

Project Manual

Divisions 23 and 28

Volume 2

Chartiers Valley High School Kitchen Make-up Unit Replacement Chartiers Valley School District

Chartiers Valley School District
2030 Swallow Hill Road
Pittsburgh, PA 15017

HVAC Construction Contract Number – 20026 - 1
Electrical Construction Contract Number – 20026 - 2

T&W Project #20026
BDA Engineering, 200801
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VOLUME 2 (Divisions 23-28)

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SECTION 230000
MECHANICAL DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Removal of existing mechanical equipment, piping, wiring, and conduit in areas to be remodeled; removal of designated construction, dismantling, cutting and alterations for completion of work.
 2. Disposal of materials.
 3. Storage of removed materials.
 4. Identification of utilities.
 5. Salvaged items.
 6. Protection of items to remain as determined by Owner.
 7. Relocate existing equipment to accommodate construction.

1.02 SCOPE OF DEMOLITION WORK

- A. All existing mechanical systems not referenced to be demolished on the contract, and/or are not required to be demolished to facilitate new work, shall remain.

1.03 PROJECT DEMOLITION REQUIREMENTS

- A. Contractor shall be aware of project demolition requirements, relevant portions of which follow. Contractor shall be responsible for checking all project specifications for additional demolition requirements.
- B. Do not begin demolition work until authorization is received from the construction manager. The work under this contract shall be performed in a manner that maximizes salvage and recycling of materials. The work includes selective demolition, salvage of identified items and materials and removal of resulting rubbish and debris. Do not allow accumulations of demolition materials inside or outside the building. Remove rubbish and debris from the site daily, unless otherwise directed. Store materials that cannot be removed daily in areas approved by the developer. In the interest of occupational safety and health, perform the work in accordance with ANSI a10.6.
- C. Perform all work in a manner to preserve the existing system and to maintain the building internal temperature at 55 deg. F.
- D. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "contract clauses," conform to the safety requirements contained in ANSI a10.6.
- E. Furnish timely notification of demolition and deconstruction operations and renovation work to state, regional, and local authorities having jurisdiction
- F. Prevent the spread of dust and debris and avoid the creation of a nuisance or hazard in the building and the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Vacuum and dust the work area daily. Sweep pavements as often as necessary to control the spread of debris.
- G. Before beginning any demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the developer.

Repair or replace damaged items as approved by the engineer. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements and pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition, or removal work. Repairs, reinforcement, or structural replacement require approval by the architect prior to performing such work.

- H. Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.
- I. For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas.
- J. Maintain existing utilities indicated to stay in service and protect against damage during demolition operations. Prior to start of work, utilities serving each area of alteration or removal shall be shut off by qualified mechanics and disconnected and sealed.
- K. Before, during and after the demolition work the contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.
- L. The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- M. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Items to be relocated which are damaged by the contractor shall be repaired or replaced with new undamaged items as approved by the engineer.
- N. Prepare a demolition plan. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Identify components and materials to be salvaged for reuse or recycling with reference to specified existing facilities to be removed. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use. Coordinate with waste management plan. include statements affirming contractor inspection of the existing roof
- O. Deck and its suitability to perform as a safe working platform or if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the work. Provide procedures for safe conduct of the work in accordance with OSHA regulations. Plan shall be reviewed by developer prior to work beginning.
- P. Comply with the environmental protection agency (EPA) requirements.
- Q. Do not begin demolition work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.
- R. Remove existing utilities uncovered by work and terminate in a manner conforming to the local code covering the specific utility and approved by the engineer. When utility lines are encountered

that is not indicated on the drawings, the developer shall be notified prior to further work in that area.

- S. Except for contractor's salvaged items and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, shall become the property of the contractor and shall be removed from property. Title to materials resulting from demolition, and materials and equipment to be removed, is vested in the contractor upon approval by the developer of the contractor's demolition and removal procedures, and authorization by the developer to begin demolition work. The developer will not be responsible for the condition or loss of, or damage to, such property after contract award.
- T. Showing for sale or selling materials and equipment on site is prohibited.
- U. Remove and store materials and equipment as shown on plan to be reused or relocated to prevent damage, and store where indicated by developer.
- V. Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from demolition operations in accordance with all applicable federal, state and local regulations off the site. Remove and transport in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.
- W. Storage of removed materials on the project site is prohibited.
- X. Materials and equipment designated for reuse damaged during removal and salvage operations shall be restored as necessary to usable condition.
- Y. If during the demolition work any hazardous materials or unsafe conditions are uncovered or disturbed by the work, it shall be identified, protected, and guarded off from access to all persons. Contractor shall notify the developer if danger to the premises or personnel is eminent. All work shall stop in affected areas until unsafe conditions are resolved.

1.04 COORDINATION

- A. Per Division 1 Section 013100 - Coordination and Meetings.
- B. Conduct demolition to minimize interference with adjacent building areas.
- C. Coordinate demolition work with Owner and other contractors.
- D. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.
- E. Identify salvage items in cooperation with Owner.

PART 2 PRODUCTS

2.01 Not Used

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify wiring and equipment indicated to be demolished serve only abandoned facilities. Verify termination points for demolished services.

3.02 PREPARATION

- A. Erect and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.

3.03 DEMOLITION

- A. Remove exposed abandoned piping and equipment, including abandoned piping above accessible ceiling finishes. Cut piping flush with walls and floors, and patch surfaces.
- B. Remove piping, supports, hangers, and devices to avoid any interference with new installation.
- C. Disconnect mechanical systems in walls, floors, and ceilings not scheduled for reuse.
- D. Reconnect equipment being disturbed by renovation work and required for continuation of service to or nearest available panel.
- E. Disconnect or shut off service to areas where work is to be removed. Remove all items which are not part of final project.
- F. Remove, relocate, and extend existing installations to accommodate new construction.
- G. Repair adjacent construction and finished damaged during demolition and extension or work.
- H. Clean and repair existing equipment to remain or to be reinstalled.

3.04 SALVAGE ITEMS

- A. Remove and protect items indicated by Owner to be salvaged and turned over to their personnel. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed.
- B. R22 refrigerant shall be saved in a container appropriate for storage and turned over to Owner

3.05 CLEANING

- A. Per Division 1 Section 017700 - Project Closeout.
- B. Clean entire construction area after other construction is complete.
- C. Remove demolished materials as work progresses. Legally dispose.
- D. Keep workplace neat.

END OF SECTION

SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 53 - Identification for Electrical Systems.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.03 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.04 QUALIFICATIONS

- A. Per Division 1 Section 014500 - Quality Control.
- B. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- C. Testing Agency: Company specializing in testing products specified in this section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Per Division 1 Section 016000 - Materials and Equipment.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

- D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.01 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- B. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.
- C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
 - 1. Voltage: As indicated on Drawings.
 - 2. Service Factor: 1.25.
 - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
 - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 5. Insulation System: NEMA Class F.
 - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 - 9. Sound Power Levels: Conform to NEMA MG 1.
- D. Single Phase Motors:
 - 1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
 - 2. Voltage: 115 volts, single phase, 60 Hz.
- E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.02 THREE-PHASE MOTORS FURNISHED LOOSE

- A. Product Description: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds indicated.
- B. Voltage: Voltage: As indicated on Drawings.
- C. Service Factor: 1.25.
- D. Enclosure: Meet conditions of installation unless specific enclosure is specified or indicated.
- E. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- F. Insulation System: NEMA Class F.

- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
- I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- J. Sound Power Levels: Conform to NEMA MG 1.
- K. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.03 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.01 EXISTING WORK

- A. Disconnect and remove abandoned motors
- B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Clean and repair existing motors to remain or are to be reinstalled.

3.02 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors in accordance with motor manufacturer's requirements.
- B. Install engraved plastic nameplates in accordance with Section 260553.
- C. Ground and bond motors in accordance with Section 260526.

3.03 FIELD QUALITY CONTROL

- A. Per Division 1 Section 014500 - Quality Control and/or 017700 - Project Close-out.
- D. Inspect and test in accordance with NETA ATS, except Section 4.
- E. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

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SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Plug valves.
- B. Related Sections:
 - 1. Section 23 11 23 - Facility Natural-Gas Piping: Product and installation requirements for piping, piping specialties, and equipment used in natural gas piping systems.

1.02 REFERENCES

- A. ASTM International:
 - 1. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - 2. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - 3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.
- B. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
- C. Underwriters Laboratories Inc.:
 - 1. UL 842 - Valves for Flammable Fluids.

1.03 RELATED DOCUMENTS

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

1.04 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

- A. Per Division 1 Section 017700 - Project Closeout.
- B. Project Record Documents: Record actual locations of valves.
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1. 06 QUALITY ASSURANCE

- A. Per Division 1 Section 014500 - Quality Control.
- B. Perform Work in accordance with Municipality standard.

1. 07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience approved by manufacturer.

1. 08 PRE-INSTALLATION MEETINGS

- A. Per Division 1 Section 013100 - Coordination and Meetings.
- B. Convene minimum one week prior to commencing work of this section.

1. 09 DELIVERY, STORAGE, AND HANDLING

- A. Per Division 1 Section 016000 - Materials and Equipment.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1. 10 ENVIRONMENTAL REQUIREMENTS

- A. Per Division 1 Section 016000 - Materials and Equipment.
- B. Do not install valves underground when bedding is wet or frozen.

1. 11 WARRANTY

- A. Per Division 1 Section 017836 - Warranties.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1. 12 EXTRA MATERIALS

- A. Per Division 1 Section 014500 - Quality Control and/or 017700 - Project Close-out.
- B. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.02 PLUG VALVES

- A. Manufacturers:
 - 1. DeZURIK, Unit of SPX Corp.
 - 2. Flow Control Equipment, Inc.

3. Homestead Valve Model
 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
-
- B. 2 inches and Smaller: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
 - C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated.

PART 3 EXECUTION

1.01 EXAMINATION

- A. Division 1 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system is ready for valve installation.

1.02 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install valves with clearance for installation of insulation and allowing access.
- D. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- E. Refer to Section 23 05 03 for piping materials applying to various system types.

