty, Manufacturer shall either repair or replace the defective product itself at Manufacturer's cost and, pay an Authorized Cable Installation Reseller for the cost of labor to repair or replace any such defective product on behalf of the Manufacturer; and
6. Corning Cable Systems LANscape solutions "landscape extended warranty" a 25-year warranty on complete fiber optic cabling solutions. The telecom contractor shall be an authorized Corning Cabling Systems extended warranty (EWP) installer

D. Application Assurance shall cover the failure of the channel structured cabling solution to operate the applications, which the Solution was designed to support, as well as additional application(s) defined below. Manufacturer shall warrant that the registered channel structured cabling solution shall be free from failures which prevent operation of the specific applications for which the original channel structured cabling solution was designed. The Application Assurance Program shall also cover the following additional applications:
1. Those identified in the current (at the time of installation) channel structured cabling solution performance specifications; and
2. In accordance with application standards specifications, any application introduced in the future by recognized standards or user forums that use ANSI/TIA 568-B or ISO/IEC 11801 components and link/channel specifications for cabling.

E. Other Warranties
1. Additional Warranty: The Contractor shall state any additional Contractor supplied warranty.
2. Self Install Warranty: The Cat 6a structured cabling manufacturers shall provide the Owner with a Self Install Warranty for all future moves, additions and changes to the end-to-end cabling solution provided for this project.

END OF SECTION 271500

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Fire Alarm work shall be defined by drawings numbered with the prefix "F-", the general provision of the Contract including General Conditions and Supplementary Conditions, Division 1 Specification sections, and Division-28 Electronic Safety and Security Specifications.

Engineer of Record for Division 28 is Jason P. Famiglietti, PE, CBHF Engineers, PLLC, 2246 Yaupon Drive, Wilmington, NC 28401.

END OF SECTION 280000

SECTION 283111A - EXISTING FIRE DETECTION AND ALARM SYSTEM EXTENSIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

Installation of new devices, new conductors, conduit and outlets, extensions/reconfiguration of the existing fire alarm system in the renovation area and recertification of the entire system.

1.2 This document substantially incorporates all of the relevant criteria contained in the "2020 SCO Fire Alarm Guidelines and Policies" as published by the Department of Administration, State Construction Office.

1.3 RELATED SECTIONS

A. Division 23 - Heating and Air Conditioning.

B. Section 260533 - Conduit.

C. Section 260519 - Building Wire and Cable.

D. Section 260534 - Boxes.

E. Section 260580 - Equipment Wiring Systems.

F. Section 260553 - Electrical Identification.

1.4 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 72 - National Fire Alarm Code.

C. NFPA 101 - Life Safety Code.

D. North Carolina State Building Code.

1.5 SYSTEM DESCRIPTION

The existing fire alarm system is a manual and automatic local fire alarm system with connections to a central station and includes a Notifier NFS-320 fire alarm control panel (FACP). The existing fire alarm control unit, auxiliary power supplies and dialer shall be expanded as required to accommodate the renovation area. Provide documentation verifying the capacity of the existing system and modifications required to accommodate the renovation area. All equipment supplied shall be listed for the purpose for which it is used, and installed in accordance with any instructions included in its listing. It shall also be new, with a full warranty (parts and labor) of at least one year from the date of final acceptance. The Contractor shall furnish all parts, materials, and labor required for a complete and operating system in accordance with all applicable requirements, even if each needed item is not specifically shown or described on the contract drawings or specifications.

1.6 SUBMITTALS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections. Please note also the requirements of Paragraph 3.2A below.

B. Shop Drawings: As a minimum, provide catalog cuts for all components and wiring/cable; control panel modules and configuration; system wiring diagram / floor plan showing each device and wiring connection required; wire types, sizes, numbers of conductors; transient protection devices; detailed battery capacity calculation and a description/sequence of system operation. Verify and coordinate all voltage, relay, contact, etc., requirements with other equipment before submitting shop drawings.

C. Product Data: Provide electrical characteristics and connection requirements.

D. The installing contractor's technicians shall, hold current (within previous 24 months) certifications issued by the manufacturer. These certifications shall be submitted to the engineer prior to installation showing name, photo identification, date of training and date of certification.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and commissioning of products.

F. Approval of samples, cut sheets, shop drawings, and other matter submitted by the Contractor shall not relieve the Contractor's responsibility for full compliance with the specifications, unless the attention of the Architect/Engineer is called to each non-complying feature by letter sent with the submitted matter, and authorization for the specific deviation is received from the Architect/Engineer in writing.

