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SECTION 055213
PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stair railings and guardrails.

1.02 REFERENCE STANDARDS

A. ASTM B241/B241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube; 2022.

B. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube; 2020.

C. ASTM B483/B483M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications; 2021.

D. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2021.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

PART 2 PRODUCTS

2.01 RAILINGS - GENERAL REQUIREMENTS

A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.

B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 75 pounds per linear foot (1095 N/m) applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935

C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds (890 N) applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935

D. Allow for expansion and contraction of members and building movement without damage to connections or members.

E. Dimensions: See drawings for configurations and heights.

F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.

G. Provide slip-on non-weld mechanical fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.02 ALUMINUM MATERIALS

A. Aluminum Pipe: Schedule 40; ASTM B429/B429M, ASTM B241/B241M, or ASTM B483/B483M.

B. Exposed Fasteners: No exposed bolts or screws.

2.03 FABRICATION

A. Accurately form components to suit specific project conditions and for proper connection to building structure.

B. Fit and shop assemble components in largest practical sizes for delivery to site.

C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

2.04 ALUMINUM FINISHES

A. Color: Match existing railing finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

C. Anchor railings securely to structure.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per floor level, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

C. Maximum Out-of-Position: 1/4 inch (6 mm).

END OF SECTION

SECTION 090160
TERRAZZO FLOORING RESTORATION

(FLOOR RESTORATION-TERRAZZO)

PART 1: GENERAL

2.01 SECTION INCLUDES

A. Refinishing terrazzo floors.

B. Provide all labor, material, and equipment necessary to complete the following terrazzo repair work

C. Preparation of all surfaces to receive patching compound

D. Repairs to delaminated areas

E. Repair of cracks (as per NTMA recommendations)

F. Placement of patching compounds/terrazzo matrix

G. Finish and curing of terrazzo

2.02 REFERENCE STANDARDS

A. NTMA – Terrazzo Specifications; The National Terrazzo and Mosaic Association, Inc.; current edition located at www.ntma.com

2.03 SUBMITTALS

A. Product Data: Provide manufacturers technical data for sealer and cleaner and grout.

B. Cleaning products to be used and Terrazzo Maintenance Data/Protocols for facility managers

C. Submit letter clearly identifying the terrazzo system (Epoxy, Cement, etc) and that the products are suitable/compatible

2.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with not fewer than 5 years of documented experience.

1. Installer shall be a contractor member of NTMA in good standing and shall perform all work in accordance with NTMA standards
2. Use only skilled journeyman who are familiar and experienced with the materials and methods specified shall be used for terrazzo restoration/refinishing.
3. Crack Repair: Prepare a sample area for each type of crack repair required (Hairline cracks 1/64” to 1/16" in size; Cracks and voids larger than 1/8”) Repair shall demonstrate methods and quality of workmanship of crack repair.
4. Patching: Prepare on-floor, a sample of patching. Patch shall demonstrate methods and quality of workmanship of patch repair

PART 2: PRODUCTS

3.01 MATERIALS

A. Cleaner: Potable water, free of iron, all cleaners (optional) must be pH neutral

B. Sealer: Liquid type water based to completely seal matrix surface; not detrimental to terrazzo components.

C. Grout: Color to match existing matrix.

D. Matrix: Pigmented epoxy to match sample submitted

E. Aggregates: Aggregates to match architects approved sample

3.02 EQUIPMENT

A. All work shall be executed with conventional terrazzo grinding equipment according to NTMA published trade practice.

PART 3: EXECUTION

4.01 GENERAL

A. Perform work in accordance with NTMA recommendations as posted on the NTMA website (www.ntma.com)

4.02 PREPARATION

A. Cover and protect all adjacent finished surfaces during restoration process.

4.03 CRACK REPAIR

A. Determination
   1. The owner and contractor shall walk the entire floor and identify cracks and agree on
      a. NA (No Action) RC (Repair Crack) or RT (Replace Terrazzo)
      b. Hairline cracks are classified as less than 1/32” (0.030)
      c. Replacement (RT) shall be from architectural break to architectural break

B. RC - Repair Crack
   1. Clean crack of loose material, dirt or sealer
   2. Fill with resin/to match existing. Use aggregate in the crack if crack is wider than ¼ inch.
      a. Remove areas to be replaced
      b. Clean area and prepare concrete for new terrazzo
   3. c. Repair concrete, fill cracks in concrete substrate as needed. Fill cracks in concrete with hardening epoxy
      a. Optional upgrade: Employ the use of a mesh (isolation membrane) to cover crack with liquid applied membrane (epoxy systems only)
   4. e. Fill area with epoxy or cement /cement matrix and approved aggregate mixture/blend

4.04 INITIAL GRINDING

A. Wet or dry grind with appropriate medium diamonds/Stones

4.05 GROUTING

A. Cleanse floor with clean water and rinse. Wet grind with 50 or higher abrasive grit medium diamonds.

B. Remove excess water and machine or hand grout with cement or epoxy material to fill as needed.

4.06 CURING GROUT

A. Allow grout to cure a minimum of 12 hours. Maintain ambient air temperature between 70°F (21°C) and 80°F (27°C)

4.07 FINE (FINAL) GRINDING

A. Grind with 120 grit carborundum or 200 grit resin bond diamond until grout has been removed from the terrazzo surface.

4.08 CLEANING AND SEALING:

A. Rinse with clean water and allow too thoroughly dry.

B. Seal: Apply sealer per sealer manufacturer’s written directions

C. Remove protection and clean any adjacent surfaces effected by the refinishing process.

4.09 PROTECTION

A. General Contractor shall protect the finish floor from all site activity until Substantial Completion.

END OF SECTION

SECTION 140100 - GENERAL PROVISIONS

1. GENERAL

1.1 These general provisions and all the subsequent sections of this Specification shall form the complete Elevator System Specification for the project, and includes the furnishing of all labor, equipment, tools, supervision, materials, technical design services, shop drawings, appliances, and related items as required and specified to install and place in satisfactory operation, complete, compatible, and fully operable elevator system.

1.2 All reference to "this Contractor", "Systems Contractor", "Elevator System Contractor", etc., in these Specifications shall mean any contractor or subcontractor performing work under the Elevator System Division of these Specifications.

1.3 Temporary electricity shall be provided as indicated under the "General Requirements" of the Specifications.

1.4 The Elevator System installation shall be made in strict conformance with the latest edition and supplements in force at the time of bid opening of the National Electrical Code, ANSI/ASME A17.1 (American Standard Safety Code for Elevators and Escalators), and ANSI/ASME A17.3, the Rules and Regulations of the Kentucky Building Code and Kentucky State Fire Marshall's Office, the applicable Standards of the National Fire Protection Association, and applicable requirements of the Occupational Safety and Health Act of the United States Department of Labor. All materials and equipment employed shall be approved by and bear the label of Underwriters' Laboratories, Inc., where such labeling is made available by any manufacturer for said materials or equipment. All codes and regulations applicable shall be considered as jointly governing and the requirements of either and all will prevail. If it occurs that Drawings conflict with any applicable code, then this Contractor shall immediately bring same to attention of Engineer or his representative for resolvement.

1.5 The Drawings are generally diagrammatic and indicate the general design and arrangement of the proposed work. The exact and final location of all the elevator equipment, and other systems, unless specifically dimensioned on the Drawings, shall be subject to existing conditions of the building and subject to the approval of the Engineer. The contractor shall be responsible for the final location of his particular equipment to suit field conditions encountered and to avoid interferences without extra cost to the Owner or the Engineer.

1.6 Following completion, a certificate of approval shall be secured from the local code enforcement authority and delivered to the Engineer.

2. EQUIPMENT CONNECTION AND WIRING

2.1 Unless specifically noted otherwise on the Drawings or elsewhere in the Specifications, all elevator control wiring and all elevator equipment connections shall be provided by the Elevator Contractor. Conduit and power wiring shall conform to the requirements of Division 26.

3. MATERIALS AND EQUIPMENT

3.1 General. Materials and equipment shall be furnished as specified in this section and each individual elevator section of these Specifications and shall be in strict accordance with applicable ANSI, ASME, ASTM, NESC, NEMA, IEEE, UL, NEC, OSHA and NFPA standards,

codes, and specifications. Applicable codes, standards, and manufacturers' products referred to in these Specifications shall establish minimum requirements for materials and equipment furnished for this installation.

4. INSTALLATION

4.1 Assembly and installation of equipment shall be in strict accordance with manufacturer's installation instructions. Equipment shall be securely anchored in place. Care shall be exercised to correctly orient equipment before securing in place.

4.2 Cutting, Fitting, and Patching

4.2.1 The Elevator System Contractor shall do all cutting and drilling of masonry, steel, wood, or iron work and all fitting necessary for the proper installation of all elevator system equipment and materials included in the Specifications or governed thereby.

4.2.2 No cutting or drilling of the structure, of any kind, shall be done without first obtaining permission from the Engineer. All cutting and drilling shall be done under the supervision of the Contractor in strict accordance with instructions furnished by the Engineer.

4.2.3 All patching and finishing shall be done by the Contractor whose work has been affected (masonry, plastering, painting, etc.). Each such Contractor shall be reimbursed by the Elevator System Contractor when his cutting or drilling makes such patching and finishing necessary.

5. PERMITS, CERTIFICATES, LAWS, AND ORDINANCES

5.1 The Elevator System Contractor shall, at his own expense, procure all permits, certificates, and licenses required of him by law for the execution of his work. He shall comply with all Federal, State, and local laws, ordinances, rules and regulations relating to the performance of the work.

6. INSPECTION

6.1 The Elevator System Contractor shall, at his own expense, furnish elevator inspection as required by the local code enforcing agency, when applicable. The Contractor shall notify the Elevator Inspector in writing upon the start of the job and a copy of the notice shall be sent to the Engineer. The Contractor shall furnish certificates of final approval by the Elevator inspector and the Fire Marshal’s office and final payment shall be withheld until he has presented the Engineer with the aforementioned certificates of approval.

7. CODES AND STANDARDS

7.1 Following is a list of abbreviations for codes and standards which are referred to in the Specifications. Where such reference is made, the code or standard becomes a part of these Specifications as if the code or standard were included herein. Reference is always to the latest edition of the code or standard unless otherwise specifically noted.

ADA - Americans with Disabilities Act
ANSI - American National Standards Institute, Inc.
ASME - American Society of Mechanical Engineers
ASTM - American Society for Testing and Materials
IEEE - Institute of Electrical and Electronics Engineers

KBC - Kentucky Building Code
NBS - National Bureau of Standards
NEC - National Electrical Code
NEMA - National Electrical Manufacturers Association
NESC - National Electrical Safety Code
NFPA - National Fire Protection Association
OSHA - Occupational Safety and Health Act
UL - Underwriters' Laboratories, Inc.

8. GUARANTEES AND WARRANTIES

8.1 This Contractor shall guarantee all equipment, apparatus, materials, and workmanship entering into the Contract to be the best of its respective kind, and shall replace all parts at his expense which are defective within one year from final acceptance of the work by the Engineer. Items of equipment which may have longer guarantees shall have warranties and guarantees completed, in order, and in effect at the time of final acceptance of the work by the Engineer. This Contractor shall furnish all such warranties and guarantees at the time of final acceptance of the work.

9. SUBMITTAL

9.1 Submittal data shall include specification data, such as metal gauges, finishes, optional accessories; even though such equipment and materials may be as specified. In addition, the submittal data shall include performance (certification) data, wiring diagrams where applicable, accurate dimensional data, and a recommended spare parts list. Outline or dimensional drawings alone are not acceptable.

9.2 No installation shall be done until accepted equipment submittals are in the hands of the Contractor. It shall be this Contractor's responsibility to obtain accepted drawings and to make all installation in the neatest and most workmanlike manner possible.

9.3 In general, normal catalog information (with the particular items underlined or otherwise denoted as being the submitted item) will be accepted as submittal data. Installation, operating and maintenance instructions must be that information specifically applicable to the items furnished, which is ordinarily supplied with the equipment to the Owner, for any modifications indicated. Submittal data sheets which indicate several different model numbers, figure numbers, optional accessories, or installation arrangements shall be clearly marked to indicate the specific items of equipment being furnished. Submittal data must be complete for each piece of equipment; piecemeal data will not be processed.

9.4 It shall be noted that acceptance of shop drawings by the Engineer applies only to general design, arrangement, type, capacity, and quality. Such acceptance does not relieve the Contractor of the responsibility for furnishing the proper equipment.

END OF SECTION

SECTION 142000 - UK STANDARDS FOR TRACTION ELEVATORS

I. GENERAL

A. ELEVATOR STANDARD - UPDATES AND REVISIONS

This standard is to be used for design, installation, construction, and/or renovation of elevators for and in University of Kentucky buildings. It is a living document; therefore, updates will be made as conditions and/or new regulations require. Further, when a user of this standard perceives the need for revisions, additions, deletions, and/or other changes, a request for revision should be put in writing to the Campus and/or Med Center Physical Plant Director for consideration. A request for a revision may not necessarily result in the Elevator Standard being revised.

B. TERMS

1. University Project Manager
   "University Project Manager" means the individual from the Capital Project Management Division (CPMD), the Campus Physical Plant Division (CPPD), or the Medical Center Physical Plant Division, or other University Facility Division who is designated to be in charge of the Project.
2. Consultant
   "Consultant" means the individual, the Elevator Consultant, the Engineer, and/or the Architect who is responsible for the design of the elevator system or renovation project. The consultant may be an employee of the University of Kentucky Facilities Management Division.
3. Contractor
   "Contractor" means the successful bidder/firm to whom the contract to construct the elevator system has been awarded.
4. Owner
   When used, "Owner" shall mean the University of Kentucky and/or one of the Facilities Management Divisions.

C. DEPARTMENT SPECIFIC CONDITIONS

This University of Kentucky Elevator Standard applies to a variety of conditions and types of elevators. Some specific peripheral requirements may differ between the Lexington Campus elevators and those for service in the Medical Center and/or other University Departments; however, the basic requirements of this standard shall be used in any elevator design or renovation.

D. CODES AND REGULATOR AGENCIES

Refer to University of Kentucky Official Design Standards for General Conditions and Special Conditions for code and regulatory compliance requirements. However, it must be understood that all codes and requirements of Federal, State,

and Local regulatory agencies are to be applied to all elevator purchases, installations, maintenance, and construction projects in University of Kentucky buildings. Some of the conditions following make reference to these; however, such limited references do not exclude University departments, the Consultant, or the contractor from fully applying all codes and regulatory requirements to University of Kentucky situations.

E. INTENT

It is the intent of these standards to provide guidelines in developing vertical transportation systems that:

1. Provide acceptable levels of elevator service as related to the Average Interval and Handling Capacity.
2. Provide safe and convenient transport of passengers and material.
3. Provide systems that meet the highest level of accessibility for people with disabilities.
4. Incorporate specifically identified standardized parts for easy maintenance and rapid repair and/or replacement.
5. Provide reliability and achieve desired lifecycle service and cost, and
6. Provide for standardized control systems and other identified equipment as chosen by the University of Kentucky thereby eliminating the installation of manufacturer proprietary equipment, parts, and controls.

F. REQUIRED DESIGN CRITERIA

The Consultant shall use and/or obtain and use the following in the design of a new elevator installation including elevators in and for building renovations and/or additions and/or for elevator modernization and upgrades.

1. Elevators shall be installed in buildings that are two stories and higher. The design shall provide direct service to all floors in the building, including floors where mechanical rooms are located.
2. Elevators shall be given an individual numbering identity. The number shall be the University 4-digit number followed by an alpha digit assigned to the individual elevator and shown on the construction documents. If the building has only one elevator the number would be XXXX-A; if two elevators the numbers would be XXXX-A and XXXX-B, etc.

   Note: When a building addition is undertaken, and additional elevator are added, the new elevators must be numbered consecutively after the existing elevators. If existing elevators are numbered xxxx-A and xxxx-B the next elevator added shall be “xxxx-C” etc. The reason being that the existing elevators are already listed as such in the State Elevator Inspector’s files and there can be no duplicates.