1.03 VALVE APPLICATIONS

- A. Install plug valves in natural gas systems for shut-off service.

END OF SECTION

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SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Tags.
 - 3. Stencils.
 - 4. Pipe markers.
 - 5. Ceiling tacks.
 - 6. Labels.
 - 7. Lockout devices.

1.02 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.03 RELATED DOCUMENTS

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

1.04 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.05 CLOSEOUT SUBMITTALS

- A. Per Division 1 Section 017700 - Project Closeout.
- B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.06 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.07 QUALIFICATIONS

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

- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
- 1.08 FIELD MEASUREMENTS
 - A. Verify field measurements prior to fabrication.
- 1.09 EXTRA MATERIALS
 - A. Per Division 1 Section 017700 - Project Closeout.

PART 2 PRODUCTS

- 2.01 NAMEPLATES
 - A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products
 - 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
 - B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- 2.02 TAGS
 - A. Plastic Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
 - 2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
 - B. Metal Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
 - 2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

- C. Information Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
 - 2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- D. Tag Chart: Typewritten letter size list of applied tags and location; plastic laminated.

2.03 STENCILS

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products
 - 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
 - 2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
 - 3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
 - 4. Ductwork and Equipment: 1-3/4 inches high letters.
- C. Stencil Paint: Paints, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.04 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Underground Pipe Markers:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
 - 2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.05 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products
 - 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. Description: Steel with 3/4 inch diameter color-coded head.

2.06 LABELS

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products
 - 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification.

2.07 LOCKOUT DEVICES

- A. Lockout Hasps:
 - 1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
- B. Valve Lockout Devices:
 - 1. Steel device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Apply stencil painting to cleaned and degreased surfaces following the paint manufacturer's recommendations.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- G. Identify control panels and major control components outside panels with plastic nameplates.
- H. Identify valves in main and branch piping with tags.

- I. Identify air terminal units and radiator valves with numbered tags.
- J. Tag automatic controls, instruments, and relays. Key to control schematic.
- K. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- L. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- M. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

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SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing adjusting, and balancing of air systems.
2. Measurement of final operating condition of HVAC systems.
3. Sound measurement of equipment operating conditions.
4. Vibration measurement of equipment operating conditions.

B. Related Sections:

1. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.02 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. Testing Adjusting and Balancing Bureau:

1. TABB - International Standards for Environmental Systems Balance.

1.03 REQUIREMENTS OF PERFORMANCE TESTING

A. Requirements of testing and demonstration described herein require a commitment from the installing contractor to participate in any/all activities required to demonstrate proper system performance.

B. HVAC performance testing process includes the following tasks:

1. Testing and startup of HVAC equipment and systems.
2. Equipment and system verification checks.
3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
4. Provide qualified personnel to assist in tests, including seasonal testing.
5. Complete functional performance test checklists to assure equipment and systems are fully operational and ready for functional performance testing.
6. Provide equipment, materials, and labor necessary to correct deficiencies found during process to fulfill contract and warranty requirements.
7. Provide operation and maintenance information and record drawings to Engineer for review verification and organization, prior to distribution.
8. Provide training for systems specified in this Section.

C. Equipment and Systems to Be Tested:

1. Rooftop Make Up Air units.

2. Rooftop Make Up Air unit duct systems.
- D. Perform seasonal function performance tests for equipment and systems as required.
- 1.04 SUBMITTALS
- A. Per Division 1 Section 013300 - Submittals.
 - B. Prior to commencing Work, submit proof of latest calibration date of each instrument.
 - C. Test Reports: Indicate data on forms prepared following ASHRAE 111.
 - D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms.
 - F. Submit draft copies of report for review prior to final acceptance of Project.
 - G. Furnish reports in binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- 1.05 CLOSEOUT SUBMITTALS
- A. Per Division 1 Section 017700 - Project Closeout.
 - B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.
 - C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.
- 1.06 RESPONSIBILITIES
- A. Equipment or System Installer Responsibilities:
 1. Ensure temperature controls installer performs assigned responsibilities as specified below.
 2. Ensure testing, adjusting, and balancing agency performs assigned responsibilities as specified.
 3. Provide instructions and demonstrations for Owner's personnel.
 4. Ensure subcontractors perform assigned responsibilities.
 5. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
 6. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be tested.
 7. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be tested.
 8. Perform and document completed startup and system operational checkout procedures, providing copy to Engineer.
 9. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
 10. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.

11. Provide personnel to assist during equipment or system verification checks and/or functional performance tests.
12. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
13. Provide factory supervised startup services for equipment and systems specified in applicable Sections. Coordinate work with manufacturer.
14. Perform verification checks and startup on equipment and systems as specified.
15. Assist in performing functional performance tests on equipment and systems as specified.
16. Perform operation and maintenance training sessions.
17. Conduct HVAC system orientation and inspection.

B. Temperature Controls Installer Responsibilities:

1. Review design for ability of systems to be controlled including the following:
 - a. Confirm proper hardware requirements exists to perform functional performance testing.
 - b. Confirm proper safeties and interlocks are included in design.
 - c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
 - d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
 - e. Confirm sensors selected are within device ranges.
 - f. Review sequences of operation and obtain clarification from Architect/Engineer.
 - g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
 - h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
2. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
3. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Architect/Engineer.
4. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
5. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application.
6. Demonstrate system performance and operation during functional performance tests including each mode of operation.
7. Provide control system technician to assist during verification check and functional performance testing.
8. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
9. Assist in performing operation and maintenance training sessions.

C. Testing, Adjusting, and Balancing Agency Responsibilities:

1. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 10 percent of measurements contained in testing, adjusting, and balancing report.
2. Assist in performing operation and maintenance training sessions.

1.07 SCHEDULING

A. Per Division 1 Section 013100 - Coordination and Meetings.

B. Prepare schedule indicating anticipated start dates for the following:

1. Equipment and system startups.
2. Automatic temperature control system checkout.

3. Testing, adjusting, and balancing.
 4. HVAC system orientation and inspections.
 5. Operation and maintenance manual submittals.
 6. Training sessions.
- C. Schedule seasonal tests of equipment and systems during peak weather conditions to observe full-load performance.
 - D. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.
1. 08 COORDINATION
- A. Per Division 1 Section 013100 - Coordination and Meetings.
 - B. Notify Engineer minimum of two weeks in advance of the following:
 1. Scheduled equipment and system startups.
 2. Scheduled automatic temperature control system checkout.
 3. Scheduled start of testing, adjusting, and balancing work.
 - C. Coordinate programming of automatic temperature control system with construction and testing schedules.
1. 09 QUALITY ASSURANCE
- A. Per Division 1 Section 014500 - Quality Control Perform Work in accordance with ASHRAE 111.
 - B. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.
1. 10 QUALIFICATIONS
- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC or NEBB..
1. 11 PRE-INSTALLATION MEETINGS
- A. Per Division 1 Section 013100 - Coordination and Meetings.
 - B. Convene minimum one week prior to commencing work of this section.
1. 12 SEQUENCING
- A. Per Division 1 Section 013100 - Coordination and Meetings.
 - B. Sequence balancing between completion of systems tested and Date of Substantial Completion.
1. 13 SCHEDULING
- A. Per Division 1 Section 013100 - Coordination and Meetings.

PART 2 - PRODUCTS

2.01 Not Used.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Per Division 1 Section 013100 - Coordination and Meetings.
- B. Verify systems are complete and operable before commencing work. Verify the following:
 1. Systems are started and operating in safe and normal condition.
 2. HVAC control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.

3.02 INSTALLATION

- A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required.
- B. Install test holes in ductwork and plenums for taking air measurements. Refer to Section 23 33 00.
- C. Prior to start of functional performance test, install replacement filters in equipment as specified in individual section.

3.03 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.04 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.05 ADJUSTING

- A. Per Division 1 Section 014500 - Quality Control and/or 017700 - Project Close-out.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck up to 10% of measured/tested points or areas as selected and witnessed by Owner in the presence of the Owner/Engineer at the Final Inspection.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air flow rate measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain:
 1. Space temperatures within 2 degrees F.
 2. Minimal objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches differential static pressure between spaces.

3.08 PERFORMANCE TESTING

- A. Seasonal Sensitive Functional Performance Tests:
 1. Test heating equipment at winter design temperatures.
 2. Test cooling equipment at summer design temperatures with fully occupied building.

3. Participate in testing delayed beyond Final Completion to test performance at peak seasonal conditions.
- B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.
- C. Occupancy Sensitive Functional Performance Tests:
1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
 2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

3.09 SCHEDULES

- A. Partial list of Equipment Requiring Testing, Adjusting, and Balancing:
1. Rooftop Make Up Air Units.
 2. Air Inlets and Outlets.
- B. Report Forms
1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
 5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM

- d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
6. Combustion Test:
- a. Manufacturer
 - b. Model number
 - c. Serial number
 - d. Firing rate
 - e. Overfire draft
 - f. Gas meter timing dial size
 - g. Gas meter time per revolution
 - h. Gas pressure at meter outlet
 - i. Gas flow rate
 - j. Heat input
 - k. Burner manifold gas pressure
 - l. Percent carbon monoxide (CO)
 - m. Percent carbon dioxide (CO₂)
 - n. Percent oxygen (O₂)
 - o. Percent excess air
 - p. Flue gas temperature at outlet
 - q. Ambient temperature
 - r. Net stack temperature
 - s. Percent stack loss
 - t. Percent combustion efficiency
 - u. Heat output
7. Cooling Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Saturated suction temperature, design and actual
 - k. Air pressure drop, design and actual
8. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
9. Duct Leak Test:
- a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size

- 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
10. Air Distribution Test Sheet:
- a. Room number/location
 - b. Outlet type
 - c. Outlet size
 - d. Area factor
 - e. Design velocity
 - f. Design air flow
 - g. Test (final) velocity
 - h. Test (final) air flow
 - i. Percent of design air flow

END OF SECTION

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SECTION 230700
HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. HVAC ductwork insulation, jackets, and accessories.