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Record actual locations of initiating devices, signaling appliances, and end-of-line devices.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Operation Data: Operating instructions.

C. Maintenance Data: Maintenance and repair procedures.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

B. Installer: Company specializing in installing the products specified in this section with minimum three years documented experience.

1.10 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70, NFPA 72, NFPA 101, and NC State Building Code.

B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.

C. Shop drawings must be submitted by the fire alarm contractor complying with the fire alarm plan review requirements policy of the local AHJ. These drawings may not constitute approval and may change after a full review by the local AHJ. A separate permit must be obtained prior to installation.

1.11 MAINTENANCE SERVICE

Furnish service and maintenance of fire alarm system for one year from Date of Substantial Completion.

1.12 EXTRA MATERIALS

A. Furnish as required under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Provide six keys of each type.

PART 2 - PRODUCTS

2.1 GENERAL

All materials utilized shall match existing materials and be fully compatible with the existing system. The Contractor shall furnish all parts, materials, and labor required for a complete and operating system in accordance with all applicable requirements, even if each needed item is not specifically shown or described on the contract drawings or specifications. The Contractor shall test the existing system prior to performing any work on the system and identify all defective components in writing to the Architect/Engineer. If none are identified, the existing equipment and devices will be considered operational and no extras will be considered for defective equipment and devices.

2.2 POWER SUPPLY

The existing FACP power supply and battery(ies) shall be modified or replaced as required to serve the modified system, and shall be adequate to serve existing and new control panel modules (if required), new initiating devices, relays, alarm signaling devices, etc. The battery-operated emergency power supply shall have a minimum capacity for operating system in standby mode for 24 hours followed by alarm mode for 5 minutes. A battery sizing calculation shall be submitted with the shop drawings. The battery manufacturer's battery discharge curve shall be used to determine the expected battery voltage after 24 hours of providing standby power. The calculated Notification Appliance Circuit current draw in the alarm mode shall be used to determine the expected voltage

drop at the end of the line (EOL). This calculation shall be based on conductor resistance per manufacturer's data sheet or NEC 2008, Table 8; with due allowance for the voltage drop in the system's power supply and the double length of the circuit conductors. The voltage drop at EOL shall not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. The resultant voltage shall not be less than the minimum listed operating voltage for the appropriate alarm notification appliance. The contractor shall use power outage testing to verify that the NAC circuit is compliant with design. Note if the contractor elects to provide additional remote power supplies, 120 VAC circuits required by the power supplies shall be provided by the contractor at no additional cost to the Owner.

2.3 INITIATING DEVICES

All devices shall match existing.

A. Manual Station: Semi-Flush mounted, analog/intelligent/addressable type, double action manual station without break-glass rod. Provide manufacturer's standard backbox.

B. Spot Heat Detector, low temperature (conditioned environments only): analog/intelligent/addressable, fixed temperature type with plug-in base, rated 135º F. (57º C.) and visual indication of detector actuation, suitable for mounting on 4 inch outlet box.

C. Spot Heat Detector, rate of rise (conditioned environments only): Analog/intelligent/addressable type, combination rate-of-rise and fixed temperature type with plug-in base, rated 135º F. (57º C.), and temperature rate of rise of 15º F. (8.3º C.) and visual indication of detector actuation, suitable for mounting on 4 inch outlet box.

D. Spot Heat Detector, low and high temperature as noted (unconditioned environments only): Conventional fixed temperature type with plug-in base, rated 135º F. (57º C.) or 190º F. (88º C.) and visual indication of detector actuation, suitable for mounting on 4 inch outlet box. Provide intelligent monitor module for each detector, mounted remote from the detector at 48" AFF.

E. Ceiling Mounted Smoke Detector: NFPA 72, analog/intelligent/addressable photoelectric, low profile type with separate plug-in base and visual indication of detector actuation, suitable for mounting on 4 inch outlet box.

F. Duct Mounted Smoke Detectors: NFPA 72, analog/intelligent/addressable photoelectric type with remote mounted key-operated NORMAL-RESET-TEST switch/alarm light, duct sampling tubes extending width of duct, and visual indication of detector actuation, in duct-mounted housing.

2.4 AUXILIARY DEVICES

All devices shall match existing.

A. Monitor Module. NFPA 72, addressable type with visual indication of module actuation, suitable for mounting in 4 inch outlet box.