3. All elevator design must be done with consideration of and for the existing University of Kentucky elevator maintenance agreements. Copies of the contracts are available from the departments and/or the Purchasing Division.
    a. The maintenance agreements for different Facilities Divisions may not be identical having area-specific or use-specific deviations.
    b. At the end of the contractual obligation (warranty period) of any new elevator installation, the new elevator will be maintained under the service agreements then in existence.
    c. The end-of-warranty maintenance contract for a new elevator installation will be awarded through existing Purchasing Division procedures.

II. ELEVATOR EQUIPMENT

A. TRACTION ELEVATORS

1. Traction elevators shall be used for all medium-duty and heavy-duty applications that exceed 50 feet of travel or four stops.
    a. Overhead traction elevators to be used when conditions allow a penthouse above 50 feet of travel. (No maximum on size or speed).
    b. Basement set traction elevators to be used on elevator capacities of 4000# or more if penthouse is not an option (due to building conditions). (No maximum on size, speed limited to 200 fpm).
2. Traction elevators shall be used in parking ramps regardless of travel or number of stops.
3. Unless specified otherwise or emergency power is not available, emergency power shall be provided to a single elevator system, or, with selectivity switching, for one elevator in a bank of elevators.
4. Elevator equipment must include hall floor indicators on every level.
5. Controllers:
    a. Non-proprietary controllers:
        - Elevator Controls Corp. www.elevatorcontrols.com
        - Virginia Controls, Inc. http://www.vacontrols.com
        - Smartrise Engineering, Inc. www.smartrise.us
        - G. A. L. Manufacturing Corp. www.gal.com
    b. The controller shall be capable of continuous operation in ambient temperatures between 65 degrees F and 90 degrees F.
    c. Specialized diagnostic devices used to check the operation of the microprocessor and not permanently attached to the controller, shall be provided as part of the contract and shall become university property.

d. Diagnostic tools or devices requiring “reloading” or “recharging” by the manufacturer shall not be used on a University of Kentucky project.

6. Car Speed:

   Minimum 200 feet per minute (The Consultant may require and/or propose a higher speed for high-rise or group systems)

7. Rise:

   Any elevator utilizing more than four openings in line, or having abnormally tall floor heights (more than 12 feet), must be reviewed for speed requirements.

F. PUSHBUTTON FIXTURES

1. Provide vandal resistant pushbutton fixtures with tamper proof screws as manufactured by:

   a. Innovation Industries, Inc. www.innovationind.com
   b. GAL Manufacturing Corp. www.gal.com., or
   c. Elevator manufacturer tamper-proof push-button system. Refer to “ NON-PROPRIETARY EQUIPMENT, PARTS, AND CONTROLS” elsewhere in this Standard.

2. Locate digital car position indicators on each floor in the elevator lobby over the door opening, adjacent to the hoist way door entrance, or contained within the hall pushbutton fixture.

3. Use vandal resistant car direction indicators located on the elevator car to indicate direction of travel and visual arrows for car direction.

4. Provide arrival gongs at each elevator lobby.

5. Provide the Fire Service key switch at the main fire-recall lobby pushbutton.
   a. Provide a lighted jewel to indicate Fire Service Operation.
   b. Engrave, etch, or emboss fire service instructions on the fixture cover in accordance with ASME A17.1a.
   c. Provide etched, embossed, or engraved Fire Service Signage located on each hall pushbutton cover.

d. All Campus (CPPD) Fireman Service Keying requirements shall be for key number FEOK1 (Barrel shaped Key). Other Facilities Management Divisions may specify their keying options in specifications if different.

6. Push button designation numbering shall match the architectural room numbering designation i.e. if architectural drawing calls the lowest floor “Ground Floor” the elevator floor designation shall not be “Basement” etc.

7. Surface applied signage is prohibited.

G. POWER DOOR OPERATOR EQUIPMENT

1. Passenger Elevators

For passenger elevators, use only door operator equipment that includes drive operator, hangers, locks, closures, etc. as manufactured by GAL manufacturing Corp. (www.gal.com) 1-877-425-3538.

a. Door operators and related equipment for passenger elevator and freight elevators with bi-parting doors shall be by GAL Corp. model MOVFR with VVVF drive.

- Use low speed operators up to three-stop elevators.
- Use high-speed operators at all other locations.

III. CARS

A. CAR DESIGN

1. Interiors:

a. The car enclosure shall meet the requirements required by ASME A17 for smoke development and flame spread.
b. Car platforms shall be standard manufacturer sizes unless the University specifically requests a non-standard platform size.
c. Standard interior walls shall be small-patterned Rimex Metals 5WL Stainless Steel (unless approved otherwise).

Note: For a new building project or architectural renovations where the atmosphere of the building design will require an exceptionally refined interior, the architect may design the interior to suit the features and use of the building and present the design for review and approval.

d. The Contractor/manufacturer shall provide to the Owner/Consultant for review, car interior designs, and finish selections.
e. Install moving pad hooks in all elevator cars.
f. When moving pads are specified, provide a locked fireproof cabinet in the elevator equipment room for hanging storage of the pads.
g. Install ADA compliant handrails in the car.
h. For all medical facilities and buildings in which cart usage is anticipated or are to be used, bump rails shall be installed 4 to 6 inches above the floor level.
i. Car Flooring:
   - For all medical facilities, flooring shall be terrazzo.

2. Indicators:

   a. Locate the car digital position indicator over the transom or within the car-operating panel.
   b. Place the Car Direction Indicators in the car doorframe where they will visible from the vicinity of the hall pushbutton.
   c. Every car direction indicator must be visible from the immediate vicinity of the hall pushbutton.

3. In-car lighting:

   Each elevator car shall have an aesthetic ceiling structure that properly supports the installation of the number of lamp holders using LED low watt bulbs to appropriately laminate the interior of the car to system and code standards. Replacement of the lamps shall be easy access from the interior of the car.

B. CONTROL PANEL

1. Keys and switches:

   a. Provide switches for lights, fan (2-speed), emergency stop and service and/or inspection.
      - Toggle switches shall be located behind a locked door keyed with a best 7-pin small format cylinder. Door to have “Slam door lockset for service cabinet with a Yale or Best 7-pin security switch with removable core by Innovation Industries, Inc. or equal.
      - Key should be removable only in the normal locked position.
      - Use Best Cylinder with removable core and 7-pin small format for CPPD Division and 7-pin small format Yale cylinders with removable core for MPPD. Other Facilities Management Divisions will specify their keying options in specifications.

   b. Provide a two-speed fan switch; key should be removable in all positions; use Best Cylinder with removable core for CPPD and 7-pin Yale with removable core for MPPD). Other Facilities Management Divisions will specify their keying options in specifications.

   c. Provide each car-operating panel with an emergency stop key switch, key should be removable in all positions; use Best Cylinder with removable core for CPPD and 7-pin Yale with removable core for MPPD). Other Facilities Management Divisions will specify their keying options in specifications.

      - Position the cylinder near the bottom of the pushbuttons with the key removable in either position and with one set of normally closed contacts.
      - Mark the switch with etched, engraved, or embossed “ON” and “OFF.”

d. Where special key switches or card readers and/or other devices are used to lock out particular floor and/or functions:

- Wire controls so as not to interfere with Fire Service operation.
- Provide temporary inactivated push buttons for each floor even if a key switch, card reader, and/or other devices are required.

e. For restricted access to a Penthouse mechanical room, provide lock-out keyed switch on the Penthouse push button (the push button is to be activated by the keyed switch); key shall not be removable in the activation position. (Use Best Cylinder with removable core for CPPD and 7-pin Yale with removable core for MPPD). Other Facilities Management Divisions will specify their keying options in specifications.

f. For unrestricted elevator service to the penthouse, provide a keyed switch to over-ride the Penthouse mechanical room keyed button lock-out switch; key shall be removable in all positions (Use Best Cylinder with 7-pin small format removable core). Place this over-ride switch in the top area of the car panel. Other Facilities Management Divisions will specify their keying options in specifications.

2. Fireman Service Controls

In-car Fireman Service Controls shall be in a reachable, recessed, and in a locked panel in the control panel and at the top portion of the panel.

a. Engrave, etch, or emboss fire service instructions inside the fixture cover in accordance with ASME A17.1a.
b. Key number shall be FEOK1 (Barrel shaped Key) for all campus buildings.

3. Provide each car-operating panel with special language etched, engraved, or embossed pertaining to the posting of the Elevator Permit and the Capacity of the elevator.

IV. PIT, HOISTWAY, AND WELL HOLES

A. PIT AND HOISTWAY

1. Pit Access:

a. Provide a metal ladder from each pit floor starting 12" above the pit floor and extending to 48” above the lowest landing floor level.
b. Locate the ladder at strike jamb side of hoistway when single panel or two speed doors are used.
c. Where center opening doors are used, locate the ladder on the

nearest sidewall.

2. Sump Pit:
    a. Provide a sump pit with easily removable sump pump and approved cover below normal pit grade for all elevators.
    b. Pipe the sump pump discharge into an open gap drain connected to nearest sanitary sewer.
    c. Furnish the sump pump with integral oil sensor so that pump will not operate if hydraulic fluid is contaminating the water. Products are available from SEEWATER, Inc. (www.seewaterinc.com) 1-888-733-9283 or (EECO) www.elevatorequipment.com (1-888-577-33260).
    d. Provide a high-water alarm and run conduit and wire to the building Energy Management System's designated location.
3. Hoistway Entrances:
    a. Provide nickel silver or chrome plated cast iron sill plate at entrance threshold as manufactured by Plymouth Engineering Shapes of Hopkinsville, Kentucky www.plymouth.com/ or approved substitute. Grout sills in place with using a non-shrink, non-metallic grout.
    b. Set entrances in vertical alignment with car openings and aligned with plumbed hoist way lines. Use ¼" clearances around frame and doors as standard. Fill or slush hoist way doorframes.
    c. Provide dust covers at hoist way entrances that conceal the hoist way door tracks and interlocks. Provide covers no less than the width of the door opening plus 12". Mount covers securely to the header by use of metal screws with keyhole openings. The cover shall be capable of being removed without need of removing screws entirely.
    d. Provide sight guards permanently fastened to the hoist way door and of the same color or finish as the hoist way door. There shall be no holes in the guards other than those used to fasten the guard to the door.
    e. Provide a means of emergency access for each hoist way door as selected by the Owner and or current codes.
    f. Provide stainless steel hoistway doors and entrances with brushed stainless steel finish.
    g. Provide an approved automatic fire detection system (smoke detector) that will respond to visible or invisible particles of combustion connected to building fire alarm system at elevator lobbies and top of the hoistway.
    h. Provide hoistway venting as may be required by the KENTUCKY BUILDING CODE Section 3004.
    i. Provide car door protective device extending the full height. This device will be designed to sense an obstruction in its path while the doors are closing and automatically cause the car and hoistway door to return to the open position. The doors will remain open until the

expiration of a time interval and then close automatically. Device shall be Janus Pana40 Plus 3D. For manufacturer package systems, their system plug and play protective device is acceptable.

4. Maintain hoistway temperature between 50 to 90 degrees F.
5. Piping, conduit, and other Items unrelated to the elevator are prohibited in the hoistway or pit.

B. FIRE PROTECTION

1. If the building is fully sprinkled, it is required to have sprinklers in the top of the shaft and in the pit.
   a. All codes associated with a hoistway as to life safety, fire alarm, and sprinkler installation shall be applied.
   b. There shall be a sump provided in the pit with a sump pump satisfying all conditions for sump pump installations as described in this standard.

Note: Hoistway exemption allowed by the KBC (2007):

If the Hoistway is of noncombustible construction (concrete or concrete block) and the car enclosure meets the requirements of ASME A17.1 for smoke development and flame spread, the sprinkler in the top of the shaft may be omitted (also found in NFPA 13 code rule 8.14.5.5). (Always check current codes before applying this exemption.)

1. For fully sprinkled building, the pit shall always be sprinkled. The pit sprinkler shall be a sidewall sprinkler type with down-direction spray and the head must be located within 2’ of the pit floor.

C. WELL HOLES, CASINGS & CYLINDERS

1. Use steel cased holes for hydraulic applications sized properly for each set of circumstances. Place hydraulic cylinders in the pre-drilled casing and use a jack aligning disk light to align the cylinder in the presence of the Consultant.
2. Enclose hydraulic cylinders in PVC to prevent corrosion and electrolysis. Cap the bottom of the PVC liner extend it upward to a point higher than the pit floor.
3. Back fill the cylinder with dry sand from the bottom of the cylinder to the pit floor to prevent the bottom of the casing from moving. Provide a minimum of four (4) inches of concrete at the top of the cylinder to finish the pit floor.
4. Fasten top of cylinder to prevent unit from moving during operation. The elevator shall operate without the piston rubbing, bumping or otherwise contacting the inside wall of the cylinder during operation.

V. ELEVATOR EQUIPMENT ROOMS

A. ELEVATOR EQUIPMENT ROOM

1. Design:
   a. Integrate the elevator penthouses into the overall building architectural design to create a unified and compatible appearance from the exterior.
   b. For new construction, provide approved stairs for access to elevator equipment rooms. Ship's ladders and alternating tread stairs are prohibited.
   c. Equipment, piping, conduit, etc. unrelated to the elevator are prohibited in the elevator equipment room.
2. Fire Protection:
   a. If the building is fully sprinkled, it is required to have sprinklers in the equipment room.

   Note: Equipment Room Exemption allowed by the KBC (2007): If the equipment room is two-hour rated, the sprinklers may be omitted. To apply this exemption, the contractor shall have the approval of the University Fire Marshal. (Always check current codes before applying this exemption.)

   c. Provide 2-hour fire-resistant, labeled, and latching door with closer and Storeroom function mortise lockset.
   d. Provide a fire extinguisher in machine room mounted on the wall near the entrance door. A cabinet for the fire extinguisher is not required.
   e. Provide an approved automatic fire detection system (smoke detector) that will respond to visible or invisible particles of combustion connected to building fire alarm system.
4. Climate Control:
   a. Provide HVAC building or self-contained equipment and ducting to maintain machine room temperature between 50 to 90 degrees F.
5. Data/Communications:
   a. Furnish data line terminated in a telephone jack in each elevator equipment room (only if specified and/or required on the specific project).
   b. Furnish two (2) telephone lines in each elevator equipment room. One line is to be used for the emergency call system and one line is to be used for a remote monitoring system. The University will be responsible for activation of the telephone lines.
   c. For all campus installations, including Medical Center, the elevator is to be connected to the existing Tridium Building Automation System. All

associated hardware, software, cabling and conduit for a complete connection to the system is to be included as part of the elevator contract. Connection is to be made via BacNet/IP, BacNet/MSTP or Modbus protocols.

7. Equipment Room Security:
   a. CPPD – Key to building mechanical room system; Owner to supply information.
   b. MPPD – Install card reader to match building system.
   c. Other Departments – Key by department instructions.
8. Equipment room signage:

   The contractor shall provide and install a sign on the door stating that "Combustible storage prohibited by Fire Codes." The sign shall match the signage in the building and prior to installation shall have the approval of the Owner. Adhesive applied signs are disallowed.

B. WIRING AND LIGHTING

1. Elevator Equipment Room:
   a. For each elevator, provide properly sized main line disconnect mounted on the wall adjacent to machine room door.

   b. Use only rigid conduit in the elevator machine room for main power equipment. Minimum conduit size of ¾".
      - EMT may be used for low-voltage control wiring.
      - Provide adequate machine room LED lighting, especially at controller and around equipment.
      - Locate lighting to avoid conflict with installation of equipment such as motors and cables.

   c. Provide a hoist way lighting system for every elevator as follows:
      - Provide a light at the top of the hoist way.
      - Provide 4-way switch control system for the lights in the elevator pit, at the top of the hoist way, and in the elevator equipment room. In the elevator equipment room, use a pilot light or lighted toggle to indicate an "on" circuit.
      - Locate Pit light switch next to pit ladder and located 42" above lobby floor level.

   d. Provide LED lighting throughout.