1.02 REFERENCES

- A. ASTM International:
1. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 2. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 3. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 4. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
 5. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 6. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
 7. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
 8. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- B. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- B. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.06 PRE-INSTALLATION MEETINGS

- A. Per Division 1 Section 013100 - Coordination and Meetings.
- B. Convene minimum one week prior to commencing work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Per Division 1 Section 016000 - Materials and Equipment.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Per Division 1 Section 016000 - Materials and Equipment.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Per Division 1 Section 017836 - Warranties.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Glass Fiber and Mineral Fiber Insulation
 - 1. Manufacturers:
 - a. Owens Corning
 - b. Manville Micro-Lok
 - c. Certainteed
 - d. Knauf
 - e. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. Closed Cell Elastomeric Insulation
 - 1. Manufacturers:

- a. Armstrong AP Armaflex
- b. Owens Corning
- c. Manville
- d. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.

2.05 DUCTWORK INSULATION

- A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
 1. Thermal Conductivity: 0.25 at 75 degrees F.
 2. Maximum Operating Temperature: 250 degrees F.
 3. Density: 1.5 pound per cubic foot.
- B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied all service facing meeting ASTM C1136, Type II.
 1. Thermal Conductivity: 0.24 at 75 degrees F.
 2. Density: 1.6 pound per cubic foot.

2.06 DUCTWORK INSULATION JACKETS

- A. Vapor Retarder Jacket:
 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
 3. Secure with pressure sensitive tape.
- B. Outdoor Duct Jacket: Asphalt impregnated and coated sheet, 50 lb/square.
- C. Membrane Duct Jacket: ASTM D4637; Type I, EPDM; non-reinforced, 0.060 inch thick, 48 inch wide roll; white color.

2.07 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- B. Vapor Retarder Lap Adhesive: Compatible with insulation.
- C. Adhesive: Waterproof, ASTM E162 fire-retardant type.
- D. Liner Fasteners: Galvanized steel, with integral head.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- H. Adhesives: Compatible with insulation.
- I. Membrane Adhesives: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Per Division 1 Section 014500 - Quality Control.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.03 INSTALLATION - DUCTWORK SYSTEMS

- A. Duct dimensions indicated on Drawings are finished inside dimensions.
- B. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. External Glass Fiber Duct Insulation:
 - 1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
 - 2. Secure insulation without vapor retarder with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 - 4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

3.04 SCHEDULES

- A. Ductwork Insulation Schedule:
 - 1. Supply Ducts - Externally Insulated, Installed Thickness:
 - a. Type: D-1 or D-2.
 - b. Thickness: 1.5 inches

END OF SECTION

SECTION 230993
SEQUENCE OF OPERATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes sequence of operation for systems applicable to the replacement Kitchen Makeup Air unit.
- B. Sequences are given as a reference to identify minimum existing sequence function to be maintained upon completion work. Any discrepancy or inconsistency shall be reported to the Engineer.
- C. Related Sections:
 - 1. Section 23 09 00 - HVAC Instrumentation and Controls: For equipment, devices, system components and software to implement sequences of operation.

1.02 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
 - 2. Submit flow diagrams for each control system, graphically depicting control logic.
 - 3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.03 CLOSEOUT SUBMITTALS

- A. Per Division 1 Section 017700 - Project Closeout.
- B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS

- A. Not Used.

PART 3 EXECUTION

3.01 SEQUENCE OF OPERATION – MUA-1 with existing Kitchen Hood Exhaust Fans EFs 1C, 2C, & 3C

- A. All setpoints shall be adjustable from the existing building BAS.
- B. Safeties:
 - 1. If the discharge air temperature falls below 40 deg. F, the unit will be stopped and the outdoor air damper will be closed to the outdoor air. The low limit thermostat must be manually reset to restart the unit.
 - 2. If smoke is sensed by the supply air smoke sensors, all other control functions shall be overridden and the supply and shall be off, the two position outdoor air damper

shall be closed, an alarm light in the unit control panel shall be activated, and a signal sent out to the building's Fire Alarm system. Smoke sensors shall be manually reset.

- C. All sequences are reversible except as noted.
- D. The existing controls serving the existing kitchen hoods shall be replaced with new manual start switches for each individual hood (total of (3)).
- E. MUA-1 shall be interlocked to operate whenever EF-1C, 2C, or 3C are energized.
- F. MUA-1 shall be energized and monitored from the existing BAS control interface. When energized, unit shall be controlled by manufacturer integrated controls with mode direction from the BAS as follows:
 - 1. MUA-1 shall operate through heating and cooling modes to maintain space temperature set point.
 - 2. MUA-1 supply fan shall be controlled via the space pressure sensor to maintain negative static pressure differential relative to the surrounding spaces of 0.05" (adjustable).
 - 3. If discharge air temperature falls below 50°F (adjustable) when in heating mode, the supply fan VFD shall be modulated to maintain the minimum discharge air temperature.
 - 4. Selection of priority between static pressure and supply temperature minimum shall be adjustable.
 - 5. Opposite season balancing shall be performed to confirm operations and settings.

END OF SECTION

SECTION 231123
FACILITY NATURAL GAS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Natural gas piping above grade.
2. Unions and flanges.
3. Strainers.
4. Natural gas pressure regulators.
5. Natural gas pressure relief valves.
6. Shutoff valves.

B. Related Sections:

1. Section 230523 - General-Duty Valves for HVAC Piping: Valves for gas piping systems.
2. Section 230553 - Identification for HVAC Piping and Equipment: Product requirements for valve and pipe identification for placement by this section.

1.02 RELATED SECTIONS

- A. All applicable Division 1 requirements shall apply to work covered in this section.

1.03 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
4. ASME B31.9 - Building Services Piping.
5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

- E. American Water Works Association:
 - 1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 67 - Butterfly Valves.
 - 3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 - 5. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

- G. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.

- H. Underwriters Laboratories Inc.:
 - 1. UL 842 - Valves for Flammable Fluids.

- 1.04 SYSTEM DESCRIPTION
 - A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
 - B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
 - C. Provide pipe hangers and supports in accordance with applicable sections of ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
 - D. Use plug valves for shut-off and to isolate equipment, part of systems, or vertical risers.

- 1.05 SUBMITTALS
 - A. Per Division 1 Section 013300 - Submittals.
 - B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 - 4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - 5. Strainers.
 - 6. Natural gas pressure regulators.
 - 7. Natural gas pressure relief valves.
 - C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

- D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- 1.06 CLOSEOUT SUBMITTALS
- A. Per Division 1 Section 017700 - Project Closeout.
 - B. Project Record Documents: Record actual locations of valves, piping system, and system components.
 - C. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.
- 1.07 QUALITY ASSURANCE
- A. Per Division 1 Section 014500 - Quality Control.
 - B. Perform natural gas Work in accordance with NFPA 54.
 - C. Perform work in accordance with local gas company requirements.
 - D. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
 - E. Perform Work in accordance with authority having jurisdiction for welding hanger and support attachments to building structure.
 - F. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.
- 1.08 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
- 1.09 DELIVERY, STORAGE, AND HANDLING
- A. Per Division 1 Section 016000 - Materials and Equipment.
 - B. Valves on site in shipping containers with labeling in place. Inspect for damage.
 - C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.
- 1.10 ENVIRONMENTAL REQUIREMENTS
- A. Per Division 1 Section 016000 - Materials and Equipment.
 - B. Do not install underground piping when bedding is wet or frozen.

1. 11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1. 12 WARRANTY

- A. Per Division 1 Section 017836 - Warranties.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1. 13 EXTRA MATERIALS

- A. Per Division 1 Section 016000 - Material and Equipment.
- B. Furnish two packing kits for each type and size valve.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.02 NATURAL GAS PIPING, FINAL CONNECTIONS ONLY

- B. Corrugated Stainless Steel Tubing: ANSI LC 1.

2.03 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Copper Piping: Class 150, bronze unions with brazed joints.
 - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
 - 2. Copper Piping: Class 150, slip-on bronze flanges.
 - 3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.04 STRAINERS

- A. Manufacturers:
 - 1. Mueller Steam Specialty
 - 2. O.C. Keckley Company
 - 3. Spirax Sarco, Inc.
 - 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

- C. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- D. 5 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.05 NATURAL GAS PRESSURE REGULATORS

- A. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 - 1. Temperatures: minus 20 degrees F to 150 degrees F.
 - 2. Body: Steel.
 - 3. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
 - 4. Disk, diaphragm, and O-ring: Nitrile.
 - 5. Maximum inlet pressure: 150 psig.
 - 6. Furnish sizes 2 inches and smaller with threaded ends.
 - 7. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.06 NATURAL GAS PRESSURE RELIEF VALVES

- A. Product Description: Spring loaded type relief valve.
 - 1. Body: Aluminum.
 - 2. Diaphragm: Nitrile.
 - 3. Orifice: Stainless steel.
 - 4. Maximum operating temperature: 150 degrees F.
 - 5. Inlet Connections: Threaded.
 - 6. Outlet or Vent Connection: Same size as inlet connection.

2.06 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- B. Cast Iron, Lubricated Plug Valves: MSS SP-78.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flowserve.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. McDonald, A. Y. Mfg. Company
 - d. Milliken Valve Company
 - e. Mueller Co.; Gas Products Division
 - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
 - 2. Body: Cast iron, complying with ASTM A 126, Class B.
 - 3. Plug: Bronze or nickel plated cast iron.
 - 4. Seat: Coated with thermoplastic.
 - 5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural gas service with "WOG" indicated on valve body.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install pipe hangers and supports in accordance with Section 22 05 29.

3.04 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.
- H. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.
- I. Provide clearance for installation of insulation and access to valves and fittings.
- J. Provide access where valves and fittings are not exposed.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- L. Provide support for utility meters in accordance with requirements of utility company.

- M. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
 - N. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting.
 - O. Install identification on piping systems including underground piping. Refer to Section 23 05 53.
 - P. Install valves with stems upright or horizontal, not inverted.
 - Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
 - R. Install medium pressure gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
 - S. Existing gas service shall be reused. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.
- 3.05 FIELD QUALITY CONTROL
- A. Per Division 1 Section 014500 - Quality Control and/or 017700 - Project Close-out.
 - B. Pressure test natural gas piping in accordance with NFPA 54.
 - C. Inspect, test and purge gas piping in accordance with local gas company requirements.
 - D. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

END OF SECTION

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SECTION 233100
HVAC DUCTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Duct Materials.
2. Transverse duct connection system.
3. Ductwork fabrication.
4. Duct cleaning.