B. Control Module. NFPA 72, addressable type with visual indication of module actuation, suitable for mounting in 4 inch outlet box.

C. Isolation Module. NFPA 72, with visual indication of module operation, suitable for mounting in 4 inch outlet box.

2.5 ALARM NOTIFICATION APPLIANCES

All appliances shall match existing.

A. Aural/Visual Device (horn): NFPA 72, flush type fire alarm electronic audible signal/strobe. Minimum sound rating: 87 dB at 10 feet (3M). Provide integral synchronized, strobe lamp and flasher with clear lens and red lettered "FIRE" on case. Provide strobe output as shown or as required by NFPA 72 and conditions. Install surface mounted devices using the manufacturer's surface mount backbox.

B. Visual Only Device: NFPA 72, flush type, synchronized, strobe lamp and flasher with clear lens and red lettered "FIRE" on case. Provide strobe output as shown or as required by NFPA 72 and conditions. Install surface mounted devices using the manufacturer's surface mount backbox.

C. Remote Annunciator: Modify the existing remote annunciator to accommodate the renovation area.

2.6 FIRE ALARM WIRE AND CABLE

A. Fire Alarm Power Branch Circuits: Building wire as specified in Section 260519. Wire shall be 12 AWG minimum, stranded copper THHN/THWN. All junction boxes that are visible or accessible shall be painted red, unless in finished areas. Conduits that penetrate outside walls or ceilings from conditioned space shall be effectively sealed to prevent condensation from infiltrating humid air.

B. Addressable loop (signaling line) circuits conductors shall match existing.

C. Indicating Appliance and Door Hold-open Device Circuits: Match existing. Minimum size: 2 C # 14 AWG for indicating appliance and control circuits. Use larger conductors as required by the manufacturer or for voltage drop compensation.

D. Provide fire alarm circuit conductors with insulation color coded to match existing installed. Color coding shall be maintained throughout the system, without color change in any wire run.

2.7 TERMINAL CABINETS

If additional terminal cabinets are required, they shall match existing, or shall be sheet steel, hinged cover type not less than 10" x 16" x 10" deep. Cabinets shall conform to Specs Section 260534 and shall be labeled in accordance with Specs Section 260553.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install manual station 48 inches above floor to top of device, and audible and visual signal devices 80 inches above floor to bottom of lens, unless required otherwise by local codes or the ADA.

C. Set visual signal device intensities for compliance with the ADA.

D. Install wiring in metallic conduit where exposed.

E. There shall be NO splices in the system other than at terminal blocks. "Wire nuts" and crimp splices will NOT be permitted. Permanent wire markers shall be used to identify all splices and terminations for each circuit. For splices, use markers or other means to indicate which conductor leads to the FACP. All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type.

F. Automatic Detector Installation: Conform to NFPA 72.

G. All isolation modules shall be clearly labeled, readily accessible for convenient inspection, and shown on the as-built drawings.

H. Addressable interface modules (used for all contact type initiating devices) shall be located in a conditioned environment which does not exceed listing test parameters.

I. Final programming of the system shall include addressable device descriptions using final actual room names and numbers.

J. Identification of individual detectors is required by assigning each a unique number on the record drawings, as follows: (Zone#, Addressable Loop #, Device #). This number shall also be permanently mounted adjacent to the detector, or affixed to its base, so as to be readable standing on the floor below without having to remove the smoke detector. Labels shall be clear, laminated, adhesive backed, type with black print, label machine printed and shall be Brother, T&B or Casio. Lettering shall be approx. ½" high.

K. Smoke detector trouble contacts (if provided) shall be series-wired between the last alarm initiating device and the end-of-line (EOL) resistor/ capacitor.

L. All air duct/plenum detectors shall have a Remote Alarm Indicator Lamp (RAIL) and a keyed or magnet-operated Alarm Test switch, installed in the nearest corridor or public area and identified by an engraved label affixed to the wall or ceiling. They are not to be subject to alarm verification. These detectors shall also be installed in a manner that provides suitable, convenient access for required periodic cleaning and calibration.

M. Duct detector sampling tubes shall extend the full width of the duct. Those over 36 inches long shall be provided with far-end support. The preferred method for doing this is to have the tube go through the far side of the duct, with the point of penetration being tightly sealed to prevent air leakage around the tube. This facilitates smoke testing and tube cleaning.

N. Detection or alarm circuits shall not be included in raceways containing AC power or AC control wiring. Within the FACP, any 120vac control wiring (such as for HVAC shutdown), or other circuits with an externally supplied ac/dc voltage above the nominal 24 vdc system potential, shall be properly separated from other circuits. The enclosure must also have an appropriate warning label to alert service personnel to the potential hazard.