VI. MANUFACTURERS, SUPPLIERS, AND INSTALLERS

A. The following Elevator Manufacturing Companies are approved; including, but not limited to:

1. CemcoLift, Inc. (Manufacturer of Traction and Hydraulic Elevators)
   2801 Township Line Road
   Hatfield, PA 19440-0500
   Toll Free: (800) 962-3626
   Phone: (215) 799-2900
   Fax: (215) 703-0358
   www.cemcolift.com

2. Canton Elevator Incorporated (Manufacturer of Hydraulic Elevators only)
   647 Third Street N.W.
   Massillon, Ohio 44647
   Phone: (330) 833-3600
   Fax: (330) 833-0229
   www.cantonelevator.com

3. ThyssenKrupp Elevator Company (Manufacturer of Traction and Hydraulic Elevators)
   7217 East 87th Street, 46256
   Indianapolis, IN
   Phone: (317) 595-1125
   www.thyssenkruppelevator.com

4. Kone, Inc. (Manufacturer of Traction and Hydraulic Elevators)
   5201 Park Emerson Dr., Suite E,
   Indianapolis, IN 46203
   Phone: (317) 788-0061 d.
   www.kone.com

5. Schindler Elevator Corporation (Manufacturer of Traction and Hydraulic Elevators)
   1761 North Sherman Drive, Suite E,
   Indianapolis, IN 46218
   Phone: (317)486-0906
   www.us.schindler.com

6. Global-Tardif Elevator Manufacturing Group Inc.
   120 De Naples Saint-Augustine-de-Desmaures
   Quebec, Canada G3A 2Y2
   Phone: (800) 661-6316
   Fax: (418) 878-1595
   www.globaltardif.com

7. Otis Elevator Company
   1901 Production Drive
   Louisville, KY 40299
   Phone: (502)491-3636
   Fax: (502)491-8611

B. The following Elevator Installing Companies may supply and install elevator equipment purchased from third party manufacturers but must meet the requirements of this standard and be approved by the University Project manager; including, but not limited to:

1. DC Elevator (Supplier and installer of Traction and Hydraulic Elevators)
   124 Venture Court- Suite 1
   Lexington, KY 40511
   Phone: (859) 254-8224
   Fax: (859) 231-8740

2. The Murphy Elevator Co., Inc. (Supplier and installer of Traction and Hydraulic Elevators)
   128 East Main Street,
   Louisville, KY 40202
   Phone: (800)321-1527
   www.murphyelevator.com

3. Oracle Elevator Company (Supplier and installer of Traction and Hydraulic Elevators)
   4523 Knopp Avenue,
   Louisville, KY 40213
   PH. (502)363-9300
   www.oracleelevator.com

End - University of Kentucky Elevator Standard

SECTION 142100 - ELEVATOR SYSTEM REFURBISHMENT

1. SCOPE

1.1 This section of the Specification includes, but is not limited to, the furnishing of all labor, equipment, tools, supervision, materials, technical design services, shop drawings, and related items as required for the refurbishment of the University of Kentucky Chandler PAV H Elevators 9 and 10.

1.2 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

2. REFERENCES

2.1 Applicable Codes (Latest Edition):

2.1.1 2018 Kentucky Building Code (2015 IBC).

2.1.2 American Society of Mechanical Engineers, A17.1 Safety Code for Elevators and Escalators with Kentucky exceptions or amendments, latest edition or as required by local code.

2.1.3 Americans with Disabilities Act – Accessibility Guidelines (ADAAG).

2.1.4 NFPA 70 – National Electrical Code (NEC).

2.1.5 American National Standard Accessible and Usable Buildings and Facilities (ANSI A117.1).

2.1.6 Earthquake provisions as required by local code.

2.1.7 Local codes.

2.1.8 Authorities having jurisdiction.

2.1.9 ASME A17-1 and ASME 17-3.

2.1.10 University of Kentucky Standards.

3. NON-PROPRIETARY EQUIPMENT, PARTS, AND CONTROLS

3.1 The University of Kentucky does not have in-house maintenance personnel and therefore relies upon contractor(s) to maintain the equipment. The maintenance contractor is acquired through a bid process and is not necessarily the original equipment manufacturer or installer. Therefore, it is required that, for specific items indicated, University of Kentucky approved and non-proprietary equipment, parts, and controls items (including circuit boards, chips, diagnostic tools, etc.) be bid and installed. Approved and acceptable non-proprietary controls, tools, passwords, equipment, parts, and training necessary to service the elevator be provided to the University of Kentucky by the manufacturer and/or the Contractor.

3.2 An elevator manufacturer and/or their suppliers may bid for and, if successful, furnish and install their as-designed elevator systems for installation in University of Kentucky buildings or construction projects. With their bid documents, there must be submitted a statement that

there are no proprietary parts or equipment in the elevator system(s) and that they are meeting the intent of this standard (i.e. that any and/or all parts, materials, maintenance drawings, maintenance tools, circuit boards, etc. will be available to the University and/or its elevator service provider(s) at the prevailing wholesale market prices at the time of need. The following statement will be part of elevator bid requests to satisfy the requirement of this item -

> "The undersigned bidder/company hereby agrees that no proprietary situations will be imposed as to the providing to the University's elevator service providers any maintenance drawings, equipment, parts, or control items (including circuit boards, chips, diagnostic tools, etc.), etc. required for the maintenance and upkeep of the elevators provided on this project. Further, the items will be sold to the University's elevator service providers at current wholesale costs and without undue delay."

4. SPECIAL REQUIREMENTS BY UK FIRE MARSHAL

4.1 When emergency power is provided for the elevator system, the elevator(s) shall be tested under FULL load on the generator. This would include all emergency lighting and other emergency loads connected to the generator.

4.2 Fireman's Service shall be tested under emergency power conditions.

4.3 Verify Fireman Service priority floor designation with the UK Fire Marshal's office.

4.4 Provide a UK Fire Marshal approved lockable secure storage box on the Priority 1 floor for the fireman's service key(s).

5. DESCRIPTION OF WORK

5.1 Provide new elevator finishes as described on architectural drawing.

5.2 Replace elevator system controllers with microprocessor type.

5.3 Replace hoist drive motor with Variable Voltage Variable Frequency (VVVF) Elevator Rated Motor.

5.3.1 The drive shall be capable of varying the torque on the motor during acceleration and deceleration.

5.3.2 The drive shall be capable of on-site programming the volts per Hertz acceleration and deceleration ride profiles to adjust the ride quality to drive control characteristics.

5.3.3 The flux vector drive shall control AC induction motors through the use of a high resolution, dual channel optical reader.

5.3.4 The flux vector drive shall be capable of delivering 100-percent rated motor torque from base speed down to zero speed.

5.3.5 The flux vector drive shall not use DC injection for slowdown braking.

5.3.6 The flux vector drive shall be adjustable to achieve the required current motor voltage and frequency so as to match the characteristics of the hoist motor.

5.3.7 The drive shall not create excessive audible noise in the elevator motor.

5.3.8 The drive shall be capable of delivering sufficient current to accelerate the elevator to contract speed at the rated load. The drive shall provide speed regulation within 3-percent during all phases of acceleration, deceleration and leveling.

5.3.9 Power Conversion and Regulation Unit: Provide solid-state motor drive. Solid state units shall be designed to limit current, suppress airborne or structural noise, and shall limit the electrical distribution system to a maximum of 3-percent. This shall include compensation for harmonic distortion, power factor, flicker and line notching. The Contractor/Installer shall be responsible for furnishing any electrical changes or upgrades required if power conversion system other than specified is provided. Provide 40 durometer double deflection neoprene mounts sized for a static deflection under load of minimum 3/16-inch for mounting the unit.

5.4 Replace geared traction machines and deflector sheaves with AC gearless machine as indicated.

5.5 Machine Beams: Review existing conditions and provide steel beams, channels and bearing plates to support machine, governors and rope hitches as required for a complete installation. Include any required clip angles; tie rods, etc. as required. Where beams project above machine room slab provide metal decking as required by Code to eliminate any tripping hazard. Provide vibration sound isolation to eliminate structure-borne sound being transmitted to the building. Select isolators to compress a minimum of 0.1-inches under load.

5.5.1 Deflector Sheaves: Where required, provide cast iron machined and grooved for diameter of ropes and supported by an “A Frame” type mounting. Provide cable guards designed to withstand shock and prevent ropes from leaving their proper grooves. All bearings are to be shielded or sealed.

5.5.2 Sleeves and Guards: Provide sleeves projecting 4-inches above concrete slabs for holes in machine room floor. Provide guards for sheaves and ropes.

5.6 Replace hoist ropes in each of the elevators.

5.7 Replace governor, associated governor ropes and tail sheaves.

5.8 Replace guide roller assemblies on car and counterweight.

5.9 Provide elevator pit ladders, light switches and GFI receptacles to meet Elevator Code requirements, if required.

5.9.1 Provide emergency stop switch in pit.

5.10 Recondition guide rails in hoist way, if required.

5.11 Replace car safety devices to meet current Codes.

5.12 Upgrade existing inspection station located above car to meet current OSHA Requirements.

5.13 Upgrade elevator systems control fixtures and hardware to meet requirements of the Americans with Disabilities Act (ADA) and use LED Technology.

5.14 Provide complete replacement for the interior finish of the elevator cars, complete with finished ceiling with lighting.

5.14.1 Existing tarazzo floors to remain and be refinished.

5.15 Replace traveling cables for each car and associated hardware.

5.16 Replace door operators, door hangers, clutch, rollers and associated hardware.

5.17 Provide safety door beam detector and door protection device.

5.18 Replace hoist way door tracks and door interlocks and door guides.

5.19 Install door jamb Braille at every elevator hall door.

5.20 Replace emergency fireman phone jacks in elevators.

5.21 Provide new doors and electrostatically paint.

5.22 Adjust door equipment.

5.23 New elevator shall match the existing elevator speed, unless noted otherwise.

5.24 Field check and repair as required fireman services for the elevator system. Provide interface to the fire alarm panel for elevator recall. Add fire alarm modules as required to meet latest Code Requirements.

5.25 Provide counter weight buffers.

5.26 Attachment of total system to building structure.

5.26.1 Structure is existing. If additional structure is required, it is to be provided by the elevator trade contractor.

5.27 Rigging from hoisting points for installation of equipment.

5.28 Acceptance testing: by local authorities.

5.29 Integration of control and technology systems: Hard wiring and point of presence coordination at cabs and machine rooms.

5.30.1 Security and access control including video monitoring.

5.31.2 Emergency power operation.

5.31.3 Building Control Systems Integration.

5.31.4 Fire and emergency protocol operation.

5.31.5 Telecommunication systems.

5.31.6 Vertical transportation systems remote monitoring.

5.31.7 Other monitoring systems identified by Owner.

5.32 Elevators 1,2,3, 9 & 10 shall have 4000 lb. capacity, 350 FPM, 9-stops.

5.33 Provide new hoistway access key switches for each elevator at ground floor and top floor for hoistway maintenance.

5.34 Provide new firefighter control station for each elevator at ground floor.

6. QUALITY ASSURANCE

6.1 The Elevator Contractor shall have previous experience renovating a minimum of (2) two elevator systems with at least (10) ten floors each in an active healthcare facility. The experience shall include work similar to this project as described in paragraph 2. The Contractor shall provide with bid a list of projects, descriptions, and references that would satisfy the experience requirements as stated in this paragraph.

6.2 The Elevator Contractor shall have a factory trained mechanic on site to supervise the installation of equipment for this project. This mechanic shall be certified by the elevator equipment manufacturer of this project to install the elevator controllers. The mechanics' certification and resume shall be submitted with bid.

6.3 The service mechanics certification, resume, address and telephone number of the service office shall be submitted with bid. An answering service is not considered as a service office. Response time for personnel will be a strict 15 minutes to rescue trapped passenger. 1 hour for maintenance call or repair.

6.4 The Elevator Contractor shall provide a 24-hour telephone answering service (not a machine) for all calls after normal office hours for the warranty and maintenance work of the equipment installed in this project.

6.5 The equipment manufacturer for the door protection system and elevator controllers shall be distributed by the manufacturer on a nation-wide basis. System that requires proprietary maintenance tool or diagnostic is not acceptable.

6.6 The installation and equipment of this project shall comply with the latest edition and applicable requirements of the "American Standard Safety Code for Elevators and Escalators" (ANSI A17.1) published by the American Society of Mechanical Engineers, the National Electrical Code, applicable NFPA codes, the Kentucky Building Code and specifically with sections relating to electrical work and elevators.

6.7 Permits and Inspections. The Elevator Contractor shall obtain and pay for necessary Municipal or State inspections and permits and make such tests as called for by the regulations of such authorities. These tests shall be made in the presence of the authorized representatives of such authorities.

6.8 Guarantee. The Elevator Contractor shall guarantee the materials and workmanship of the apparatus installed by him under this specification; and that he will make good any defects, which may develop within one year from date of final acceptance.

6.9 Safety Provisions. The Elevator Contractor shall supply all necessary materials, labor, equipment, and tools as required to install, maintain and remove safety and protection devices

and systems as necessary to protect the building occupants, the public, and construction personnel as well as all existing building components adjacent to or within the existing elevators during all work. All damage to existing work and property within or adjacent to the existing elevators shall be repaired or replaced by the Elevator Contractor at no additional expense to the Owner.

6.10 Coordination. The Elevator Contractor shall coordinate all work sequences and material installation with the Engineer and the Owner to allow for the minimum length of time for work to be performed on site. The Contractor shall plan his work in such a manner that once an elevator is removed from service, all work has to be completed before the elevator can be returned to service. When in-car work is performed the Elevator Contractor shall position the car at a floor designated by the Owner and perform all work at that location.

7. TEMPORARY SERVICE

7.1 Should service of any elevator be required for other contractors to install work such as sprinklers, smoke alarms, heat detectors, conduits and other work related to elevator hoist way, or for any other reason, before completion and final acceptance, obtain permission in writing from Engineer and elevator manufacturer and meet the following conditions:

7.1.1 Comply with safety regulations of agencies referenced herein and in the CPMD Division 01 - General Requirements.

7.1.2 Coordinate with temporary hoisting specified in the CPMD Division 01 - General Requirements. User shall sign the elevator manufacturer's temporary acceptance form and be bound by terms and conditions thereof.

7.1.3 Pay costs of personnel, special inspections, and any additional equipment required for temporary use of elevators.

7.1.4 Do not overload or abuse elevators or related equipment.

7.1.5 Repair damages or replace with new if directed by Engineer

7.1.6 Extend warranty starting on date of acceptance of elevators by Engineer. Termination of use of elevators if after date of Substantial Completion.

8. ELECTRIC SERVICE

8.1 Power: 208-volts, 3-phase, 60 hertz. Contractor/Installer to verify.

8.2 Lighting: 120-volts, 1-phase, 60-hertz.

9. MATERIALS AND EQUIPMENT

9.1 ADA COMPLIANCE The elevator car equipment and signal fixtures shall be replaced to comply with ADA. The work includes but not limited to the following:

9.1.1 The elevator system shall have an automatic self-leveling feature that will bring each car to floor landings within a tolerance of 1/8 inch of floor landing under rated loading to zero loading conditions.

9.1.2 Hall call station buttons shall be centered at 42 inch above finish floor with visual signals to indicate call is registered and answered. Replace all Hall call station buttons with vandal resistant type with tamper proof screws that are ¾ inch diameter and with #4 stainless steel finish unless otherwise noted. Hall call buttons shall be raised. Station shall be compatible with the existing elevator equipment to remain. Each intermediate station shall consist of two L.E.D. illuminated pushbuttons with raised direction arrow, one for the up direction and the other for the down direction. Each station shall contain an illuminated pushbutton with raised direction arrow. The buttons shall be illuminated to indicate that a call has been registered at that floor for the indicated direction.

9.1.2.1 Hall call stations shall be manufactured by GAL Manufacturing Corp. or equal.

9.1.3 Provide Hall Position Indicator on each floor for each elevator. Hall position indicator shall be LED type with Hall Lanterns with two digit display and up and down arrows. Hall Lanterns with vandal resistant type with #4 stainless steel finish and visible/audible signal at each hoistway entrance. This Hall Lantern shall indicate which car is answering a call. The audible signal shall sound once for UP, twice for DOWN. Hall Lanterns shall be mounted at least 72 inches above lobby floor and the visual element shall be at least 2 ½ inches in the smallest dimension.