B. Related Sections:

1. Section 233300 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.02 REFERENCES

A. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
4. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
9. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
10. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - Fibrous Glass Duct Construction Standards.
2. SMACNA - HVAC Air Duct Leakage Test Manual.
3. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:

1. UL 181 - Factory-Made Air Ducts and Connectors.

1. 03 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. 04 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1. 05 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than ¼ inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
 - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
 - 3. Fittings.
 - 4. Reinforcing details and spacing.
 - 5. Seam and joint construction details.
 - 6. Penetrations through fire rated and other walls.
 - 7. Terminal unit, coil, and humidifier installations.
 - 8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

1. 06 CLOSEOUT SUBMITTALS

- A. Per Division 1 Section 017700 - Project Closeout.
- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1. 07 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Construct ductwork to NFPA 90A standards.

1. 08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum years experience.
- B. Installer: Company specializing in performing Work of this section with minimum 5 years experience.

1. 09 PRE-INSTALLATION MEETINGS

- A. Per Division 1 Section 013100 - Coordination and Meetings.

1. 10 ENVIRONMENTAL REQUIREMENTS

- A. Per Division 1 Section 016000 - Materials and Equipment.
- B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- C. Maintain temperatures during and after installation of duct sealant.

1. 11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.
- B. Per Division 1 Section 014500 - Quality Control and/or 017700 - Project Close-out.

1. 12 WARRANTY

- A. Per Division 1 Section 017836 - Warranties.

PART 2 PRODUCTS

2.01 DUCT MATERIALS

- A. Manufacturers:
 - 1. McGill AirFlow Corporation
 - 2. Semco Incorporated
 - 3. Tangent Air Corp
 - 4. Spiral Mfg. Co., Inc.
 - 5. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.
- C. Galvanized Steel Ducts: ASTM A653/A653M.
- D. Fasteners: Rivets, bolts, or sheet metal screws.
- E. Hanger Rod: ASTM A36/A36M; steel; threaded both ends, threaded one end, or continuously threaded.

2.04 TRANSVERSE DUCT CONNECTION SYSTEM

- A. Product Description: SMACNA rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.05 DUCTWORK FABRICATION

- A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and as

indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

- C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Per Division 1 Section 013100 - Coordination and Meetings.
- B. Verify sizes of equipment connections before fabricating transitions.

3.02 INSTALLATION

- A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inch and smaller.
- D. Install duct hangers and supports in accordance with Section 23 05 29.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Connect flexible ducts to metal ducts with adhesive.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
- B. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- C. Connect air terminal units and air outlets and inlets to supply ducts directly or with five foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.04 CLEANING

- A. Per Division 1 Section 017700 - Project Closeout.
- B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- C. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
- D. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.

3.05 SCHEDULES

- A. Refer to drawings for Ductwork Pressure Class and Material Schedule.

END OF SECTION

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SECTION 233300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Duct access doors.
 - 2. Volume control dampers.
 - 3. Flexible duct connections.
 - 4. Duct test holes.
 - 5. Static pressure gages.

- B. Related Sections:
 - 1. Section 23 09 00 - Instrumentation and Control for HVAC: Execution and Product
 - 2. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
 - 3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.02 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

- B. ASTM International:
 - 1. ASTM E1 - Standard Specification for ASTM Thermometers.

- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 92A - Recommended Practice for Smoke-Control Systems.

- D. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 RELATED DOCUMENTS

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

1.04 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.

- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.

- C. Product Data: Submit data for shop fabricated assemblies and hardware used.

- D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
 - 1. Flexible duct connections.
 - 2. Volume control dampers.
 - 3. Duct access doors.

- 4. Duct test holes.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.05 CLOSEOUT SUBMITTALS
 - A. Per Division 1 Section 017700 - Project Closeout.
 - B. Project Record Documents: Record actual locations of access doors and test holes.
 - C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.
- 1.06 QUALITY ASSURANCE
 - A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
 - B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- 1.07 QUALIFICATIONS
 - A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- 1.08 DELIVERY, STORAGE, AND HANDLING
 - A. Per Division 1 Section 016000 - Materials and Equipment.
 - B. Protect dampers from damage to operating linkages and blades.
 - C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
 - D. Storage: Store materials in a dry area indoor, protected from damage.
 - E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.
- 1.09 FIELD MEASUREMENTS
 - A. Verify field measurements prior to fabrication.
- 1.10 COORDINATION
 - A. Per Division 1 Section 013100 - Coordination and Meetings.
 - B. Coordinate Work where appropriate with building control Work.
- 1.11 WARRANTY
 - A. Per Division 1 Section 017836 - Warranties.
- 1.12 EXTRA MATERIALS
 - A. Per Division 1 Section 014500 - Quality Control and/or 017700 - Project Close-out.

PART 2 PRODUCTS

2.02 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Greenheck
 - 2. Ruskin
 - 3. Carnes
 - 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less than 12 inches square, secure with sash locks.
 - 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
 - 3. Up to 24 x 48 inches: Three hinges and two compression latches .
 - 4. Larger Sizes: Furnish additional hinge.
 - 5. Access panels with sheet metal screw fasteners are not acceptable.

2.03 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Greenheck
 - 2. Ruskin
 - 3. Carnes
 - 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
- D. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings.
- E. Quadrants:
 - 1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.04 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Connector: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30oz per sq yd.
 - 2. Net Fabric Width: Approximately 2 inches wide.
 - 3. Metal: 3 inch wide, 24 gage galvanized steel.

2.05 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.06 STATIC PRESSURE GAGES

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

PART 3 EXECUTION

3.01 EXAMINATION

- A. Per Division 1 Section 014500 - Quality Control.
- B. Verify ducts and equipment installation are ready for accessories.
- C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.02 INSTALLATION.

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Access Doors: Install access doors at the following locations:
 - 1. Spaced every 50 feet of straight duct.
 - 2. Upstream of each elbow.
- C. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access. Install 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

3.03 DEMONSTRATION

- E. Per Division 1 Section 017700 - Project Closeout.
- F. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION

SECTION 238103
DEDICATED OUTDOOR AIR UNITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Dedicated outdoor air units.
 - 2. Roof curbs.
- B. Related Sections:
 - 1. Section 23 33 00 - Air Duct Accessories: Flexible connections.
 - 2. Section 26 05 03 - Equipment Wiring Connections: Electrical connection to units.

1.02 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - 2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 - 3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.
 - 3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
 - 2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.03 DEFINITIONS

- A. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.
- B. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling (in Btu) divided by total electric energy input during the same period (in Wh).

1.04 Per Division 1 Section 013300 - Submittals.

- A. Submit schedule for all types, sizes, and accessories. Schedule shall include certified performance data, room locations and all operating data.
- B. Submit shop drawings for all units including all dimensional information, construction details, installation details, required opening sizes, roughing locations for piping and electrical work and

accessory equipment. Equipment must meet specifications. Where deviations from the specifications exist, they must be identified.

- C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.
 - D. Include the following paragraph for submission of physical samples for selection of finish, color, texture, and other properties.
 - E. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
 - F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
 - G. Provide field wiring diagrams for all electrical power and temperature control field-wiring connections.
 - H. Submittals shall also include complete operating and maintenance instruction manuals and unit specific replacement parts lists.
- 1.05 CLOSEOUT SUBMITTALS
- A. Per Division 1 Section 017700 - Project Closeout.
 - B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.
 - C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- 1.06 QUALITY ASSURANCE
- A. Unit ventilators shall be listed by Underwriters Laboratories Inc. (U.L.) for the United States.
 - B. Motors shall conform to the latest applicable requirements of NEMA, IEEE, ANSI, and NEC standards.
 - C. Unit ventilation rate to be certified and tested per Air Conditioning and Refrigeration Institute (ARI) standard 840.
 - D. Unit to be certified and labeled compliant with the seismic design provisions of the International Building Code (IBC) Chapter 16 and independent test agency requirements of Chapter 17.
- 1.07 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
 - B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.
- 1.08 PRE-INSTALLATION MEETINGS
- A. Per Division 1 Section 013100 - Coordination and Meetings.

- B. Convene minimum one week prior to commencing work of this section.
- 1.09 DELIVERY, STORAGE, AND HANDLING
- A. Per Division 1 Section 016000 - Materials and Equipment.
 - B. Accept units on site in factory packing. Inspect for damage. Store under roof.
 - C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.
- 1.10 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.
 - B. Verify field-required side panels and other options/accessories for complete installation.
- 1.11 WARRANTY
- A. Per Division 1 Section 017836 - Warranties.
 - B. Provide 10-year (non-prorated) parts warranty covering the entire unit when accompanied by a company provided service plan. 5-year (non-prorated) parts warranty covering the entire unit otherwise.
 - C. 25-year (non-prorated) parts warranty for SS heat exchanger on indirect fired units.
- 1.12 EXTRA MATERIALS
- A. Per Division 1 Section 017700 - Project Closeout.
 - B. Furnish one set of filters and fan belts for each unit.
- PART 2 PRODUCTS
- 2.01 DEDICATED OUTDOOR AIR UNITS (MUA-1)
- A. Manufacturers:
 1. Basis of Design: Captive Aire Paragon.
 2. AAON (in accordance with 5.b. & 5.c.)
 3. McQuay (in accordance with 5.b. & 5.c.)
 4. Substitutions: Per Division 1 Section 016000 - Materials and Equipment
 - a. With prior approval only.
 - b. Submit detailed listing of all variations in anticipated delivery date, form, fit, or function, in addition to specified submittal data for approval before bidding.
 - c. If Bidder submits manufacturer other than basis of design, then Contractor shall be responsible for modifications to roof curb, electrical service, structural support, gas piping, and associated controls.
 - B. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, cabinet, supply fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, gas-fired heating section, air filters, dampers, controls, and accessories.
 - C. Configuration: Downflow air delivery or horizontal air delivery, as indicated on drawings.