O. All system components including relays, transient suppressors, terminal strips, etc. shall be securely mounted by mechanical means. Adhesives are not permitted.

P. Spot type smoke detectors mounted within 12 feet of a walking surface shall have their built-in locking device activated. Detectors for open area use shall have a concealed locking device securing them to their base, to prevent unauthorized removal.

Q. Unless suitably protected against dust, paint, etc., detectors shall not be installed until the final construction clean-up is completed. Contaminated detectors shall be replaced.

R. All addressable loop controller circuits shall be Class "A" and shall have a minimum of 20% spare addresses for future use. "T" taps are not permitted. Alarm notification appliance circuits shall be Class B. The load connected to each circuit shall not exceed 80% of the rated module output and the coverage of each circuit shall not exceed three floors. To minimize the impact of a wiring fault on the system, isolation modules shall be provided as follows:

1. After each 20 devices/ control points on any addressable circuit.
2. For each addressable circuit extending outside the building walls.
3. In or immediately adjacent to the FACP, at each end of the addressable loop.
4. For loops covering more than one floor, an isolator shall be installed at terminal cabinets on each floor, with additional isolators on any floor with more than 20 addresses. Each isolator module shall be clearly labeled, readily accessible for convenient inspection (not above lay-in ceilings) and shown on the as-built drawings.

S. Notification Appliance Circuit booster ("ADA") power supplies, if required, shall be individually monitored for integrity and shall not be located above a ceiling, or in non-conditioned space. Provide spot smoke detectors within 15 feet of any NAC power supply.

T. Any 24vdc power circuits serving addressable control relays must also be monitored for integrity.

U. All junction boxes shall be painted red prior to pulling the wire. Those installed in finished areas are permitted to be painted outside to match the finish color.

3.2 PROGRAMMING, TESTING, AND CERTIFICATION

A. All connections to the FACP, and the system's programming, shall be done only by the manufacturer, or by an authorized distributor that stocks a full compliment of spare parts for the system. The technicians who do this shall be trained and individually certified by the manufacturer, for the FACP model being installed. Copies of their certifications shall be part of the contractor's submittal to the engineer, prior to installation. The submittal cannot be approved without this information.

B. Upon completion of the installation and its programming, the fire alarm technician shall test every alarm initiating device for proper response and indication, and all alarm notification appliances for effectiveness. Also, in coordination with the other building system contractors, all other system functions shall be verified, including (where applicable) elevator capture and the control of HVAC systems, door locks, pressurization fans, fire or smoke doors/ dampers/ shutters, etc. The Architect/Engineer shall be given advance notice of these tests, to permit them to be witnessed if desired.

C. **The existing system shall be reprogrammed for the new devices, tested and certified.** The contractor shall submit the following documentation to the Owner, through the Architect/Engineer, prior to the system acceptance inspection:
   1. Written verification that this Code-required 100% system test was done.
   2. NFPA 72 "Record of Completion" Form. Use only the referenced form, or an identical reprint. No substitutions are acceptable.
   3. The System Status and Programming Report shall be generated on the day of the system acceptance inspection.
   4. Reacceptance Testing: Test and recertify the existing fire alarm system per NFPA 7214.1 and Annex A 14.4. Provide written test results to the Architect/Engineer.

D. After completion of the described 100% system test and submission of the above documentation (Items 1, 2, 3 only), the contractor shall request the Architect/Engineer set up a system acceptance inspection. The system must operate for at least two days prior to this inspection

3.3 DOCUMENTATION AND OWNER TRAINING

A. The contractor shall provide to the Architect/Engineer two bound copies of the following technical information, for transmittal to the Owner:
   1. As-built wiring diagram showing all loop numbers and device addresses in the system, plus equipment terminal numbers
   2. Manufacturer's detailed maintenance requirements
   3. Technical literature on all control equipment, isolation modules, power supplies, alarm/ supervisory/signal initiating devices, alarm notification appliances, relays, etc.
   4. The as-built "calculations" sheet.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Test in accordance with NFPA 72, local fire department requirements and provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

3.5 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.

B. Include services of a manufacturer-certified technician to supervise installation, adjustments, final connections, and system testing. All connections at the FACP shall be made by the manufacturer's authorized and factory trained representative (rather than by the Electrical Contractor).

END OF SECTION 283111A