9.1.4 Provide raised and Grade 2 Braille characters for floor designations on both jambs at each Hoistway entrance. The characters shall be located at centerlines 60 inches above each floor level, raised 1/32 inch minimum. The characters shall be upper case type and 2 inches high.

9.1.5 Replace Car control panel buttons with vandal resistant type with #4 stainless steel finish. The control buttons shall be designated by Braille, minimum 5/8 inch high but no higher than 2 inches. Car control buttons shall be located between 35 inches and 48 inches above elevator floor.

9.1.6 Replace visual car position indicators (CPI) to provide audible and visual indication as the car passes or stop at a floor. The CPI shall have #4 stainless steel finish.

9.1.7 Door and signal timing for hall calls shall comply with ADA requirements.

9.1.8 Door delays for car calls shall comply with ADA requirements.

9.1.9 Two-Way Communication

9.1.9.1 The device shall consist of a single pushbutton, automatic dialer with appropriate indicator lights, and all other essential features necessary to comply with ADA.

9.1.9.2 T**he emergency phone shall be Ramtel Model RR833-OEM and be mounted flush on the back of a hinged door at the bottom portion of the in-car control panel and locked with a barrel key (Barrel Key #EX513.) .**

9.1.9.3 **The communication device shall be as manufactured by Ramtel to match the existing elevator emergency communication system including remote location indicator and other existing features now in use (for example, the Blue Tower emergency phones throughout campus).**

9.1.9.4 A stand-alone flush box-type device is not to be used without approval of the Owner.

9.1.9.5 The face plate shall have, including but not necessarily limited to:

EMERGENCY PHONE

UNIVERSITY OF KENTUCKY
(include UK logo - Contact UK Public Relations for most recent logo updates)

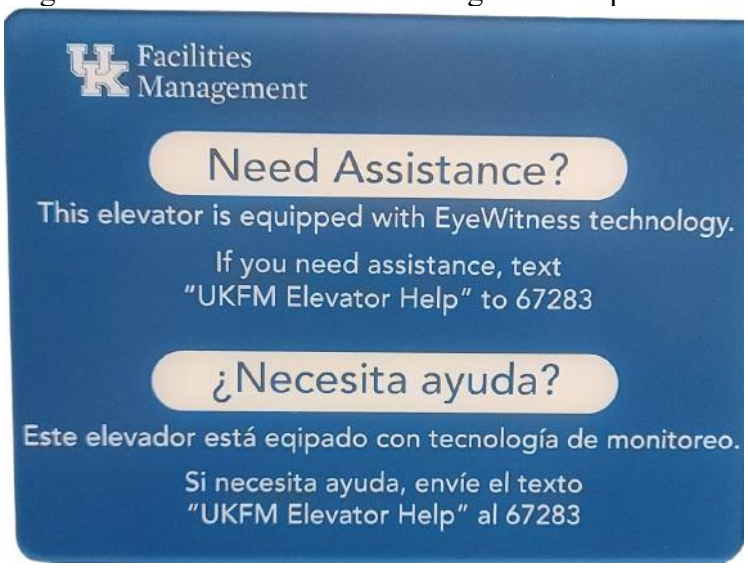
Other information and instructions on the faceplate are as provided by TAP VOIP communication device.

Note: Emergency phones on the campus grounds at selected locations may be added to and annunciate on the Digital Display system.

9.1.10 **RAVE Eyewitness Signage** should be included in every University of Kentucky owned elevator. The signs are 7.5 inches wide and 5.5 inches tall and should be installed at eye level as close to the emergency elevator call box as possible inside the elevator car. The signs are constructed from a hard plastic with quality 3M 467MP 200MP adhesive on the back. They should be UK Blue with white wording.

9.1.10.1 The University Sign Shop has this on file and sample pictured below.

9.1.10.2 Wording should be as follows in both English and Spanish:



Need Assistance?
This elevator is equipped with EyeWitness technology.
If you need assistance, text
"UKFM Elevator Help" to 67283

9.1.11 Contractor shall provide a minimum of (2) cat 6 phone lines in traveler cable for each elevator car for VOIP connection.

9.2 Control System. The elevator system shall have a microprocessor based and software oriented control system including but not limited to controllers and group controllers. The control system shall be compatible with the existing elevator equipment being used during renovation. The control system shall use a centralized control scheme with all control functions located in the elevator machine room. The microprocessor software package shall be factory written. However, the programming shall be flexible and allow programming to match operational requirements. The control system shall be located in a single, self-supporting, floor

mounted cabinet installed in the existing elevator machine room. The control system cabinet shall include built-in climate control.

9.2.1 Selective Collective:

9.2.1.1 With two cars in service, one car shall normally park at the main floor ("home car") with doors open. The other car ("free car") shall park at landing last served with doors closed.

9.2.1.2 The free car shall answer hall calls above or below the landing at which the car is standing, except main floor hall calls.

9.2.1.3 When the free car is clearing calls, the home car shall respond to:

9.2.1.3.1 A call registered on the home car buttons.

9.2.1.3.2 An up hall call from the landing below the free car while the free car is traveling up.

9.2.1.3.3 An up or down call registered from the landing above the free car while it is traveling down.

9.2.1.3.4 Inability of the free car to clear all hall calls within approximately 40 seconds.

9.2.1.4 Registration of car call button shall cause the car to start. The car shall respond to its own car calls and corridor calls, in the direction of travel, and in order in which the landings are reached.

9.2.1.5 Only one car shall stop in response to any one-hall call. The first car to complete all calls shall return to the main floor.

9.2.1.6 The car shall remain at the arrival floor for an adjustable interval to permit passenger transfer. Doors shall close after a predetermined interval, unless the car is parked at the main floor, after opening unless closing is interrupted by car door reversal device or door open button in car.

9.2.1.7 Delayed Car Protection: The system shall automatically disassociate a car from the Duplex system in the event the car is delayed for a predetermined time. The car shall be automatically restored to the Duplex System when the cause of the delay has been eliminated.

9.2.1.8 Programmed Door Control: Separate adjustable times shall be provided for each car to establish minimum passenger transfer time for car stops, intermediate floor hall call stops and lobby floor stops. All timing shall be computerized to coincide with traffic demands.

9.2.1.9 Designated Parking: The system shall provide for cars to park as designated by the Duplex system or park at its last call.

9.2.1.10 Ascending Car Overspeed and Unintended Car Movement Protection: Provide operation to prevent the elevator from striking the hoistway overhead or unintended car movement per the requirements of the code.

9.2.2 Failure of any single magnetically operated switch, contactor, or relay to release in the intended manner; the failure of any static control device, speed measuring circuit, or speed pattern generating circuit to operate as intended; the occurrence of a single accidental ground or short circuit; shall not permit the car to start or run if any hoistway door or gate interlock is

unlocked or if any hoistway door or car door or gate contact is not in the made position. Furthermore, while on car top inspection or hoistway access operation, failure of any single magnetically operated switch, contactor or relay to release in the intended manner; the failure of any static control device to operate as intended; or the occurrence of a single accidental ground, shall not permit the car to move even with the hoistway door locks and car door contacts in the closed or made position.

9.2.3 An out of service timer (T.O.S) shall be provided to take the car out of service if the car is delayed in leaving the landing while there are calls existing in the system (timer shall be adjustable).

9.2.4 Door protection timers shall be provided for both the opening and closing directions, which will protect the door motor and will help prevent the car from getting stuck at a landing. The door open protection timer shall cease attempting to open the door after a predetermined time in the event that the doors are prevented from reaching the open position. In the event that the door closing attempt fails to make up the door locks after a predetermined time, the door close protection timer shall reopen the doors for a short time. If, after a predetermined number of attempts, the doors cannot successfully be closed, the doors shall be opened and the car removed from service.

9.2.5 A minimum of four different door standing open times shall be provided. A car call time value shall predominate when only a car call is canceled. A hall call time value shall predominate whenever a hall call is canceled. In the event of a door reopen caused by the safety edge, photo eye, etc., a separate short door time value shall predominate. A separate door standing open time shall be available for lobby return.

9.2.6 If the doors are prevented from closing for longer than a predetermined time, door nudging operation shall cause the doors to move at slow speed in the closed direction. A buzzer shall sound during the nudging operation.

9.2.7 The control system shall provide field programmability of specific timer values (i.e., door times, etc.). The value of these timers may be viewed and/or altered through use of the on-board switches and pushbuttons.

9.2.8 The control system shall provide programmable parking operation, lobby operation, time activated or demand activated dispatching configurations including but not limited to lobby up peak traffic, down peak traffic, and up peak traffic.

9.2.9 The elevator control system shall include load weighing device which, when the particular car is filled to an adjustable percentage of the capacity load, shall cause the car to bypass the landing calls but not car calls.

9.2.10 The elevator control system shall include an anti-nuisance call control. The control system shall evaluate the number of people on the car and compare that value to the number of car calls registered. If the number of car calls exceeds the number of people by a field programmable value, than the car calls shall be canceled after the first call has been answered.

9.2.11 The control system shall use a device to establish incremental car position to an accuracy of .1875" (4.76 mm) or better utilizing a quadrature signal for the entire length of the hoistway.

9.2.12 The elevator control system shall use the optimized velocity profile in a dual-loop feedback system based on car position, speed and distance feedback. A velocity feedback device (tachometer or encoder) shall permit continuous comparison of car speed with the calculated

velocity profile to provide accurate control of the acceleration and deceleration right up to and including the final stop, regardless of direction of travel or load in the car.

9.2.13 Hospital Emergency (Code Blue) Operation:

9.2.13.1 Provide a spring return momentary contact two-position key switch within each hall station.

9.2.13.2 Key switch shall have its "OFF" and "ON" positions identified on a blue bezel. The key shall be removable only in the "OFF" position.

9.2.13.3 Provide a blue LED indicator on all group Hall Call station that will illuminate when a car is in code blue operation.

9.2.13.4 Provide a timing feature that shall return the elevator to operation if the Code Blue switch within the elevator is not activated within 30 seconds.

9.2.13.5 Momentary contact of the key switch in the "ON" position summons the nearest elevator to that designated floor.

9.2.13.6 Upon arrival the attendant activates a two-position key switch within the car operating panel.

9.2.13.7 Key switch shall have its "OFF" and "ON" positions identified on a blue bezel. The key shall be removable only in the "OFF" position.

9.2.13.8 Activation if the car key switch places the elevator in the Independent Service mode.

9.2.13.8.1 Elevator is removed from normal operation.

9.2.13.8.2 Control is from car buttons only.

9.2.13.8.3 Car shall not respond to hall calls.

9.2.13.9 The elevator then proceeds to the requested floor.

9.2.13.9.1 The car key switch in the "OFF" position deactivates the operation.

9.2.14 Central Monitoring System:

9.2.14.1 The elevator is to be connected to the existing Tridium Building Automation System. All associated hardware, software, cabling and conduit for a complete connection to the system is to be included as part of the elevator contract. Facilities Management will provide the programming at the existing headend to interface with the BAS. Refer to following table for points that will be interfaced to the Tridium System:

Object List	Object Type	Alarmable	Description
Floor	A1	N	Current Floor Card is on or floor being called to
Controller Power	B1	Y	Power condition of controller
Controller Communications	B1	Y	Communication condition of controller
Up Direction	B1	N	Travel Direction

Down Direction	B1	N	Travel Direction
Door Open	B1	N	Door Open Limit
Door Closed	B1	N	Door Close Limit
In Normal Service	B1	N	Service Condition
Inspection Service	B1	N	Service Condition
Independent Service	B1	N	Service Condition
Fire Service	B1	N	Service Condition
Door Disabled	B1	Y	The doors appear to be disabled for use
Emergency Power	B1	Y	Power condition of controller
Safety Circuit	B1	Y	An electrical contact wired in the main safety circuit is open. Car will not run. May be temporary condition.
Door Fully Open and Locked at the Same Time	B1	Y	The doors appear to be locked and fully open simultaneously.
Bypass System Fault	B1	Y	Either the car door or hall door bypass switch (or circuit) has failed.
Door Lock Relay Fault	B1	Y	Either the car gate or the hall door relay (or input) has failed.
Door Zone Relay Fault	B1	Y	The door zone relay (or input) has failed.
Emergency Stop Relay Fault	B1	Y	Either the GTS or GTSX relay has failed
Inspection Switch Fault	B1	Y	An Inspection switch or input has failed
Level Relay Fault	B1	Y	The LVL relay has failed.
Stop Relay Fault	B1	Y	The STOP relay has failed.
Door Lock System Fault	B1	Y	Either the car gate or a hall door lock has been shunted.
Governor Contact System Fault	B1	Y	The overspeed governor has activated.
Front Door Limit System Fault	B1	Y	One of the two front door limit switches has failed in the open state.
Rear Door Limit System Fault	B1	Y	One of the two rear door .imit switches has failed in the open state.
Contactor Drop System Fault	B1	Y	Contactor proffing fault (a monitored contactor did not drop as expected).
Unintended Movement System Fault	B1	Y	The car has left the floor with doors open.
Car Stop Bypass Relay Fault	B1	Y	The CSB relay has failed.
Drive Fault	B1	Y	The drive has declared a fault (or the DDRV relay has failed).
Down Relay Fault	B1	Y	The D relay has failed.
Up Relay Fault	B1	Y	The U relay has failed.

9.2.16 The car controller shall include a minimum of one serial port for display terminal communication. The display terminal shall be used to view and alter the individual car operating parameters such as jerk, acceleration, deceleration, contract speed, leveling distances, etc. Remote configuration of individual car operating parameters shall be permitted when the car controller is attached to a CRT/modem and an established protocol has been followed.

9.2.17 A special event calendar shall record approximately 500 noteworthy events or faults of a particular car. They shall be displayed in chronological order for examination or review. Data

displayed shall include the type of event or fault, the date and time it occurred, the position counter value and the status of various flags at the time of the occurrences.

9.2.18 Specialized diagnostic devices used to check the operation of the microprocessor and not permanently attached to the controller, shall be provided as part of the contract and shall become University property.

9.2.18.1 Diagnostic tools or devices requiring "reloading" or "recharging" by the manufacturer shall not be used on a University of Kentucky project.

9.2.19 The elevator control system Controller shall be by Smartrise Engineering Inc., or approved equal.

9.3 Car Design.

9.3.1 Keys and switches.

9.3.1.1 Provide switches for lights, service or inspection. Keys should be removable for lights in all positions; keys should be removable only in the normal positions for temporary use functions. Provide cylinders with removable core as specified by the University.

9.3.1.2 Provide a two-speed fan switch; key should be removable in all positions; Provide cylinder with removable core as specified by the University.

9.3.1.3 Provide each car-operating panel with an emergency stop key switch, key should be removable in all positions; Provide cylinder with removable core as specified by the University.

9.3.1.3.1 Position the cylinder near the bottom of the pushbuttons with the key removable in either position and with one set of normally closed contacts.

9.3.1.3.2 Mark the switch with etched, engraved, or embossed "ON" and "OFF".

9.3.1.4 Where special key switches or card readers and/or other devices are used to lock out particular floor and/or functions -

9.3.1.4.1 Wire controls so as not to interfere with Fire Service operation.

9.3.1.4.2 Provide inactive push buttons for each floor even if a key switch, card reader, and/or other devices are required.

9.3.2 Fireman Service Controls

9.3.2.1 In-car Fireman Service Controls shall be in a reachable, recessed, and in a locked panel in the control panel and at the top portion of the panel.

9.3.2.1.1 Engrave, etch, or emboss fire service instructions inside the fixture cover in accordance with ASME A17.1a.

9.3.2.1.2 Keying options will be specified by the University.

9.3.3 Provide each car-operating panel with special language etched, engraved, or embossed pertaining to the posting of the Elevator Permit and the Capacity of the elevator.

9.3.4 Car Control Panel. Replace Car Control Panel in each of the cars. The station shall be installed in such a manner to provide optimum viewing and accessibility. The lowest module shall contain the "door open," "door close," "emergency stop switch," and alarm button. Intermediate modules shall contain L.E.D. illuminated floor buttons which will illuminate when a call is registered and will remain illuminated until the call is answered. The top module shall contain the required switches. All raised floor indications and handicap symbols shall be located immediately adjacent to the floor buttons and fully integrated in the module design. No applied symbols shall be allowed. There shall be no floor indications or symbols on the buttons.