- D. Roof Mounting Curb: 24 inch high, 16 gauge galvanized steel, channel frame with supply gasket, nailer strips. Full perimeter type for mounting under entire unit. Curb shall be fully insulated with 1" acoustical and thermal insulation.
- E. Roof Mounting Curb for replacement units as noted: curb adaptor as required to set replacement unit on existing curb.
- F. Provide factory startup service by manufacturer.
- G. MAU-1
 - 1. Designed for outdoor installation with weatherproof construction.
 - 2. Unit furnished and installed shall be gas/electric packaged makeup air rooftop as scheduled on contract documents and these specifications. Cooling performance shall be based on AHRI testing procedures. Wiring internal to the unit shall be numbered for simplified identification. Units shall be cULus listed and labeled, classified in accordance with cULus for Central Cooling Air Conditioners. Unit(s) shall be factory assembled, internally wired, fully charged and consist of insulated weathertight casing with compressors, air cooled condenser coil, condenser fans, evaporator coil, filters, supply motor and drive, unit controls, gas heat.
 - 3. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.
 - 4. Cabinet
 - a. Unit shall be constructed of minimum 20 ga. G-90 galvanized steel riveted together via structural pop-rivets. All metal shall be CNC bent for precise assembly.
 - b. Roof Construction shall be fabricated by forming a double-standing, self locking seam that requires no additional support. Roof shall be pitched to allow for proper drainage.
 - c. All exterior walls shall consist of a double wall, G-90 galvanized steel construction insulated with 2" thick, R13 closed cell foam.
 - d. All door jambs shall be gasketed around their perimeter, and allow for doors to be mounted via removable, spring actuated, stainless steel hinges with stainless steel rivets, and self-compressing latches. Each compartment shall have removable access panels to allow for ease of service and maintainability. Electrical cabinet access doors shall have a door hold installed to proper doors open. All doors shall have stainless steel latches which are pad lockable. Electrical cabinet doors shall be outfitted with schematic/manual pouches formed into the door, along with wiring diagram attached to the interior of the door from the factory.
 - 5. Electrical Power and Controls Connections
 - a. All controls shall be pre-wired and housed in an insulated electrical cabinet within the cabinet to protect against risk of condensation.
 - b. All indirect fired and cooling units shall be provided with single point electrical connection.
 - c. Unit shall be provided with a door safety switch that de-energizes the supply fan when the door is opened.
 - d. Unit shall be provided with a factory mounted averaging supply air temperature sensor to allow for accurate discharge temperature readings within unit when a downstream sensor is not installed.
 - e. Unit shall be provided with a factory mounted intake air temperature sensor to allow for accurate intake temperature readings regardless of how the OA dampers are positioned.
 - f. The electrical cabinet shall be outfitted with the following:
 - 1) LED electrical cabinet service light with automatic activation upon door switch.
 - 2) Color wiring schematics, laminated to the interior wall of the cabinet doors.
 - 3) Factory mounted disconnect with unit bottom knockouts.

- 4) A LED backlit, LCD HMI shall be mounted within the unit's control cabinet to allow for all set points configuration and refrigeration system monitoring at the unit.
 - 5) Up to 4 additional space mounted HMIs available. Additional HMIs shall allow for full programming capabilities and are outfitted with integral temperature and humidity sensors. Additional HMIs shall be capable of being individually averaged for space temperature/humidity readings. All HMIs shall be wired using standard CAT 5/6 cables.
 - 6) 120V, 15 A unit powered convenience outlet.
 - g. All sensors shall be wired back to the main control board that continuously monitors all critical components and makes decisions based on pre-determined logic to accurately control the following:
 - 1) PID logic to control heater modulation ensuring precise discharge/space temperature control.
 - 2) PID logic to control compressor speed to provide precise control over evaporative coil temperatures, leaving dew point, and discharge/space temperatures.
 - 3) PID logic for Outdoor fan modulation to maintain an optimal outdoor coil temperature.
 - 4) PID logic for Electronic Expansion Valve (EEV) position to maintain a precise superheat temperature.
6. Air Filters
- a. All filters shall be furnished and installed to meet the performance requirements.
 - b. All filters shall be installed on tracks for easy removal from the unit.
 - c. Unit shall ship with 2" washable metal mesh outdoor air filter. Final filter shall be MERV-8.
 - d. Unit shall have an adjustable pressure differential sensor for the filter bank to alert in the event of a clogged filter.
7. Fans – Supply
- a. All supply fans shall be direct drive variable speed plenum fans.
 - b. Motor shall be a premium efficiency motor.
 - c. Fans shall be selected at or near efficiency peak.
 - d. Blower and motor assembly shall be dynamically balanced. The entire blower and motor assembly shall be mounted on rubber vibration isolators. Wheels shall be balanced as per AMCA 204-96, Balance Quality and Vibration Levels for Fans.
8. Gas Fired Heating Section
- a. The gas burner shall be an indirect-fired, push-through type, using natural gas at an inlet supply pressure to the unit of 7" w.c. minimum.
 - b. Burner shall be a tubular in0shot fired design capable of using natural gas. Each burner ignition shall be of the direct-spark design with remote flame sensing at the inlet of the last firing tube of the gas manifold.
 - c. Direct sparking sequence shall last through the complete duration of the trial for ignition period for guaranteed light off. Each burner ignition module shall have LED indicators for troubleshooting and a set of exposed prongs for testing flame indication signal.
 - d. All furnaces shall be controlled by an electronic Vernier-type fully modulating control system capable of achieving 80% combustion efficiency over the entire gas firing range of the unit.
 - e. Each furnace shall have:
 - 1) A minimum turndown ratio of 6:1 while maintaining a constant 80% efficiency. No cold air bypass of the heat exchanger.
 - 2) A bent-tube style design made entirely of stainless steel.
 - 3) Stainless steel Quick Seal Connection for gas connection.
 - 4) Manifold and input gas pressure gauges.
 - 5) Factory piped condensate drain to exterior of cabinet.

- 6) A combustion flue to be installed on adjacent side as combustion intake with integrated high velocity wind cap.
- 7) A blocked vent safety airflow switch with high temperature silicone tubing operating off of absolute pressure measured inside of the power-vent blower housing.
- 8) A high temperature auto-recycling limit with a maximum non-adjustable set point.
- 9) A manual reset high temperature flame roll out switch with a non-adjustable set point.
- 10) Each furnace compartment shall have a removable post and panel that allows the furnace to be easily removed for service and maintainability.
- 11) A power-vent assembly for exhausting flue gases with a PSC or ECM type motor that is securely mounted and easily accessible/removable for service.
- 12) A 0-10" w.c. gas pressure gauge installed on the gas manifold.

9. Refrigeration System

- a. Unit shall utilize a variable speed inverter duty scroll compressor with the following features:
 - 1) Compressor shall be capable of compressor speed modulation from 25% - 100%.
 - 2) Unit shall be factory charged with R410A refrigerant.
 - 3) Compressor shall be mounted on rubber vibration isolators.
 - 4) Internal thermal overload protection.
 - 5) Crankcase heater, which must remain powered when compressor is not in operation.
 - 6) Unit shall utilize both passive and active oil return management using Oil Level Sensor and scheduled oil boosts.
 - 7) Unit shall monitor all critical refrigeration points to ensure compressor does not operate outside of safe operating envelope.
 - 8) Unit shall allow for high head pressure monitoring throttle mode for high ambient operation, and low suction pressure throttle mode for low capacity operation or any conditions resulting in low suction pressure.
 - 9) Active pump-down mode with discharge line check valve to protect against liquid migration into compressor during idle times.
- b. Indoor coil shall be a high efficiency 7 row coil design with aluminum fins mechanically bonded to copper tubes. Coil is staggered to increase turbulence, reduce the coil bypass factor, and ultimately increase the time the air stays within the coil.
- c. Each refrigeration circuit will be outfitted with an electronic expansion valve metering device which can be throttled from 1=100% open to allow for precise superheat control.
- d. The indoor coil shall be outfitted with a sloped stainless steel drain pan. This pan shall be insulated along the entire base and shall be outfitted with a safety overflow switch. The entire drain pan shall be 20 GA stainless steel construction and wrap beneath the entire coil with flashing on the entering side of the coil. Drain pan discharge pipe shall also be stainless steel construction. Drain pan shall be pitched to exceed ASHRAE 62.1 standard.
- e. The base of the condensing coil cabinet shall be pitched away from the unit to ensure all draining exits away from the curb.
- f. Outdoor coil shall be a high efficiency coil design with aluminum fins mechanically bonded to copper tubes. The coil shall be downward sloped to protect coil from hail damage.
- g. The outdoor coil shall have a vertical discharge outfitted with a quiet, efficient, fully modulating ECM condensing fans. These fans shall modulate to maintain a temperature differential between outside air and the outdoor coil.

- h. Suction line accumulator for added protection against liquid entering suction line of compressor.
- i. Bi-flow, low pressure drop, filter drier.
- j. Electronic Expansion Valve (EEV) for precise superheat control. EEV shall open partially allowing system pressure equalization prior to activation of the compressor.
- k. Protective rubber sleeves shall be installed on all distribution lines of indoor coil to prevent wear from rubbing.
- l. All refrigeration ports shall be short-stub assembly and any access port with a transducer or switch is mounted vertically to mitigate risk of bent/cracked stub joints.
- m. Refrigeration circuit shall be mechanically CNC pre-bent tubing wherever possible with minimal brazed joints.
- n. Factory tested for leaks.
- o. Suction line temperature sensor failure detection.
- p. Preventative failure alerts through a manufacturer provided, cloud based, cellular remote monitoring system.