9.4 Hoist way Cables. Replace hoist way cables for all cars.

9.4.1 Hoisting ropes shall be designed for elevator service, with flexible construction traction steel with lubricated fiber core; sized and provided with number of strands to suit loading imposed. Ropes shall be free of kinks and displaced or broken wires. Provide sheet metal and angle iron guards at openings in machine room floor and as required to protect personnel from accidental contact.

9.5 Governors and Safety Devices: Replace governors, safety devices and ropes.

9.5.1 Provide emergency stop switch at elevator pit next to each ladder to stop elevator on emergency.

9.6 Provide additional controller and relay to sequence each elevator automatically on emergency power upon normal power failure. Modify existing relays as required.

9.7 Elevator Gearless Traction and Equipment:

9.7.1 Replace present geared traction machines completely with AC gearless machine with permanent magnetic synchronous motor, direct current electromechanical disc brakes and integral traction drive sheave, mounted to the car guide rail at the top of the hoistway.

9.7.2 Replace all drive motors with new motors.

9.7.3 All Drive Motors shall be designed for Elevator Operation.

9.7.4 Provide a complete new disc brake system, complete with pins, and brake with OEM approved linings.

9.8 Performance: Rated speed shall not vary more than 5% under all loads.

9.9 Hoist way Equipment: Miscellaneous holes shall be patched, ledges over 2 inch shall be beveled as required to meet ANSI Code Requirements.

9.9.1 Inserts: Inspect, tighten, repair inserts as necessary to ensure a smooth safe ride.

9.9.2 Supports: Inspect all machine, deflector, governor, buffer, and related supports and fastenings.

9.9.3 Guide Rails: Inspect, clean, align, tighten rails to comply with ASME A17.1. File surfaces for smooth even ride. Plumb rails to existing building conditions.

9.9.4 Buffers: Inspect, clean, repair, flush, fill, lube, and paint buffers.

9.9.5 Counterweight and Guard: Provide new counterbalance to meet current Codes.

9.10 Terminal Stops:

9.10.1 Provide new upper and lower normal terminal stopping devices in hoistway to automatically stop car and counterweight from any speed attained in normal operation within top and bottom overtravels, independent of operating device, final terminal stopping devices, and buffers.

9.10.2 Provide new final terminal stopping devices for elevators arranged to automatically stop car and counterweight within top clearance and bottom overtravel independently of operation of normal terminal stopping devices, but with buffer operative. When operated, final terminal stopping device shall prevent further normal operation.

9.10.3 Provide and install a second stop switch and locate existing stop switch as required by code for each elevator.

9.10.4 Wiring:

9.10.4.1 Conductors: Provide copper insulated wiring with flame retarding and moisture resisting outer cover. Install in galvanized metal wire ways and raceways. Conductors from shaft riser to door interlocks shall be SF 2 type or equal, maximum operating temperature 392-degrees F. All terminations shall be insulated to maintain integrity of wiring. Flexible conduit may be used for short connections. Provide 10-percent conductors throughout.

9.10.4.2 Trail Cables: UL labeled fire and moisture resistant outer braid and steel supporting strand. In addition to elevator control circuits provide four pairs of shielded RS-485 communication wires and car lighting circuits.

9.10.4.2.1 PER UK REQUIREMENTS; PROVIDE TWO (2) CAT-6A CABLES WITHIN THE TRAVELER; RATED AND APPROVED FOR ELEVATOR APPLICATIONS.

9.10.4.3 Provide Security Reader wiring. Prevent cables from rubbing or chafing against hoist way or car items.

9.10.5 Data/Communications:

9.10.5.1 Furnish data line terminated in a telephone jack in each elevator equipment room.

9.10.5.2 Furnish two (2) telephone lines in each elevator equipment room. One line is to be used for the emergency call system and one line is to be used for a remote monitoring system. The University will be responsible for activation of the telephone lines.

9.10.5.2 The elevator is to be connected to the existing Tridium Building Automation System. All associated hardware, software, cabling and conduit for a complete connection to the system is to be included as part of the elevator contract. Connection is to be made via BacNet/IP, BacNet/MSTP.

9.11 Traveling Cables: Provide new traveling cables designed for elevator service in accordance with NFPA 70, and suspend, anchor and run so that strain on individual cable connectors is minimized and connections to terminal blocks are free of strain. Pad or shield areas that contact hoistway construction. Color code each conductor and indelibly label each terminal connection. Provide (5) sets of spare travel cable for future use.

9.12 Governors & Safety Devices: Furnish and install new governors and safety devices suitable for duty involved. Provide new governor ropes.

9.13 Door beam detector shall have cross beams.

9.14 Door operator equipment that includes drive operator, hangers, locks, closures, etc. shall be as manufactured by GAL Manufacturing Corp.

9.15 Elevator cab floors shall be terrazzo.

9.15.1 Epoxy-Resin Terrazzo: Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and aggregate proportions and mixing.

9.15.1.1 Products: Subject to compliance with requirements, provide one of the following:
9.15.1.2 General Polymers Corporation; Terrazzo 1100.
9.15.1.3 Key Resin Company; Key Epoxy Terrazzo.
9.15.1.4 Master Terrazzo Technologies LLC; Morricite.
9.15.1.5 Quadrant Chemical Corporation; Quadset Epoxy Terrazzo.
9.15.1.6 TEC Specialty Construction Brands, Inc.; Tuff-Lite Epoxy Terrazzo.
9.15.1.7 Terrazzo & Marble Supply Companies; Terroxy Resin Systems.
9.15.1.8. Thickness: 1/4 inch nominal.
9.15.1.9 Custom Mix Color and Pattern: As selected by architecture from manufacturers full range.

9.15.2 Materials:

9.15.2.1 Flexible Reinforcing Membrane: Manufacturer's resinous membrane for substrate-crack preparation and reflective-crack reduction.

9.15.2.1.1 Reinforcement: Fiberglass scrim.

9.15.2.2 Primer: Manufacturer's product recommended for substrate and use indicated.
9.15.2.3 Epoxy-Resin Matrix: Manufacturer's standard recommended for use indicated and in color required for mix indicated.

9.15.2.3.1 Physical Properties without Aggregates:

9.15.2.3.1.1 Hardness: 60 to 85 per ASTM D 2240, Shore D.
9.15.2. 3.1.2 Minimum Tensile Strength: 3000 psi per ASTM D 638 for a 2-inch specimen made using a "C" die per ASTM D 412.
9.15.2. 3.1.3 Minimum Compressive Strength: 10,000 psi per ASTM D 695, Specimen B cylinder.
9.15.2. 3.1.4 Chemical Resistance: No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D 1308.

9.15.2. 3.1.4.1 Distilled water.
9.15.2. 3.1.4.2 Mineral water.
9.15.2. 3.1.4.3 Isopropanol.
9.15.2. 3.1.4.4 Ethanol.
9.15.2. 3.1.4.5 0.025 percent detergent solution.
9.15.2. 3.1.4.6 1.0 percent soap solution.
9.15.2. 3.1.4.7 10 percent sodium hydroxide.

9.15.2. 3.1.4.8 10 percent hydrochloric acid.
9.15.2. 3.1.4.9 30 percent sulfuric acid.
9.15.2. 3.1.4.10 5 percent acetic acid.

9.15.2.3.2 Physical Properties with Aggregates: For resin blended with Georgia white marble, ground, grouted, and cured per requirements in NTMA's "Terrazzo Specifications and Design Guide"; comply with the following:

9.15.2.3.2.1 Flammability: Self-extinguishing, maximum extent of burning 1/4 inch per ASTM D 635.
9.15.2.3.2.2 Thermal Coefficient of Linear Expansion: 0.0025 inch/inch per deg F for temperature range of minus 12 to plus 140 deg F per ASTM D 696.

9.15.2.4 Aggregates: Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.

9.15.2.4.1 Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131.
9.15.2.4.2 24-Hour Absorption Rate: Less than 0.75 percent.
9.15.2.4.3 Dust Content: Less than 1.0 percent by weight.

9.15.2.5 Finishing Grout: Resin based.

10. EXECUTION

10.1 Execution of Building and Contract Documents

10.1.1 The Contractor shall examine the supporting structure and the conditions under which the work shall be installed and notify the Owner of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the installation until unsatisfactory conditions have been corrected and are acceptable.

10.1.2 Verify dimensions of supporting structure at the site by accurate field measurements. The work shall be accurately fabricated and fitted to the structure. Contractor shall be satisfied by review of the working drawings and field observation that the clearances and the alignments are proper for the installation of this work.

10.1.3 Coordinate works with the work of other trades, and provide items to be placed during the installation at the proper time to avoid delays.

10.1.4 The Contractor shall review the drawings and verify all conditions for proper installation of this work. Verify the size of all electrical feeders and related equipment and furnish all equipment for proper operation.

10.2 Installation

10.2.1 Fully comply with manufacturer’s written instructions.

10.2.2 Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby eliminate sources of structure-borne noise emanating from elevator system.

10.2.3 Lubricate operating parts of systems as recommended by manufacturers.

10.3 Adjusting, Cleaning, Lubrication and Painting

10.3.1 Perform the following work prior to final testing and acceptance.

10.3.1.1 Adjust all equipment for optimum performance, including controllers, motors, drives, landing systems, hoist way switches, door operating equipment and safety equipment to achieve the required performance levels.

10.3.1.2 Thoroughly clean all equipment areas free of all dust, dirt, debris and excessive oil and grease.

10.3.1.3 Lubricate all equipment in accordance with manufacturer's guidelines.

10.3.1.4 Patch and paint exposed work soiled or damaged during installation. Repair to match adjoining work prior final acceptance.

10.3.1.5 Clean the elevator pit and machine room.

11. TESTING

11.1 Perform all acceptance tests as required and recommended by Code and also perform other tests, if any, as required by governing regulations. Advise the Engineer, Owner and Inspection Department of governing agencies in advance of dates and times that tests are to be performed on the elevator.

11.2 Acceptance Testing: Upon nominal completion of each elevator refurbishment and before permitting use of elevator (either temporary or permanent), perform acceptance tests as outlined in ASTM A17.1. That inspection procedure shall form a part of final inspection. Furnish all test instruments and materials required at time of final inspection to determine compliance of work with contract requirements. Perform the following tests.

11.2.1 Full Load - Run Test: Subject elevator to full specified rated load run continuously for one hour. During test, stop car at all floors in both travel directions for standing periods of 10 sec. per floor.

11.2.2 Speed Test: Determine actual elevator speed in both directions with full contract load and no load in car. Proceed and follow full load-run tests with tests. Measure speed by applying tachometer to car hoist cables. Measured speed of car with all loads in any direction shall be within 5% of specified rated speed.

11.2.3 Car Leveling Tests: Test leveling devices at all floors for accuracy with no load and full load, in both directions. Verify compliance within specification limits both before and after full load-run tests.

11.2.4 Emergency Operation Test: Perform functional tests of Fireman's Service & Emergency Power recall systems.

11.2.5 Car & Counterweight Safety and Governor Test: Test as specified in ANSI/ASME A17.1. Full load and 125% overload tests are required.

11.2.6 Oil Buffer Tests: Test oil buffers for car and counterweight as specified in ANSI/ASME A17.1.

11.2.7 Performance Standards: Demonstrate that the elevators, as refurbished, meet the following performance criteria: (NEII Vertical Transportation Standards 1994 Supplement)

11.2.7.1 Acceleration: 5 Ft/Sec^2 with initial ramp of 0.5-0.75 seconds.
11.2.7.2 Deceleration: 5 Ft/Sec^2 with initial ramp of 0.5-0.75 seconds.
11.2.7.3 Max. Jerk Rate: Less than 8 Ft/Sec^3
11.2.7.4 Vertical Vibration: Less than 15 mg
11.2.7.5 Horizontal Vibration - S/S: Less than 12 mg peak to peak within 1-10 mz.
11.2.7.6 Horizontal Vibration - F/B: Less than 25 mg peak to peak within 1-10 mz.
11.2.7.7 Stopping Zone ± ½"
11.2.7.8 Performance Time: Less than 9.5 sec.
11.2.7.9 Door Opening Time: Less than 2.0 sec.
11.2.7.10 Door Sound: Less than 45 dbA measured in elevator lobby 10 feet from elevator doors.
11.2.7.11 Sound in Car Rated Speed: Less than 50 dbA measured 5 feet above cab floor.
11.2.7.12 Sound in Stopped Car w/Fan On: Less than 50 kdA measured 5 feet above cab floor.
11.2.7.13 Sound in Machine Room: Less than 80 dbA measured 3 feet above equipment.

12. INSTRUCTION

12.1 Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s). Provide at least 8 hours of instruction schedule over a minimum of two separate sessions on different days.

12.2 Check operation of each elevator with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

12.3 Check operation of each elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

12.4 Upon completion of all work, the Contractor shall provide an instruction period. Instructions shall be given by competent supervisory personnel and shall apply to actual field conditions. The instructions shall cover, but shall not be limited to the following:

12.4.1 Operation of elevators under emergency conditions, maintenance, adjustment, troubleshooting and diagnostic procedures.

12.4.2 Operation of elevator fire recall system and tenant security system.

12.4.3 Operation of elevator communication, door reversal device, etc.

13. MAINTENANCE DATA

13.1 Wiring diagrams: Provide one complete set of schematic wiring diagrams for each elevator. Diagrams shall match every circuit of elevator system. When elevators have been completely adjusted, changes shall be noted on schematic wiring diagrams and three new complete sets given to Owner. They also shall include a complete list of symbols and relays and a write-up on their functions. Prints shall be property of Owner. Do not stamp prints: "Property of elevator company."

13.2 Parts Book: Provide a complete parts book. Book shall have elevator equipment listed with a description, a picture and a current part number. It shall include a print(s) of controller (relay panel, starter panel, selector panel) to show apparatus and their exact location. Number apparatus on these prints; include number in parts book for proper identification. Include the following: job name, address, voltages, major equipment, features of elevator, type of door equipment, type of safeties, and names of superintendent and field personnel who have installed equipment. Include a list of parts and quantity needed for stocking. Book shall be property of Owner. Do not stamp: "Property of elevator company".

13.3 Maintenance manual and lubrication charts: Provide a maintenance manual which shall include a troubleshooting section, lubrication charts and proper lubricant to be used, including an alternate (other than elevator manufacturer's product).

13.4 Solid state equipment: Along with solid state equipment being installed, if there are any special tools, manuals or equipment of any kind needed to either maintain or adjust equipment, they shall be available for either rent or purchase by Owner. These items shall be made available upon request with no longer than a 90-day waiting period. Elevator company shall also guarantee in wiring that equipment will not become obsolete for a period of not less than 20 years, mainly including solid state boards. Solid state equipment shall also have a delivery of no longer than 90 days.

14. SHOP DRAWINGS AND RELATED SUBMITTALS

14.1 Submittals shall be made in accordance with paragraph 9 of Section 14010.

14.2 Corrections or comments made on the shop drawings during the Engineer's review do not relieve the Elevator Contractor from compliance with the Drawings and Specifications. The Engineer's review of shop drawings is only for general conformance with design concept and general compliance with the information given in the Contract Documents. The Elevator Contractor's responsibility includes, but is not limited to, confirming and correlation all quantities and dimensions, selecting fabrication process and techniques and construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner.

14.3 Shop drawings, consisting of manufacturer's catalog data, dimensional data, and specification data shall be submitted on the following:

14.3.1 Microprocessor Control System.
14.3.2 Control Panel.
14.3.3 Hall call stations.
14.3.4 VVVF Elevator rated motors.
14.3.5 Infrared door protection system
14.3.6 Car Position Indicators
14.3.7 Emergency Communication Equipment
14.3.8 Hall Lanterns
14.3.9 Hall Position Indicators
14.3.10 Braille Floor Designation
14.3.11 Car Control Panel Elevation

END OF SECTION

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.

1.3 DEFINITIONS

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

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, capable of supporting combined weight of supported systems, system contents, and test water.

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

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." AWS D1.4, "Structural Welding Code--Reinforcing Steel." and ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Empire Industries, Inc.
3. ERICO/Michigan Hanger Co.
4. Globe Pipe Hanger Products, Inc.
5. Anvil Corp.
6. GS Metals Corp.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing, Inc.
9. PHS Industries, Inc.
10. Piping Technology & Products, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FASTENER SYSTEMS

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

1. Available Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Masterset Fastening Systems, Inc.
d. MKT Fastening, LLC.
e. Powers Fasteners.

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

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.

2.6 MISCELLANEOUS MATERIALS

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

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

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

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

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

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

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

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

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

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

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

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

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb
    d. de-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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

K. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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

3.2 HANGER AND SUPPORT INSTALLATION

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

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

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

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Fastener System Installation:

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

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

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

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

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

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

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

3.3 METAL FABRICATIONS

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

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

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

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

3.4 ADJUSTING

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

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

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe labels.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

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

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 PIPE LABELS

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

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

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

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

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.

C. Pipe Label Color Schedule:

1. Pump Dischardge Piping:

a. Background Color: Green.
b. Letter Color: White.

END OF SECTION

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

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

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) Fernco, Inc.
2) Ideal Div.; Stant Corp.
3) Mission Rubber Co.
4) Tyler Pipe; Soil Pipe Div.

2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. Manufacturers:

1) Clamp-All Corp.
2) Ideal Div.; Stant Corp.
3) Mission Rubber Co.

4) Tyler Pipe; Soil Pipe Div.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping shall be any of the following:

1. Hubless cast-iron soil pipe and fittings heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Copper DWV tube, copper drainage fittings, and soldered joints.
3. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.2 PIPING INSTALLATION

A. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

B. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper

size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

C. Install soil and waste drainage piping at the State Plumbing Codes minimum slopes.

D. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

E. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.

2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

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

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

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

3.5 CONNECTIONS

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

B. Connect drainage piping to the following:

1. Plumbing Equipment: Sump Pump.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

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

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

3.7 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. All work and material on this project shall be in compliance with all local, state and federal regulations including but not limited to the following:

1. Established Federal Standards of the Occupational Safety and Health Administration under the Department of Labor.
2. Kentucky Building Code as based on International Building Code.
3. International Mechanical Code (Kentucky Version).
4. International Energy Conservation Code.
5. Kentucky Plumbing Code.

C. The above regulations are considered a part of the specifications and shall prevail should they differ with the plans and specifications. Prior to construction the Contractor shall notify the Architect of the difference. Should the Contractor not so notify the Architect, the Contractor shall fully comply without claim for extra costs

1.2 SUMMARY

A. This section includes General Provisions for HVAC/Mechanical work.

B. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Mechanical sleeve seals.
3. Sleeves.
4. Equipment installation requirements common to equipment sections.
5. Painting and finishing.
6. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 SUBMITTALS

A. SHOP DRAWINGS AND OTHER RELATED SUBMITTALS

1. The type submittal information required for each item of equipment shall be as indicated in the individual sections of the specification.
2. When a substitute item of equipment has been submitted for approval, submit layout drawings indicating the changes necessary to adapt the substituted item of equipment to the system design.
3. Submittal data shall include Specification data, such as metal gauges, finishes, optional accessories, etc., even though such equipment and materials may be detailed on the drawings or specified. In addition, the submittal data shall include performance (certification) data, wiring diagrams where applicable, accurate dimensional data and a recommended spare parts list. Outline or dimensional drawings alone are not acceptable. No roughing-in, connections, etc., shall be done until Architect reviewed equipment submittals are in the hands of the Contractors. It shall be the Contractor's responsibility to obtain drawings and to make all connections, etc., in the neatest and most workmanlike manner possible.
4. In general, normal catalog information (with the particular items underlined or otherwise denoted as being the submitted item) will be acceptable as submittal data. Installation, operating and maintenance instructions must be that information, specifically applicable to the items furnished, ordinarily supplied with the equipment to the Owner with any modifications indicated. Wiring diagrams must be correct for the application. Generalized wiring diagrams, showing alternate methods of connection, will not be acceptable unless all unrelated sections are marked. out. Submittal data sheets, which indicate several different model numbers, figure numbers, optional accessories, installation arrangements, etc., shall be clearly marked to indicate the specific items of equipment to be furnished. Samples and certificates shall be furnished as requested. Submittal data must be complete for each piece of equipment; piecemeal data will not be processed.
5. It shall be noted that the reviewing of shop drawings by the Architect applies only to general design, arrangement, type, capacity, and quality. Such review does not apply to quantities, dimensions, connection locations and the like. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, that all equipment fits the available space in

a satisfactory manner, all equipment characteristics are appropriate and that all connections are suitably located.

6. Before the project is accepted, all submittal data (shop drawings, etc.) must be complete and reviewed.
7. After equipment requiring temperature control connection has been reviewed by the Architect, furnish complete manufacturer's data and wiring diagrams to the Automatic Temperature Control Supplier.

B. Product Data: For the following:
1. Mechanical sleeve seals.

C. SUBSTITUTION OF MATERIALS AND EQUIPMENT

1. When the Contractor requests approval of substitute materials and/or equipment, except when under formal alternate proposal, it shall be understood and agreed that such substitution, if approved, will be made without cost to the Owner, regardless of changes in connections, spacing, electrical service, etc. In all cases where substitutions affect other trades the Contractor offering such substitutions shall reimburse all affected Contractors for all necessary changes in their work (without cost to Owner).

1.5 QUALITY ASSURANCE

A. Disclaimers and Limitations: Manufacturer’s disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products. Manufacturer’s disclaimers and limitations on product warranties do not relieve suppliers, manufacturers and subcontractors required to countersign special warranties with the Contractor.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Coordination Between Trades:

1. Carefully examine all architectural, structural, electrical and any other drawings and specifications pertaining to the construction before fabricating and installing the work described and indicated under these drawings and specifications. Cooperate with all other Contractors in locating piping, ductwork, sleeves, equipment, etc., in order to avoid conflict with all other Contractor's work. No extra compensation will be allowed to cover the cost of relocating piping, ducts, etc., or equipment found encroaching on space required by others.
2. Lay out work from construction lines and levels established by the General Contractor. This Contractor shall be responsible for the proper location and placement of his work.
3. Any discrepancies occurring on the accompanying drawings and between the drawings and the specifications shall be reported to the Architect prior to any fabrication and installation so that a workable solution can be presented. Extra payment will not be allowed for the relocation of, or revision to, piping, ductwork, equipment, etc., not installed in accordance with the above instructions, and which interferes with work and equipment of other trades.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

PART 3 - EXECUTION

3.1 STRUCTURAL RESPONSIBILITY

A. Properly shore, brace, support, etc., any construction to guard against cracking, settling, collapsing, displacing or weakening. No structural member shall be cut without the written consent of the Architect.

B. Any damage occurring to the structure, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Owner or Architect, without cost.

3.2 EXISTING IMPROVEMENTS

A. Maintain in operating condition all active utilities, sewer, gutters and other drains, etc., encountered in the utility installation. Repair to the satisfaction of the Architect and the Owner any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

B. Any obstructing utilities encountered in the course of this work, not shown on the drawings, nor evident during inspection prior to starting the work, shall be relocated as directed by the Architect.

3.3 PROTECTION OF THE BUILDING AND STORED EQUIPMENT

A. Do not store materials or equipment on any floor or roof of building in such quantity that these parts of the building will be overloaded in any way. Do not move heavy equipment across any floor or roof without first submitting the details of the work to the Architect and having obtained his approval. In cases where frequent movement of men or materials over the roof is encountered, provide walking boards or other suitable protection for the roofing.

B. Provide suitable storage for, and completely protect all materials and equipment prior to installation. Storage shall be dry, clean and safe. Any materials or equipment lost through theft or mishandling shall be replaced, all without additional cost to the Owner

3.4 DRAWINGS

A. The drawings accompanying these specifications are diagrammatic and indicate the general design and arrangement of the proposed work. Do not scale drawings for the exact location of equipment and work. The exact routing and/or location of piping, ductwork, sleeves, equipment, etc., unless specifically dimensioned on the drawings, shall be determined to suit field conditions encountered, and to avoid interferences with other Contractors' work.

3.5 EQUIPMENT CONNECTIONS

A. Make all water and drainage connections, etc., to equipment furnished by others under this Contract whenever such equipment is shown on any of the drawings or mentioned in any section of the specifications, unless otherwise specifically specified hereinafter.

3.6 TOOLS

A. Furnish and install all special wrenches, valve handles, keys, or other special tools as necessary to dismantle or service any piece of equipment installed. This shall include thermostat keys in the number directed by the Architect.

3.7 PERMITS AND APPROVALS

A. All permits and certificates of approval for the complete system shall be obtained by the respective Contractors from the authorities governing such work. The cost of all permits, tap-in-fees and approvals shall be borne by the Contractor furnishing the work, except as noted in the General Requirements. All work shall be approved by the Architect before final payment will be made.

3.8 TEMPORARY UTILITIES

A. Temporary utilities for water, gas, electricity, and heat shall be provided as indicated under the "General Requirements" of the Specifications.

3.9 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Insulated Piping: One-piece, stamped-steel type with spring clips.

c. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and spring clips set screw or spring clips.
d. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
e. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

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

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 92 00 Section "Joint Sealants" for materials and installation.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 84 13 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.10 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

3.11 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.12 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.13 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.14 INSTALLATION

A. All equipment shall be installed at locations indicated.

B. Assembly and installation of equipment shall be in strict accordance with manufacturer's installation instructions.

C. Equipment shall be securely anchored in place. Care shall be exercised to correctly orient equipment before securing in place.

3.15 EQUIPMENT MOUNTING

A. All equipment with moving parts, such as fans, air handling units, etc., shall be mounted on vibration supports and in addition, said equipment shall be isolated from external connections, such as piping, ducts, raceways, etc., by means of flexible connectors.

B. Unitary equipment, such as small exhaust fans, etc., shall be rigidly braced and mounted to wall, floor, or ceiling, as required, and tightly gasketed and sealed to mounting surface to prevent air leakage and to obtain quiet operation

C. Where drivers are connected with couplings, the alignment shall be checked and the driver reconnected. Couplings shall have tolerances as indicated by the manufacturer.

D. Where drivers are connected with belt or chain drives, the driver and driver shafts shall be aligned parallel. The motor adjustment shall be loosened sufficiently to put on the belts or chain and then tightened to the proper centerline distance or tension. No belt compound shall be used.

3.16 CUTTING, FITTING AND PATCHING

A. Each respective Contractor shall do all cutting and drilling of masonry, steel, wood, or iron work, and all fitting necessary for the proper installation of all apparatus and materials.

B. No cutting or drilling of the structure, of any kind, shall be done without first obtaining permission from Architect. All cutting and drilling shall be done under the supervision of the General Contractor in strict accordance with instructions furnished by Architect.

C. All patching and finishing shall be the responsibility of the Contractor whose cutting or drilling makes such patching and finishing necessary. Patching and finishing shall be done by workmen skilled in the trade affected (masonry, plastering, painting, etc.).

3.17 CLEANING, TESTING AND PREPARATION FOR START-UP

A. All equipment shall be cleaned of all foreign material.

B. All equipment shall be lubricated and placed in proper working order. Drives on rotating equipment shall be checked for proper rotation and alignment. V-belt drives shall be checked and adjusted for proper tension. All fans shall be operated for at least 24 hours so that the initial stretch of the V-belt drives will take place before testing. When the belts have stretched, the fan drives shall be realigned and adjusted for tightness to make sure that the excess slippage is eliminated. All drives shall be set for the recommended speeds. All sheaves and bearing blocks shall be checked for any loose screws or nuts.

C. All controls and safety devices shall be checked to determine that they are in place and properly installed.

D. Where equipment is intended to contain fluids, it shall be filled and tested for leaks as recommended by the equipment manufacturer.

E. Equipment shall be operated for a reasonable time to determine any undue vibration, heating of parts, or other improper operation.

END OF SECTION

SECTION 230593 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:

    a. Constant-volume air systems.

2. Hydronic Piping Systems:

    a. Variable-flow systems.

3. HVAC equipment quantitative-performance settings.
4. Verifying that automatic control devices are functioning properly.
5. Reporting results of activities and procedures specified in this Section.

1.02 SUBMITTALS

A. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

C. Warranties specified in this Section.

1.03 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC, NEBB or TABB.

B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural

Standards for Testing, Adjusting, and Balancing of Environmental Systems." or SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing." TAB firm's forms approved by Architect. TABB "Contractors Certification Manual."

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.7.2.3 - "System Balancing."

1.04 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.05 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.06 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine equipment for installation and for properly operating safety interlocks and controls.

O. Examine automatic temperature system components to verify the following:
1. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
2. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
3. Sensors are located to sense only the intended conditions.
4. Sequence of operation for control modes is according to the Contract Documents.
5. Controller set points are set at indicated values.
6. Interlocked systems are operating.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111, AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS (EXHAUST FANS AND AIR HANDLING UNITS)

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
3. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check flow-control valves for specified sequence of operation and set at indicated flow.
3. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.07 PROCEDURES FOR HYDRONIC SYSTEMS

A. Set calibrated balancing valves, if installed, at calculated presettings.

B. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

C. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

D. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

3.08 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

3.09 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.11 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Conditions of filters.
    b. Cooling coil, wet- and dry-bulb conditions.
    c. Fan drive settings including settings and percentage of maximum pitch diameter.
    d. Settings for supply-air, static-pressure controller.

e. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Water flow rates.
2. Duct, outlet, and inlet sizes.
3. Pipe and valve sizes and locations.
4. Position of balancing devices.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Insulation Materials:

    a. Mineral fiber.

2. Adhesives.
3. Sealants.
4. Factory-applied jackets.
5. Tapes.
6. Securements.

1.02 SUBMITTALS

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

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application at linkages of control devices.

C. Field quality-control reports.

1.03 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I or II with factory-applied vinyl jacket, III with factory-applied FSK jacket or III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed Corp.; Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; All-Service Duct Wrap.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fibrex Insulations Inc.; Coreplus 1200.
    b. Johns Manville; Micro-Lok.
    c. Knauf Insulation; 1000 Pipe Insulation.
    d. Manson Insulation Inc.; Alley-K.
    e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied

ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 ADHESIVES

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

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Speedline Vinyl Adhesive.

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

2.03 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-76.
    b. Foster Products Corporation, H. B. Fuller Company; 30-45.
    c. Marathon Industries, Inc.; 405.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.
    f. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-76-8.
    b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    c. Marathon Industries, Inc.; 405.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-76.

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

6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 FACTORY-APPLIED JACKETS

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.05 FIELD-APPLIED JACKETS

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

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; Metal Jacketing Systems.
    b. PABCO Metals Corporation; Surefit.
    c. RPR Products, Inc.; Insul-Mate.

2. Sheet and roll stock ready for shop or field sizing.
3. Finish and thickness are indicated in field-applied jacket schedules.

4. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick Polysurlyn.
5. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Flange and union covers.
    d. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.06 TAPES

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    b. Compac Corp.; 104 and 105.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

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

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    b. Compac Corp.; 110 and 111.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.07 SECUREMENTS

A. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
2) GEMCO; Press and Peel.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel, Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel, aluminum, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; RC-150.
        2) GEMCO; R-150.
        3) Midwest Fasteners, Inc.; WA-150.
        4) Nelson Stud Welding; Speed Clips.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:

        1) GEMCO.
        2) Midwest Fasteners, Inc.

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

PART 3 - EXECUTION

3.01 PREPARATION

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

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.02 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

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

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

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

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

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

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

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

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

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

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

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

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

3.03 GENERAL PIPE INSULATION INSTALLATION

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

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

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

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

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached

insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.04 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two < locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.06 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, supply and outdoor air.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.

5. Factory-insulated access panels and doors.

3.07 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket , 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

3.08 PIPING INSULATION SCHEDULE, GENERAL

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

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

1. Underground piping.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.09 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water, above 40 Deg F: Insulation shall be one of the following:

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

END OF SECTION 230700

SECTION 230900 – INSRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions, General Mechanical Provisions and General Requirements, Division 1 Specification Sections apply to the work specified in this section.