10. Unit Controls

- a. Unit shall be outfitted with a control board to allow for full control of the entire unit.
- b. Provide air flow switch on the supply fan system to sense air flow with available set of contacts for connection to BMS for airflow alerts.
- c. All unit controls shall be compatible with BACnet and LonWorks based building management systems.
- d. All units shall be outfitted with CASLink cloud based monitoring, which monitors every point of operation. Provides configurable automated fault alert e-mails, and remote control capabilities.
- e. Integrated cellular module to provide remote connection to monitoring services to view both real time and historical unit operation. Data shall be stored a minimum of 3 years on the cloud. Data sample rate shall be a maximum of 60 seconds.
- f. Unit shall be factory outfitted with logic allowing for low-ambient operation of the DX system down to 15°F outdoor temperatures purely through software utilizing the standard factory modulating components.
- g. Refer to Sequence of Operation for additional controls information.

11. Variable Frequency Drives

- a. Provide variable frequency drive for the compressor as part of the AC unit.
- b. Accessories to be furnished and mounted by the drive manufacturer and contained in a single enclosure.
- c. Provide VFD for all direct drive supply fans.
- d. All VFDs shall provide the following inherent protections:
 - 1) Phase Protection.
 - 2) Brownout protection.
 - 3) Overload/overheat protection.
 - 4) Soft starts to protect bearings/hardware.
 - 5) Low and high voltage and over-torque protections.

2.02 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: In accordance with Section 26 05 03 and the drawing schedule.
- B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.
- C. Provide factory convenience outlet.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Per Division 1 Section 013100 - Coordination and Meetings.
- B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.03 INSTALLATION

- A. Roof Curb:
 - 1. Assemble roof curb.
 - 2. Install roof curb level.
 - 3. Coordinate curb installation and flashing with existing conditions.
 - 4. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
 - 5. Install gasket material between unit base and roof curb.
- B. Install units on vibration isolators.
- C. Connect units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.
- D. Install condensate piping with trap and route from drain pan to splash block on roof.
- E. Install components furnished loose for field mounting.
- F. Install electrical devices furnished loose for field mounting.
- G. Install control wiring between unit and field installed accessories.
- H. Connect natural gas piping in accordance with NFPA 54.
- I. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
- J. Install the following piping accessories on natural gas piping connections. Refer to Section 23 11 23.
 - 1. Strainer.
 - 2. Pressure regulators.
 - 3. Shutoff valve.
 - 4. Pressure relief valve.
- K. Install natural gas piping accessories above roof.

3.05 MANUFACTURER'S FIELD SERVICES

- A. Per Division 1 Section 014500 - Quality Control.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.06 CLEANING

- A. Per Division 1 Section 017700 - Project Closeout.

- B. Vacuum clean coils and inside of unit cabinet.
- C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.07 DEMONSTRATION

- A. Per Division 1 Section 017700 - Project Closeout.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to owner of training date.

END OF SECTION

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SECTION 260001
ELECTRICAL CODES AND FEES

PART 1 GENERAL

1. 01 DESCRIPTION

- A. General: Comply with Codes in accordance with the Contract Documents.

1. 02 CODES

- A. The electrical installation shall be in compliance with the requirements of O.S.H.A., N.E.C., Local Codes and the rules, regulations and requirements of the power company supplying power to the building.
- B. The electrical installation shall comply fully with all county and state laws, ordinances and regulations applicable to electrical installations.
- C. All equipment shall be equal to or exceed the minimum requirements of N.E.M.A., I.E.E.E. and U.L.

1. 03 FEES

- A. All local fees and permits and services of inspection authorizes shall be obtained and paid for by the Contractor. Contractor shall pay for all subcontracted services.

1. 04 CERTIFICATE OF INSPECTION

- A. Certificate of Inspection and approval shall be procured and paid for by this Contractor for an independent electrical inspection and delivered to the Owner before final payment is made.

END OF SECTION 260001

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SECTION 260519
BUILDING WIRE AND CABLE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Building wire and cable.
 - 2. Wiring connectors and connections.

- B. RELATED SECTIONS
 - 1. Section 26 05 53 – Electrical Identification.
 - 2. Section 26 05 33 – Raceway and Boxes.

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.

1.03 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Product Data: Provide for each cable assembly type.
- 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.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.

1.05 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

1.06 FIELD SAMPLES

- A. Reserved

1.07 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper. All conductors shall be copper.
- C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions. Coordinate final conduit run with district.

- D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required. Coordinate final conduit run with district.

1.08 COORDINATION

- A. Determine required separation between cable and other work.
- B. Determine cable routing to avoid interference with other work.

PART 2 PRODUCTS

2.01 MANUFACTURERS - BUILDING WIRE AND CABLE

- A. American Insulated Wire Corporation.
- B. Carol Cable Company.
- C. Rome Cable.

2.02 BUILDING WIRE AND CABLE

- A. Description: Stranded conductor insulated wire.
- B. Conductor: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation: ANSI/NFPA 70, Type THHN/THWN.

2.03 WIRING CONNECTORS

- A. Split Bolt Connectors:
 - 1. Burndy Corporation.
 - 2. IlSCO.
 - 3. Teledyne Penn Union.
 - 4. Substitutions: Under provisions of Division 1.
- B. Solderless Pressure Connectors:
 - 1. Burndy Corporation.
 - 2. IlSCO.
 - 3. Teledyne Penn Union.
 - 4. Substitutions: Under provisions of Division 1.
- C. Spring Wire Connectors:
 - 1. 3M.
 - 2. Buchanan.
 - 3. Burndy.
 - 4. Substitutions: Under provisions of Division 1
- D. Compression Connectors:
 - 1. Burndy Corporation.
 - 2. IlSCO.
 - 3. Teledyne Penn Union.
 - 4. Substitutions: Under provisions of Division 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.

3.02 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.03 WIRE COLOR

- A. General
 - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - 3. For ground wire shall be green.
 - 4. For neutral wire shall be white.

3.04 WIRING METHODS

- A. Concealed Dry Interior Locations above lay-in ceilings or non block partition walls: Use THHN/THWN insulation, in EMT raceway.
- B. Exposed Dry Interior Locations: Use building wire THHN/THWN insulation in EMT raceway.
- C. Above Accessible Ceilings: Use building wire THHN/THWN insulation in EMT raceway.
- D. Wet or Damp Interior Locations: Use only building wire Type THHN/THWN insulation in RGS raceway.

3.05 INSTALLATION

- A. Install products in accordance with manufacturers instructions.
- B. Use stranded conductor for feeders and branch circuits.
- C. Use stranded conductors for control circuits.
- D. Use conductor not smaller than 12 AWG for power and lighting circuits.
- E. Use conductor not smaller than 14 AWG for control circuits.
- F. Use one size larger conductors for runs longer than 100 feet.
- G. Pull all conductors into raceway at same time.
- H. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- I. Protect exposed cable from damage.

- J. Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.
- K. Use suitable cable fittings and connectors.
- L. Neatly install wiring inside boxes, equipment, and panelboards.
- M. Clean conductor surfaces before installing lugs and connectors.
- N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- O. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- P. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- Q. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller. Provide separate neutral for each single phase branch circuit.
- R. Install wiring concealed in finished spaces. Provide any required fishing and patching where required. Wiring in finished spaces with concrete block walls shall be wired with wiring concealed in the block wall cavity and all devices and fixture boxes set flush with concrete block surfaces. Interior Concealed wiring in block walls shall be schedule 40 PVC or rigid metal raceway. Do not mount boxes or devices in block joints.
- S. Provide separate neutral for each branch circuit
- T. Stranded conductors shall be used in MC Cable (where permitted by University Senior Electrical Engineer) and in Liquid Tight and standard flex pipes.

3.06 INTERFACE WITH OTHER PRODUCTS

- A. Identify wire and cable under provisions of Section 26 05 53.
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.07 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
- C. Verify continuity of each branch circuit conductor.

END OF SECTION 26 0519

SECTION 260529
ELECTRICAL HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Conduit supports.
 2. Formed steel channel.
 3. Spring steel clips.
 4. Sleeves.
 5. Mechanical sleeve seals.
 6. Firestopping relating to electrical work.
 7. Firestopping accessories.

1.02 REFERENCES

- A. ASTM International:
1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- B. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- C. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
- D. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 5. UL - Fire Resistance Directory.
- E. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.03 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.04 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479 to achieve fire ratings as required for adjacent construction, but not less than 1 hour fire rating.
1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

- B. Surface Burning: ASTM E84, UL 723 with maximum flame spread / smoke developed rating of 25/450.
 - C. Firestop interruptions to fire rated assemblies, materials, and components.
- 1.05 PERFORMANCE REQUIREMENTS
- A. Firestopping: Conform to applicable code FM, UL, WH for fire resistance ratings and surface burning characteristics.
 - B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.
- 1.06 SUBMITTALS
- A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
 - B. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
 - C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
 - D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
 - E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
 - F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
 - G. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.
- 1.07 QUALITY ASSURANCE
- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
 - B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum years documented experience approved by manufacturer.
- C. Convene minimum one week prior to commencing work of this section.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F
- B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- C. Provide ventilation in areas to receive solvent cured materials.

PART 2 PRODUCTS

2.01 CONDUIT SUPPORTS

- A. Manufacturers:
 1. Allied Tube & Conduit Corp.
 2. Electroline Manufacturing Company.
 3. O-Z Gedney Co.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.

- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.02 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems.
 - 3. Midland Ross Corporation, Electrical Products Division.
 - 4. Unistrut Corp.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.03 SPRING STEEL CLIPS

- A. Product Description: Mounting hole and screw closure.

2.04 FIRESTOPPING

- A. Manufacturers:
 - 1. Dow Corning Corp.
 - 2. Fire Trak Corp.
 - 3. Hilti Corp.
 - 4. International Protective Coating Corp.
 - 5. 3M fire Protection Products.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
 - 1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
 - 2. Foam Firestopping Compounds: Single component foam compound.
 - 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 - 4. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
 - 5. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 - 6. Firestop Pillows: Formed mineral fiber pillows.
- C. Color: Dark gray as selected from manufacturer's full range of colors.

2.05 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Dam Material: Permanent:
 - 1. Mineral fiberboard.
 - 2. Mineral fiber matting.
 - 3. Sheet metal.

- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
 - 1. Furnish UL listed products.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
 - 2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing materials to arrest liquid material leakage.
- D. Obtain permission from Engineer before using powder-actuated anchors.
- E. Do not drill or cut structural members.
- F. Obtain permission from Engineer before drilling or cutting structural members.

3.03 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts, anchors, and preset inserts.
 - 2. Steel Structural Elements: Provide beam clamps and welded fasteners.
 - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide hollow wall fasteners.
 - 5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches

4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- C. Install conduit and raceway support and spacing in accordance with NEC.
- D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- E. Install multiple conduit runs on common hangers.
- F. Supports:
1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
 4. Support vertical conduit at every floor.

3.04 INSTALLATION – FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.
- E. Remove dam material after firestopping material has cured. Dam material to remain.
- F. Fire Rated Surface:
1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 2. Where cable tray, conduit, wireway, and trough penetrate fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- G. Non-Rated Surfaces:
1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 2. Install escutcheons floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.

4. Interior partitions: Seal pipe penetrations at telecommunication rooms data rooms and electrical rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.05 INSTALLATION – SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.06 FIELD QUALITY CONTROL

- H. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.07 CLEANING

- I. Clean adjacent surfaces of firestopping materials.

3.08 PROTECTION OF FINISHED WORK

- J. Protect adjacent surfaces from damage by material installation.

END OF SECTION 26 0529

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SECTION 260531
WIRING CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes electrical connections to equipment.
- B. Related Sections:
 - 1. Section 26 05 19 - Building Wire and Cable.
 - 2. Section 26 05 33 - Raceway and Boxes.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.03 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Product Data: Submit wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's installation instructions.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.05 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 Not Used.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.02 EXISTING WORK

- A. Remove exposed abandoned equipment wiring connections.
- B. Disconnect abandoned utilization equipment and remove wiring connections. Remove abandoned components when connected raceway is abandoned and removed. Install blank cover for abandoned boxes and enclosures not removed.

3.03 INSTALLATION

- A. Make electrical connections.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp wet locations or equipment connections
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Install receptacle outlet to accommodate connection with attachment plug.
- E. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- F. Install terminal block jumpers to complete equipment wiring requirements.
- G. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.04 ADJUSTING

- H. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

3.05 EQUIPMENT CONNECTION SCHEDULE

- A. As noted on Contract Documents.

END OF SECTION 26 0503

SECTION 260533
RACEWAY AND BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.03 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Outdoor Locations, Above Grade: Provide rigid aluminum. Provide cast aluminum outlet, pull, and junction boxes.
- C. Interior Wet and Damp Locations: Provide rigid galvanized steel. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- D. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- E. Exposed Dry Locations: Provide rigid galvanized steel or electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.04 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.05 SUBMITTALS

- A. Product Data: Submit for the following:
 - 1. Metal Conduit
 - 2. Liquidtight Flexible metal conduit.
 - 3. Electrical Metallic Tubing (EMT)
 - 4. Pull and junction boxes.

- B. Manufacturer's Installation Instructions: Submit 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.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- 1.07 COORDINATION
- A. Coordinate installation of outlet boxes for equipment.
 - B. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.01 METAL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Intermediate Metal Conduit (IMC): Rigid steel.
- C. Rigid Aluminum Conduit.
- D. Fittings and Conduit Bodies: NEMA FB 1; threaded type.

2.02 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Product Description: Interlocked steel construction with PVC jacket.
- B. Fittings: NEMA FB 1.

2.03 ELECTRICAL METALLIC TUBING (EMT)

- A. Product Description: ANSI C80.3; galvanized tubing.
- B. Fittings and Conduit Bodies: NEMA FB 1; steel, compression type up to and including 2 inch diameter.

2.04 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- B. Hinged Enclosures: As specified in Section 26 27 16.
- C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.02 INSTALLATION

- A. All wiring shall be concealed.
- B. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- C. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- D. Identify raceway and boxes in accordance with Section 26 05 53.
- E. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.03 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Route exposed raceway parallel and perpendicular to walls.
- H. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- I. Maintain clearance between raceway and piping for maintenance purposes.
- J. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- K. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- L. Bring conduit to shoulder of fittings; fasten securely.
- M. Install conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.
- N. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2 inch size.

- O. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- P. Install fittings to accommodate expansion and deflection where raceway crosses, control expansion joints.
- Q. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- R. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- S. Install all conductors in EMT raceway, except where approved by University.

3.04 INSTALLATION - BOXES

- A. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- B. In Accessible Ceiling Areas: Install junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- C. Do not fasten boxes to ceiling support wires or other piping systems.
- D. Support boxes independently of conduit.

3.05 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with local codes and standards.

3.06 ADJUSTING

- B. Install knockout closures in unused openings in boxes.

3.07 CLEANING

- C. Clean interior of boxes to remove dust, debris, and other material.
- D. Clean exposed surfaces and restore finish.

END OF SECTION 26 0533

SECTION 260553
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Labels.

1.02 SUBMITTALS

- A. Per Division 1 Section 013300 - Submittals.
- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.03 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept identification products on site in original containers. Inspect for damage.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

PART 2 PRODUCTS

2.01 NAMEPLATES

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
- B. Product Description: Laminated three-layer plastic with black engraved letters on contrasting white background color.

- C. Letter Size:
 - 1. 1/8 inch high letters for identifying individual equipment and loads.
 - 2. 1/4 inch high letters for identifying grouped equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

2.02 LABELS

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Substitutions: Division 1 - Product Requirements.
- B. Labels: Embossed adhesive tape, with 3/16 inch black letters on white background.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces for stencil painting.

3.02 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
 - 1. Install nameplate parallel to equipment lines.
 - 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
 - 4. Secure nameplate to equipment front using adhesive.
 - 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
 - 6. Install nameplates for the following:
 - a. Panelboards.
 - b. Switchboard.
 - c. Switchboard breakers.
 - d. Disconnects.
- C. Label Installation:
 - 1. Install label parallel to equipment lines.
 - 2. Install label for identification of individual control device stations, and
 - 3. Install labels for permanent adhesion and seal with clear lacquer.
 - 4. Install arc-flash labels for all electrical equipment as directed by and in the presence of the Engineer.

END OF SECTION 260533

SECTION 262413
SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes molded-case circuit breaker for distribution switchboards.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 53 - Identification for Electrical Systems.

1.02 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C12.1 - Code for Electricity Metering.
 - 2. ANSI C39.1 - Requirements, Electrical Analog Indicating Instruments.
- B. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
 - 2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- C. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 4. NEMA PB 2 - Deadfront Distribution Switchboards.
 - 5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- D. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- E. Underwriters Laboratories:
 - 1. UL 891
 - 2. UL 1449, 3rd Edition, SPD

1.03 SUBMITTALS

- A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.
- B. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.
- C. Test Reports: Indicate results of factory production and field tests.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.

- B. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- 1.05 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- 1.06 DELIVERY, STORAGE, AND HANDLING
- A. Accept equipment on site. Inspect for damage.
 - B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
 - C. Handle in accordance with NEMA PB 2.1.
- 1.07 ENVIRONMENTAL REQUIREMENTS
- A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.
- 1.08 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.
- 1.09 SEQUENCING
- A. Sequence Work to avoid interferences with building finishes and installation of other products.
- 1.10 MAINTENANCE MATERIALS
- A. Furnish two of each key.
 - B. Furnish two fuse pullers.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER

- A. Manufacturers:
 - 1. Square D.
 - 2. Substitutions: No other manufactures will be accepted.
- B. Product Description: NEMA AB 1, molded-case circuit breaker.
- C. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 200 amperes and larger have mechanism for adjusting long time short time and continuous current setting for automatic operation.

2.02 SOURCE QUALITY CONTROL

- A. Furnish shop inspection and testing in accordance with NEMA PB 2.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing switchboard manufacturer, model, AIC rating and bussed space to ensure the new equipment matches and fits within the existing switchgear.

3.02 INSTALLATION

- A. Install in accordance with NEMA PB 2.1.
- B. Install fuses in each switch and coordinate sizes with connected load.
- C. Install engraved plastic nameplates in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- D. Inspect and test in accordance with NETA ATS, except Section 4.
- E. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.04 ADJUSTING

- F. Adjust operating mechanisms for free mechanical movement.
- G. Tighten bolted bus connections.
- H. Adjust circuit breaker trip and time delay settings to values as instructed by Engineer.

3.05 CLEANING

- I. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

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SECTION 283100
FIRE DETECTION AND ALARM

PART 1– GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of this section include raceways, electrical boxes and fittings, wiring/cabling, and control/signal amplification and transmission media, as specified.

1.2 DEFINITIONS

- A. Alarm Initiating Device: A manual station, smoke detector, heat detector, duct detector, sprinkler water flow switch, or sub-system, e.g. kitchen range hood.
- B. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of a manual station and the operation of a sprinkler system flow switch.
- C. Class A (style D & Z) Wiring: Circuits arranged and electrically supervised so a single break or single ground fault condition will be indicated by a trouble signal at the FACP and the circuit will continue to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.
- D. Class B (style B & Y) Wiring: Circuits electrically supervised such that a single break or a single ground fault condition will be indicated by a trouble signal at the FACP no matter where the break or ground fault condition occurs. Only devices that are electrically further than the fault will be inoperative.
- E. Supervisory Signal: Indicates need for action regarding fire suppression or other protective system.
- F. Trouble Signal: Indicates that a fault, such as an open circuit or ground, has occurred in the system.

1.3 SYSTEM DESCRIPTION

- A. General: Non-coded, addressable, microprocessor based system with manual and automatic alarm initiation and analog addressable smoke, heat and duct detectors.
- B. The Fire Alarm System shall as be manufactured by Simplex, which constitutes the type and quality of equipment and software to be supplied.
- C. The Fire Alarm system shall include all required hardware and programming to provide a complete, operational and functional system.
- D. System connections for alarm initiation and notification appliance circuits shall be Class B wiring.