1.2 DESCRIPTION OF WORK:

Furnish a BACnet system compatible with existing University systems. All building controllers, application controllers, and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet. This system shall communicate with the University of Kentucky Facility Management's existing BACnet head-end software using BACnet/IP at the tier 1 level and BACnet/MSTP at the tier 2 level. No gateways shall be used for communication to controllers installed under section. BACnet/MSTP or BACnet/IP shall be used for all other tiers of communication. No servers shall be used for communication to controllers installed under this section. If servers are required, all hardware and operating systems must be approved by the Facilities Management Controls Engineering Manager and/or the Facilities Management Information Technology Manager.

All Building Automation Devices should be located behind the University firewall, but outside of the Medical Center Firewall and on the environmental VLAN.

Provide all necessary hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers. These must be in compliance with Front End systems PICS and BIBBS and attached Tridium PICS and BIBBS. Provide all hardware and software to backup, restore, troubleshoot and install system. Software, backups, unitary, and ASC files shall be delivered to UEM (Utilities & Energy Management) for archiving purposes.

It is the contractor's responsibility to insure that the University of Kentucky Facilities Management's head-end system's licensed device/point count is increased to accommodate the number of devices and/or points that are added to fulfill the contractor's obligation to meet the requirements of the project.

Prepare individual hardware layouts, interconnection drawings and software configuration from project design data.

Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.

Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.

Provide a comprehensive operator, administrator and technician training program as described herein.

Provide as-built documentation, programming software for use site wide, electronic copies of all diagrams, and all other associated project operational documentation (such as technical manuals on approved media, the sum total of which accurately represents the final system.

Furnish, install, and fit-up in complete working order, with all accessories required, the automatic temperature control and monitoring systems shown on the Drawings and specified herein. The systems shall be properly connected, piped and wired in a manner conforming to the laws, ordinances and codes now in force in the Commonwealth of Kentucky.

The controls and all listed I/O points from this project shall communicate with the University of Kentucky Facilities Management's existing BACnet software head-end station using BACnet/IP. All BACnet points shall be exposed to the University of Kentucky Facilities Management's head-end station. Graphics will be installed by UEM on the head-end system. All point and device names shall comply with the University Facilities Management standards and shall be approved before and included in the shop drawings submittal. Cooperate with the Owner (UEM) to ensure that all specified points and alarms communicate and operate on the head-end system. All point and device names shall comply with the University Facilities Management standards (format listed below, consult Utilities and Energy Management (UEM) for the correct abbreviations) and shall be included in the shop drawings submittal for review and approval. Point naming conventions and formats are listed further in this specification in the Direct Digital Controls Equipment section. Refer to University Standard 230553S02 for the AHU Naming Convention.

Related to the alarms, the contractor is to set up the alarm parameters specified by the system sequences of operations without enabling the alarms. Contractor is to provide a list of points containing alarm extensions to Owner (UEM). UEM will be responsible for doing the alarm names, alarm texts and enabling the alarm points provided on the list.

All work must be coordinated and scheduled with the UEM Controls group prior to any work being done on site.

Thermostats: Each split system requires a thermostat for operation, unless specifically indicated on the Drawings to be slaved to another unit. Slaved units shall be controlled to match the CFM and discharge air temperature of the master unit. Thermostat locations have been identified on the Drawings to the extent possible, but all such locations may not be shown. Provide the required thermostats whether or not shown on the Drawings. For those thermostats not shown on the Drawings, work out an acceptable location with the Architect/Engineer. Thermostats are to be provided with no doors.

The control equipment shall be complete and shall include, but not be limited to, all necessary valves, damper operators, pipe, fittings, etc.

Electronic Control System installer must physically demonstrate to Owner and Owner's representatives (UEM) via software simulations that the proposed building automation system and control sequences will function as outlined in the contract documents prior to field implementation.

The control and monitoring system for this project shall be made up using standard materials, equipment and components regularly manufactured for systems of this type. The system shall be complete in every respect and shall be a functioning system.

Electrical power wiring and interlock wiring for all controls, signal devices, equipment, alarms, etc., shall be in accordance with diagrams and instructions from the supplier of the systems. All power and control wiring, conduit and wiring connections required for the complete installation, including wiring to smoke dampers and combination fire/smoke dampers and their motors, shall be provided by this Contractor in accordance with Electrical specification requirements. Controls shall be on emergency power.

Refer to other Mechanical Division sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.

1.3 QUALITY ASSURANCE:

Manufacturer: Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work at Tier 1 BACnet/IP include the following:

Vykon
Johnson Controls
Alerton

Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work at Tier 2 BACnet/MSTP include the following:

Honeywell
Johnson Controls
Alerton
Distech

Acceptable controls manufacturers shall include any controls manufacturers which utilize a BACnet protocol in accordance with the specification. If the bidding manufacturer is not listed above, documentation for approval as an equal must be submitted 10 days prior to the bid opening date to allow for evaluation by the university.

Installing Contractor: Installing controls contractors must comply with the following requirements:

The installing systems integration contractor has been in the business of installing BACnet controls for the last 5 years minimum. In addition, the installing systems integration contractor needs to demonstrate with documentation that they have provided the controls in a minimum of (3) hospital or university renovation projects of similar size and scope where they utilized a BACnet system.

The systems integration contractor must have on staff the following number of key personnel as a minimum, each with a minimum of 5 years of related BACnet controls installation experience: Project Manager - 2, Controls Applications Engineer - 2, Programmer - 2, Installation Supervisor - 2, Controls Technician - 5.

Prefer contractor staff to include Niagara Tridium AX/N4 certified technicians.

Contractor to have experience with successful integrations of controls with Niagara Tridium systems.

Contractor to have a minimum of 3 years of installation history with the brand of controls being bid.

Contractor must have a help desk operation or staff available for phone contact 24/7 for providing technical support to university staff. Call forward and emergency service numbers are not acceptable during normal business hours.

Codes and Standards:

Electrical Standards: Provide electrical components of pneumatic control systems which have been UL-listed and labeled, and comply with NEMA standards.

NFPA Compliance: Comply with NFPA 90A "Standard for the installation of Air Conditioning and Ventilating Systems" where applicable for controls and control sequences.

Kentucky Building Code: Comply with requirements where applicable for controls.

Provide products of the temperature control system with the following agency approvals:

UL-916; Energy Management Systems
UL-873; Temperature Indication and Regulating Equipment
UL-864; Subcategories UUKL, OUXX, UDTZ; Fire Signaling and Smoke Control Systems
CSA; Canadian Standards Association

FCC, Part 15, Subpart J., Class A Computing Devices

All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, NEC, Local and National Codes.

1.4 SUBMITTALS:

Product Data: Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes, also include installation and start-up instructions.

A. Shop Drawings, Product Data, and Samples

1. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; BAS Contractor name, address and phone number; BAS Contractor project manager, quality control manager, and project engineer names and phone numbers.
2. Each submittal shall include the following information.
    a. BAS riser diagram showing all DDC controllers, network repeaters, and network wiring.
    b. One-line schematics and system flow diagrams showing the location of all control devices.
    c. Points list for each DDC controller, including: Tag, Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Module Type, Terminal ID, Panel, Slot Number, Reference Drawing, and Cable Number. The initial shop drawing submittal for review needs to include all point names meeting the naming convention outlined in this specification for UEM approval at the shop drawing phase prior to the contractor beginning any programming.
    d. Vendor’s own written description for each sequence of operations, to include the following:
        - Sequences shall reference input/output and software parameters by name and description.
        - The sequences of operations provided in the submittal by the BAS Contractor shall represent the detailed analysis needed to create actual programming code from the design documents.

- Points shall be referenced by name, including all software points such as programmable setpoints, range limits, time delays, and so forth.
- The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.

e. Detailed Bill of Material list for each panel, identifying: quantity, part number, description, and associated options.

f. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, and so forth.

g. Range and scale information for all transmitters and sensors. This sheet shall clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.

h. Hardware data sheets for all local access panels.

i. Software manuals for all applications programs to be provided as a part of the programming devices, and so forth for evaluation for compliance with the performance requirements of this Specification.

j. The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for each device.

3. BAS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. BAS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

4. Submittal shall have approved point names.

Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device. Include that type data, product and shop drawings in maintenance manual.

Operation and Maintenance Instructions:

This contractor shall prepare an electronic Operations Manual entitled "Automatic Temperature Control and Monitoring Systems Operation and Maintenance Data." Manual shall be PDF files with separate PDFs for each of the items noted below.

Each manual shall contain the following information:

Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor (name and address).

Complete brochures, descriptive data and parts list, etc., on each piece of equipment, including all approved shop drawings.

Complete maintenance and operating instructions, prepared by the manufacturer, on each major piece of equipment, including preventative maintenance instructions.

Complete shop drawing submittal on temperature and monitoring controls including control diagrams updated to reflect "as-built" conditions.

All wiring and component schematics necessary for Owner (UEM) to troubleshoot, repair and expand the system.

All manuals shall be submitted to the Engineer prior to final inspection of the building.

Provide a laminated copy mounted in a sleeve on the outside of the panels for the controls sequences pertinent to equipment supplied by that specific controls panel.

Controls Program Backup: At the end of the project, the contractor is to supply digital back-up copies of all final complete operating controls programs. These shall be delivered to UEM for archiving purposes.

1.5 DELIVERY, STORAGE AND HANDLING:

Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL SYSTEM

General: This specification defines the minimum hardware and performance requirements for a computer-based building automation system to be furnished and installed.

2.2 SCOPE OF WORK:

System Requirements:

Contractor shall provide all equipment, engineering and technical specialist time to check the installation required for a complete and functioning system. The contractor shall furnish and install all interconnecting system components. Components to include, but not be limited to: power line conditioners, field panels, sensors, motor starter interfaces, and any other hardware items not mentioned above but required to provide the Owner with a complete workable system.

Any feature or item necessary for complete operation, trouble-shooting, and maintenance of the system in accordance with the requirements of this specification shall be incorporated, even though that feature or item may not be specifically described herein. This shall include hardware and software.

All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall be thoroughly tested and proven in actual use.

Input/Output Summary:

The system as specified shall monitor, control and calculate all of the points and functions as listed in the Input/Output Summary.

System Start-Up and Acceptance:

Upon completion of the installation, the BAS Contractor shall start-up the system and perform all necessary testing and debugging operations. An acceptance test in the presence of the Owner's representative shall be performed. The vendor shall check all sensors that exhibit any problems or faulty reading. When the system performance is deemed satisfactory in whole by UEM, the system parts will be accepted for beneficial use and placed under warranty. The BAS Contractor is to be available for system commissioning at the end of the installation when requested by the Engineer and/or Owner. The contractor is to also be available for seasonal commissioning for the other seasons beyond the initial commissioning.

This Contractor shall work with the Owner (UEM), who is developing the graphics, to ensure that all points report, function and alarm as required on the BACnet head-end system. The Contractor will also work with the Project Manager or CNS/MCIS to obtain all necessary IP’s and Ethernet drops needed for BACnet panel. The Owner (UEM) will assign all BACnet/IP instance numbers and all BACnet/MSTP network numbers for use by the Contractor. All BACnet/IP devices will report directly to the head-end system.

UEM will be performing their own complete point by point evaluation as part of this project, independently of the commissioning activity. This will occur during the warranty period of the project.

Facilities Management's Instruction:

The BAS Contractor shall provide two copies of an electronic version of the operator's manual describing all operating and routine procedures to be used with the system. This user's manual should contain subjects such as: standard operation, error message explanations, software usage, commands, system troubleshooting, etc. The Contractor shall also provide wiring schematics for all system components.

The BAS Contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than four (4) hours during two 2 hour sessions. (Number of hours may be adjusted to a max of 40 dependent upon the size and scope of project. For larger projects, training vouchers for instructional training at the manufacturer's facilities may be requested in lieu of on-site training.) These instructions are to be conducted during normal working hours at the Owner's convenience and are to be prearranged with the Owner. The owner can request this training any time within the one year warranty period and may request any number of classes adding up to the total number of hours. The contractor shall provide an hourly unit price for additional on-site training.

The instructions shall consist of both hands-on at the job site and classroom training at a classroom location on the University of Kentucky campus coordinated with the Project Manager and UEM.

Upon completion, the attendees shall be able to operate the system and implement system changes including start-up, boot load, add point to the data base, enter messages, and down line load field units.

Prior to the scheduling of the sessions, an agenda outlining the training topics must be submitted for approval. Agenda items shall include, but not be limited to, the following topics:

1) Explanation of control sequences. Include which sensors are used and how output device operates.
2) Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
3) Walk-through of project to identify controller locations and general routing of network cabling.
4) Review of operation and maintenance of hardware devices including air compressor, air dryers, controllers, instruments, and sensors. Include schedule for routine maintenance.
5) Programming Application Specific Controllers
   (a) Backing up and Restoring Application Specific Programming
   (b) Adding/Deleting/Editing points on Application Specific controllers
   (c) Troubleshooting Application Specific controllers (inputs/outputs/logic/master – slave relationships/bus issues)
6) Programming Building Specific Controllers
   (a) Backing up and Restoring Building Specific Controllers Programming
   (b) Adding/Deleting/Editing points on Building Specific Controllers controllers

(c) Troubleshooting Building Specific Controllers controllers (inputs/outputs/logic/network issues)

7) How to use tools and cables

Warranty:

The system including all hardware and software components shall be warranted for a period of one year when the system performance is deemed satisfactory in whole by UEM. The system parts will be accepted for beneficial use and placed under warranty at that time. A Certificate of Occupancy does not initiate the control system warranty. Any defects in materials and workmanship arising during this warranty period shall be corrected without cost to the Owner.

All applicable software as detailed in this specification shall be updated by the BAS Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the BAS Contractor.

2.3 DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

System Software

All software required for monitoring, modifying, configuring and backup for the system shall be embedded in the controller and accessible via VT terminal, hyper-terminal or the web. This software shall allow any computer with access (and security) to the University's network to perform the work described above using a web browser or provided software. No software upgrades should be required unless provided at no additional cost to the customer. The software version used for installation of any new devices must either be at the current software version used on the University Facilities Management campus at the current JAVA version or the new software at the most current JAVA version must be installed on all devices and the current system prior to the installation of the new devices. All software is to also operate on the latest version of Microsoft Windows operating system. All configuration and programming tools required for the upgraded version must be provided at the time of installation.

Provide a USB, standard RS-232 9 pin female, Bluetooth, RJ11, RJ12 or RJ45 connection for on-site access.

BACnet Conformance

Building Controller shall as a minimum support MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a BACnet device and shall support simultaneous routing functions between all supported LAN types. Global controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:

1. Clock Functional Group

2. Files Functional Group
3. Reinitialize Functional Group
4. Device Communications Functional Group
5. Event Initiation Functional Group

Please refer to end of this section for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data.

Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. Alarms should also be setup on this system with limits. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data.

The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork. It must support interoperability on the campus area network and function as a BACnet Broadcast Management Device (BBMD) and/or a BACnet router.

Building Controller (B-BC)

General

Building Controller (B-BC) shall be minimum 16 bit microcomputer based, utilizing a multi-tasking, multi-user operating system.

The B-BC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board B-BC controller database shall be performed on-line using the built-in software. Systems which require the B-BC to be removed from service while DDC control sequences are modified shall not be acceptable.

B-BC controllers shall utilize true floating point arithmetic capabilities.

All B-BC controllers shall have open licensing to connect to existing UK UEM Tridium BACnet BAS.

Databases and Memory Back-Up

All programming defining the functions to be performed by the B-BC, including but not limited to application programs and point database within each B-BC, shall be protected from loss due to power failure for a minimum of 72 hours. All database and backup shall be provided to the UK UEM Controls group.

Service Ports

B-BC controllers shall be equipped with a minimum of one operator service port for the connection of a laptop computer. The service port shall be either a built-in standard RS-232 data terminal port, USB port, CAT5 cable or RJ11/12 connection.

Connection of a service device, to a service port, shall not cause the B-BC controller to lose communications with its peers or other networked device controllers.

Display and Readout Capability

The B-BC controller shall additionally provide diagnostic LED indication of device transmit and receive data communications for all communication port and peripheral ports, normal operation, abnormal operation and control relay operation indication.