1.4 SUBMITTALS

- A. Provide documentation of staff experience, certification and business history.
 - 1. Evidence that the technicians that are to oversee, commission and test the system, are NICET Level 2 Certified, minimum.
- B. Manufacturer product data sheets for each fire alarm system component, and list of materials.
- C. Complete drawings including the following shall be submitted by the Contractor for the purposed system:
 - 1. Floor plans and showing all initiating, end of line, supervisory, indicating appliances, and output control devices; including circuit interface panels, annunciators, supplementary power supplies and the main CPU locations. Raceways shall be shown, marked for size, conductor count with type and size, meeting the percentage of allowable National Electric Code fill used.
 - 2. Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.
- D. The contractor shall include the following calculations in the equipment submittal:
 - 1. Power calculations.
 - a. Battery capacity calculations, indicating the following:
 - b. Supervisory power requirements for all equipment.
 - c. Alarm power requirements for all equipment.
 - d. Voltage drop calculations for notification appliance circuits, as required by the authority having jurisdiction.
 - 2. Circuit loading calculations.
 - a. Signaling Line Circuit(s) shall not be loaded greater than 90 percent of their rated device capacity.
 - b. Alarm notification appliance circuits shall have a load not to exceed 80 percent of its rating.
- E. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, submit documentation, as required, to the Authority Having Jurisdiction (AHJ).
- F. To avoid delays in the progress of the project, submittals-proposing substitutions to the specified equipment shall be provided for evaluation within seven (7) days of the award of the contract.
 - 1. A single evaluation of submittal data will be provided for proposed substitutes. Any subsequent resubmittal of substitute equipment will be evaluated and charged to the contractor, at the normal hourly billing rates, for the design Architects' and Engineers' services.

1.5 RECORD DOCUMENTS

- A. Provide maintenance data for materials and products. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.
 - 1. Provide to the owner three (3) "Operation and Maintenance Manuals".
 - 2. These shall be provided in 3-ring or other suitable binders, with the following information inscribed on the cover:
 - a. "OPERATION AND MAINTENANCE MANUAL"
 - b. Building location.
 - c. The name and telephone number of the contractor, system manufacturer and system supplier.
 - 3. The manual shall be legible and easily read with large drawings folded and contained in pockets.

- a. Included in the manual shall be circuit drawings, wiring and control diagrams with data to explain detailed operation and control of each item and a control sequence describing start up instructions.
 - b. Included shall be installation instructions, maintenance instructions, safety precautions, test procedures, performance data, and software documentation.
- B. Provide both a "Certificate of Completion" as outlined in Chapter 1, Section 7.2 of NFPA 72 and the "Inspection and Testing Form" as outlined in Chapter 7, Section 5 of NFPA 72. Each shall be fully executed by the manufacturer's representative and the local building inspector.
- C. Provide complete system wiring diagrams detailing 'as built' wiring for power, signal, and control differentiating clearly between manufacturer-installed wiring and field-installed wiring. Identify terminal numbers and wiring color codes to facilitate installation, operation, and maintenance.

1.6 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer Qualifications: The Contractor shall retain and pay for the services of a factory-trained NICET Certified, technical representative of the system supplier, to supervise the installation of the system and to verify that the system has been installed and is functioning properly. The technical representative shall furnish installation drawings and technical assistance to the Installing Contractor. At the completion of the installation, the Technical Representative shall completely test the system including each initiating device and signaling device and each circuit of the system shall be tested for trouble reporting. Documentation shall be provided to the Owner and authority having jurisdiction that these tests were completed. The documentation shall list each device of the system, when it was tested, and the name of the Technical Representative.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- D. NFPA Compliance: Provide Fire Alarm and Detection System conforming to the following National Fire Protection Association (NFPA) standards:
 - 1. NFPA Standards:
 - a. NFPA 70 "National Electrical Code".
 - b. NFPA 72 "National Fire Alarm Code".
- E. IFC: Components and installation shall comply with the International Fire Code (IFC).
- F. UL Listing and Labeling: Provide system and components specified in this Section that are listed and labeled by UL.
- G. State and Local Building Codes and amendments, as adopted By the Authority Having Jurisdiction (AHJ), of the respective local municipality.
- H. Factory Mutual (FM): FM AG Approval Guide.
- I. The Americans with Disability Act, Public Law 101-336 (A.D.A.).

- J. Prior to commencing with the installation of the fire alarm system, this contractor shall submit the plans for the fire alarm system to the local Authority Having Jurisdiction for approval. This contractor shall pay all fees associated with this approval including the fee for all inspections.

1.7 MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months commencing with Substantial Completion, using factory-authorized service representatives.
 - 1. Basic services: Respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
 - 2. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

PART 2- PRODUCTS

2.1 MANUFACTURERS

- A. In order to assure the Owner of all factory warranties, all equipment shall be obtained from an approved factory authorized distributor. The manufacturer and/or his authorized distributor shall show satisfactory evidence that he maintains a fully equipped factory authorized service organization, stocked with factory approved replacement parts within 50 miles of the project site and is capable of furnishing adequate inspection and service of equipment.
- B. The system shall be complete in every respect including all necessary equipment shown or now shown on the drawings to perform the functions relative to the system operation. All published specifications of the above manufacturer shall be considered as part of this specification even though they may not be shown in complete detail. All equipment provided shall be by a single manufacture.

2.2 PHOTOELECTRIC DUCT DETECTOR

- A. Intelligent photoelectric duct smoke detectors and remote test station provided by MC and installed by EC.

2.3 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Section 16123.
- B. Initiating, Signal Circuits, Data and 24 VDC Power Cables: Building wire as specified in Section 16123. Non-power limited fire-protective signaling cable, copper conductor, 150-volt insulation rated 60 degree C; power limited fire-protective signaling cable, copper conductor, 300 volts insulation rated 105 degree C.
 - 1. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.
 - 2. Wiring for the analog loop circuits shall be 16 AWG twisted, West Penn Wire No. 990 or equal.

3. Wiring for strobe, horn/strobe, audible bases and remote annunciator power circuits shall be a 14 AWG type FPL, West Penn Wire No. 994 or equal. (Horns and strobes may be installed on the same circuit).
 4. All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer's recommendations.
 5. A consistent color code for fire alarm system conductors shall be used, throughout the installation.
- C. The contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.
 - D. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.
 - E. If applicable, Contractor may, at their discretion and with verification from the system supplier, reuse existing fire alarm wiring. Contractor shall verify existing wiring is in good working order and free from defects.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Provide in accordance with the manufacturer's instructions, all wiring, conduit, raceways, outlet boxes, and auxiliary equipment required for the installation of the system.
- B. Install system in accordance with NFPA Standards referenced in Parts 1 and 2 of this Section.

3.2 EQUIPMENT INSTALLATION

- A. Existing Fire Alarm Equipment: Maintain fully operational until the new equipment has been tested and accepted. As new equipment is installed, labeled it "NOT IN SERVICE" until the new equipment is accepted. Remove tags from new equipment when put into service and tag existing fire alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of the new fire alarm system, remove existing, disconnected fire alarm equipment and restore damaged surfaces to match adjacent finishes. Package operational fire alarm and detection equipment that has been removed and deliver to the Owner. Remove from the site and legally disposed of the remainder of the existing material.

3.3 WIRING INSTALLATION

- A. The wiring system shall meet the requirements of all applicable national, state, and local electrical codes and shall conform to the requirements of Standard #72 of the National Fire Protection Association.
- B. The number of conductors shall be as shown or as required by the equipment manufacturer.
- C. Wiring Method: Install wiring in metal raceway in accordance with Division 16 Section RACEWAYS. Conceal raceway except in unfinished spaces and as indicated.
- D. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points neatly.

- E. Alarm Wiring: For the low-voltage portion of the fire alarm system, install No. 16 AWG conductors and 75-deg C insulation in wet, damp, or dry locations. Provide wiring operating at line voltage as minimum No. 12 AWG size having similar insulation.
- F. Color Coding: Color-code all fire alarm conductors differently from the normal building power wiring. Provide one color code for alarm circuits wiring and a different color code for supervisory circuits. Provide a color code for audible alarm indicating circuits different from alarm initiating circuits. Use different colors for visual alarm indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Provide vertical cable risers to serve the fire alarm system as required.
- H. Final connections between control equipment and wiring system shall be made under the direct supervision of a representative of the fire alarm equipment manufacturer.
- I. The exact wiring arrangement shall be in accordance with the fire alarm equipment manufacturer's requirements and the exact number of initiating and signaling devices to be furnished and installed shall be as shown on the drawings.
- J. Mount end-of-line device box with last device or separate box adjacent to last device in circuit.
- K. Make conduit and wiring connections to duct mounted smoke detectors..

3.4 PROGRAMMING

- A. The Contractor and Manufacturer's Representative shall meet with the Owner and review the requirements for device and location identifications prior to entering any script files. All custom labels shall be in accordance with the Owner's requirements.

3.5 GROUNDING

- A. Ground equipment, in accordance with the manufacturer's requirements.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable. The letter shall include the names and titles of the witnesses to the preliminary tests.
- D. Final Test Notice: Provide 10 days' minimum notice in writing when the system is ready for final acceptance testing.

- E. Minimum System Test: Test the system in accordance with the procedures outlined in NFPA 72, Chapters 1 and 7. Testing specified shall be performed by the installing contractor, the distributor's technician and the building inspector. Minimum required tests are as follows:
1. Verify the absence of short circuits between conductors and ground.
 2. Test all circuitry for short circuits between conductors.
 3. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
 4. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Proper signal transmission in accordance with class of wiring used shall be observed.
 5. Test each initiating and indicating device for alarm operating and proper response at the control unit. Test smoke detectors with actual products of combustion.
 6. Test the system for all specified functions in accordance with the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
 7. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.
- F. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.
1. Provide both a "Certificate of Completion" as outlined in Chapter 1, Section 7.2 of NFPA 72 and the "Inspection and Testing Form" as outlined in Chapter 7, Section 5 of NFPA 72. Each shall be fully executed by the manufacturer's representative and the local building inspector.

3.7 GUARANTEE

- A. The contractor shall warrant the entire system against mechanical and electrical defects for a period of one (2) year from the date of final acceptance and as described in the contract general conditions.
1. This period shall begin upon completed certification and test of the system or upon first beneficial use of the system, whichever is later.

END OF SECTION