Manual/Auto Control and Notification

The B-BC controller shall provide commanded override capability from the built-in operator interface. Such overrides shall be annunciated to the head-end station. Such overrides shall be valid as long as power is applied to the controller.

Adjustments

Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all setpoints used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual B-BC. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the B-BC. From a single B-BC user interface, any other B-BC shall be accessible and full adjustment capabilities shall be provided.

B-BC Naming Convention

B-BC devices shall be named using the following naming convention:

> *B-BC devices shall be named using the following format:*
> *BuildingName_BuildingNumber_Floor_RoomNumber_B-BC Device Type* OR
> *BuidlingNumber_BuildingName_Floor_RoomNumber_B-BC Device Type*
>
> *All B-AAC points shall be named using the following format:*
> *Building_Floor_RoomNumber_Device Type_Equipment ShortName_Function*

Examples:

A B-BC device located in the Pavilion HA mechanical room HA4001 would be named as follows:

PAVHA_0293_04_HA4001_JACE

An exhaust fan status point for a fan in Pavilion HA mechanical room HA3001 fed directly from the above panel would be named as follows:

PAVHA_03_HA3001_HVA_EF1_STAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

Application Specific Controller (B-ASC)

General

Controls shall be microprocessor based Application Specific Controller (B-ASC). B-ASC's shall be provided for Unit Ventilators, Fan Coils, Heat Pumps and other applications as shown on the drawings. B-ASC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-ASC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter.

Contractor shall provide a minimum of one B-ASC controller per unitary system as shown on the drawings.

The BAS contractor shall provide and install all B-ASC's specified under this section.

All input/output signals shall be directly hardwired to the B-ASC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

B-ASC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The B-ASC's shall communicate with the B-BC at a baud rate of no less than 38,400 baud.

Non-Volatile Memory

All control sequences programmed into the B-ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the B-ASC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The B-ASC shall allow for the creation of unique application control sequences.

The B-ASC shall be provided with the ability to interface with a laptop computer. The interface port shall be provided at the wall sensor or within the unitary equipment. Connection to the wall sensor must be a standard RJ-45 or USB port.

The B-ASC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken.

Systems unable to provide the above capability shall provide for the individual input/output point trending at the B-BC. Specifics as to how each B-ASC point will be trended, at the B-BC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the B-BC and the number of B-ASC's per B-BC that can be expected.

Controller Location

To simplify controls and mechanical service troubleshooting, the B-ASC shall be mounted directly in the controls compartment of the unitary system. The B-ASC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The B-ASC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

For compatibility to the environment of the unitary equipment, B-ASC shall have wide ambient ratings. B-ASC's shall be rated for service from 32 DegF (Degrees Fahrenheit) to 140 DegF.

Contractor shall submit description of location of B-ASC's on all mechanical and unitary equipment.

B-ASC Naming Convention

B-ASC devices shall be named using the following naming convention:

> *B-ASC devices shall be named using the following format:*
> *Building_Floor_RoomNumber_B-ASC Device Type*
>
> *All B-ASC points shall be named using the following format:*
> *Function*

Examples:

A VAV controller in the Pavilion HA room HA498 would be named as follows:

PAVHA_04_HA498_VAV

The discharge air temperature point for the above room would be named as follows:

DAT

Therefore, when this point is learned, the entire point name will be:

PAVHA_04_HA498_VAV_DAT

For function short names and building short names and numbers, contact the University Controls Engineering Department.

2.4 CONTROL PANELS

Panelboard shall contain all instruments and accessories. Provide each item of equipment with an engraved nameplate. Panelboard shall be wall-mounted or stand-mounted and shall be completely enclosed.

As far as is practical, the control components for each system shall be grouped. Provide each group of components with identification.

The entire panelboard shall be pre-wired and brought to a main terminal strip. All relays, switches, etc., shall be installed, furnished and wired on panelboard. Clearly mark each terminal strip as to which wire from which component is to be connected.

Fabricate panels of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color.

Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.

Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.

Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

SENSORS

Electronic Sensors used in air ducts or liquid lines shall utilize non-adjustable RTD or thermostat sensing elements with + or -0.36ºF, accuracy and stability of at least + or -0.05ºF per year. All sensors used in liquid line shall be provided with separable stainless steel immersion wells. Averaging sensors shall be a minimum of five (5) feet in length, and shall be installed in such a manner so as to sense representative sample of the medium being controlled.

Equipment Operation Sensors: As follows:

Status Inputs for Fans: Differential-pressure switch with adjustable range set to 175 percent of rated fan static pressure. A hawkeye sensor should also be provided so that the owner knows if belts are lost or fans are running backwards.

Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

2.5 SENSOR INPUT AND OUTPUT DEVICES:

The following sensors and devices, or their equivalents, shall be considered acceptable. Other sensors and devices required for this specification are outlined in their respective subsystem.

Analog sensing elements for remote indication shall be independent of local pneumatic sensors used for local control loops.

System Accuracy: The system shall maintain an end-to-end accuracy for one year from sensor to operator's console display for the application specified.

STANDARD	Temperature Sensors
TYPE	Electronic
APPLICATION	BAS, HVAC, BTU, Boiler Control
STANDARD	100 or 1000 ohm platinum wire wound RTD element Standard J (3 wire) configuration European curve, Alpha = .00385 Ohms/Ohm/deg.C., meets DIN SID 43760 Wire in conduit
MECHANICAL	1/4" stainless steel sheath
SPACE TEMPERATURE	Sensor housing to be similar in appearance to existing thermostats except that thermometers are not required. Similarity to be Owner's decision. Locate on an outside wall if possible.
DUCT TEMPERATURE	Standard lengths -- 5.5", 11.5" and 17.5" Other lengths with owner's written approval. Locate in central area of airstream at minimum of 18" from reheat coil. 1/2" NPT mounting thread and flange and conduit connection.

Glass encapsulated element unless otherwise approved.

THERMOWELL Drilled brass or stainless steel or brass fitting with stainless steel sheath built-up well with Owner approval.

Glass encapsulated element unless otherwise approved.

3/4" process connection with drilled wells.

1/2" NPT process connection on built-up wells.

Insertion into measured medium - 1" + 1/2" diameter of pipe.

Cast iron connector head - 1/2" NPT process connection and conduit connection.

Rated thermowell pressure = 250 psi.

ELEMENT ACCURACY must meet .1% DIN and the DIN 43760 standard.

OVERALL ACCURACY + 1 deg.F. General duct, space and thermowell temperatures.
+ .75 deg.F. for thermowell ele. on 4" or larger pipes.
+ .5 deg.F. for thermowell ele. on 8" or larger pipes.

OVERALL RANGE -20% to l20% of possible operating conditions.

GENERAL NOTE If wires from RTD probe to DGP are to be more than 200 feet long, provide extra large cast iron connector head (nominal size 2-11/16 x 1/4) or junction box to accommodate a resistance to 4-20 mA convertor transmitter.

STANDARD Pressure Sensor

TYPE Electronic with LVDT element.

APPLICATION 4-20 mA Output (2 wire)
Wire in conduit
Input voltage 10-35 volts DC
Loop resistance greater than or equal to 500 ohms

MECHANICAL Linear variable differential transformer (LVDT) element
Allowable Standard Ranges 0- 30 PSI
0-100 PSI

0-200 PSI
Other ranges with Owner written approval
1/2" NPT input thread and conduit connection.
Provide differential inputs unless otherwise approved.
Provide an air filter on unused differential ports.
Provide with a NEMA 4 watertight enclosure unless otherwise approved.
Min. rate pressure - l50% FS proof and 450 PSI static.

OVERALL ACCURACY + 0.5% F.S. including Linearity, hysteresis and repeatability.

ACCURACY NOTE: If pressure transducer is used to calculate flow with a pilot tube, then the accuracy of the pressure sensor should be dictated by the overall accuracy requirement of the system and would probably require a high accuracy sensor.

This section covers all new transducers provided. All new transducers provided shall be of the following type:

	INPUT	OUTPUT
l.	Temperature (deg.F.) Temperature (deg.F.)	4-20 mA, 2 wire 100 ohm platinum wire RTD
2.	Pressure	4-20 mA, 2 wire
3.	Flow Instantaneous	4-20 mA, 2 wire
4.	Flow Integrated	Pulse 10 PPS Max A25 msec open (min.) 40 msec closed (min.)
5.	KW Instantaneous	4-20 mA, 2 wire
6.	KWH - Integrated	Pulse – 10 PPS Max A25 msec open (min.) 40 msec closed (min.)

Digital inputs from devices with isolated, dry type contacts (no grounds, no voltage) of either normally open (N.O.) or normally closed (N.C.) configuration. Live contact inputs, those that have voltage present, shall be provided with isolating devices to meet dry contact requirement.

2.6 THERMOSTATS:

Room Thermostats: Provide room thermostats that work in conjunction with the B-AAC and B-ASC terminal unit controllers. Thermostats shall have visible thermometers, setpoint indication

and exposed setpoint adjustment in all areas except public spaces. Thermostats are to have push buttons on the front face for adjusting the temperature setpoints. Thermostats are to have no doors.

In cases where a single room sensor is to be shared by multiple controllers the slave box reheat control valves and dampers shall be individually controlled to track the discharge temperature of the master unit. The Master shall be identified locally and on the FMS.

An RJ-11 type connection to serial port shall allow a local portable operator or programmer's terminal to access all program blocks and attributes for complete programmability.

Room Thermostat Accessories: As follows:

Insulating Bases: For all thermostat installations.

Thermostat Guards: Locking transparent-plastic mounted on separate base.

Adjusting Key: As required for device.

Aspirating Boxes: Where indicated for thermostats requiring flush installation.

2.7 MISCELLANEOUS:

Current Sensing Relays: Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for application. Setpoint of contact operation shall be field adjustable.

Low Voltage Wiring: Control wiring for analog functions shall be 18 AWG minimum with 600 volt insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

Low Voltage Wiring: Wiring for electric or electronic circuits less than 25 volts shall be cabling manufactured for express use in air plenums. The plenum cable shall be 24 gauge or larger as required, tinned copper, Teflon insulated, twisted pairs, shielded or unshielded, as required, a color coded, overall tape wrap, with transparent Teflon jacket, 150V., NEC725, Class 2 classified for use in air plenum non-conduit signaling application.

PART 3 - EXECUTION

3.1 INSPECTION:

Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF AUTOMATIC TEMPERATURE CONTROLS

General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on the Drawings.

3.3 CONTROL WIRING:

Contact the project manager for all required Ethernet connections for this project.

Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code. Install wiring in electrical conduit in all areas. All controls conduit shall be green in color.

Conceal conduit, except in mechanical rooms and areas where other conduit and piping are exposed.

Install all control wiring with color-coded wire in ¾" minimum size conduit. Wire gauge to be in accordance with National Electrical Code.

Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

3.4 POWER WIRING:

Provide power wiring and conduit to air terminal units (if required) and to smoke dampers and combination fire/smoke dampers and their damper motors.

Furnish and install power cabling and conduit for temperature controls panels and equipment from emergency power panels. Each temperature control panel shall be connected to a separate circuit. Conduits shall connect to panels at the locations directed by the Contractor under Division 26. Final connection in the power panels shall be by Temperature Control Contractor in coordination with Division 26 Contractor.

3.5 MISCELLANEOUS:

Software Programming: All software programs shall be programmed by this Contractor.

Installation of Mechanical Devices: Refer to Mechanical Division sections for installation of valve bodies, control wells and dampers; not work of this section.

3.6 ADJUSTMENT AND SERVICE:

After completion of the installation, the automatic temperature control manufacturer shall regulate and adjust all thermostats, control valves, motors, and other equipment provided under his contract and shall place them in complete operating condition, subject to approval by the Engineer and Owner.

This shall include but not be limited to "tuning" of all control systems. Systems shall be tuned for decaying wave response and minimal overshoot of setpoint. Contractor is to not leave any system in an Auto Tune mode.

Room temperature controls shall have one temperature setpoint with less than a 0.5˚F between calculated heating and cooling temperatures.

This Contractor shall work with Balancing Contractor to provide verification of CFM reading from the DDC terminal unit controllers.

Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

After completion of installation, perform the following:

Installation.

Check proper installation and connection of each control device.
Verify electric power.
Verify each sensor and actuator connection to field computer.

Field Computer Operation.

Point Test.
- check of wiring of each sensor and actuator end-to-end
- verify calibration of each sensor.
- verify manual operation of each actuator.

Local loop control.
- bring each local loop under control.
- check response to upset, change in setpoint.
- check full and partial load operation.

Supervisory functions.
- verify time clock schedules.
- verify reset control.

Verify communication with each field device.
- perform end-to-end sensor and actuator checks.
- verify that the database is correct.

Test other software.

Trend Logging.
Report Generation.
Remote Access.
System Documentation.

Verify proper operation of every control point in the presence of the Engineer. Include point-by-point checkout.

The control manufacturer shall provide a period of free service extending through one complete heating season and one complete cooling season, after acceptance of the control system, and shall report the condition of the control equipment to the Owner and the Architect.

PART 4 - SEQUENCE OF OPERATION:

BACnet Protocol Implementation Conformance Statement:
The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for their BACnet Interface with their shop drawings. The interface shall comply with the following as a minimum.

Vendor Name: Tridium, Inc.
Product Family: Niagara Framework, including N4 Web Supervisor, JACE 6XX at Release 3.8, JACE 8xxx at release 4.6 or greater using the most current version of JAVA or HTML 5. All control work associated with this project must be fully compatible with this version of Tridium such that all alarms, points, etc. communicate and clear alarms seamlessly with the existing system.
Description: This product family provides bi-directional communication between the Tridium Niagara Framework and a BACnet system operating at BACnet Conformance Class 3, over Ethernet media.

BACnet Protocols are documented in Appendices A, B & C.

4.1 REQUIRED SUBMITTALS:

The following chart is supplied for the benefit of the Owner, Architect, Engineer and contractor to assure a complete submission of required information. It is a reference listing of documents required by the Specifications under this Section. Refer to Specifications Section - General Provisions for the general requirements of submittals.

ITEM	SHOP DRAWING	M&O MANUAL	PARTS LIST	WRITTEN DESCRIPTION
Control equipment	x	x	x	
Control systems	x			

Control sequence				x
"As-builts" drawings	x	x	x	
Frequency drives	x	x	x	
Air terminal units	x	x	x	
I/O Summary Charts	x			

Print and Save Excel I/O Summary Sheet in Spec Directory (Add general IO Point list)

Appendix A – Vykon Niagara Compatibility Statement (NiCS)

VYKON Niagara^{AX} Compatibility Statement (NiCS) Includes all VYKON branded JACE and Software Products

VYKON Niagara^{AX} Compatibility Statement (NiCS)

Includes all VYKON branded JACE and Software Products

The following information describes Tridium's VYKON branded Niagara^{AX} product licensing.

Tridium's VYKON AX branded products utilizes an open access licensing procedure. VYKON AX branded products can be connected to and managed by any Niagara based tools or systems without the need to modify the license. This means the end user does not have to authorize changes to a VYKON AX license for another systems integrator to gain access to the system. The end user does need to have the necessary user names and passwords installed by the original system integrator so they can be used by another Niagara trained system integrator.

The following is an explanation of the VYKON licensing scheme.

BrandID

Every licensed station and tool has a Brand Identifier (BrandID). This field holds a text descriptor that the OEM chooses as the identifier for its product line. Each station or tool can have only one BrandID entry.

Tridium's VYKON products have the following:

BrandID – VYKON

Station Compatibility In

This field is a list of brands that this local station will allow Niagara AX data to come in from. Simply stated from the point of view of a JACE, "this is the list of brands that can I can accept data from". Tridium's VYKON products contain:

Station Compatibility In – All (In the actual license ALL is define by an *)

Note: The compatibility fields can contain; a single brand "ABC", a list of multiple brands "ABC, XYZ", no brand

"None" or all brands "All".

Station Compatibility Out

This field is a list of brands that this local station will allow Niagara AX data to be shared with. Simply stated, "This is the list of brands that I can share data with". Tridium's VYKON products contain:

Station Compatibility Out – All

Tool Compatibility In

This field is a list of brands that this station will allow to be connected to it for engineering of its application. Simply stated, "This is the list of brands that can engineer me". Tridium's VYKON products contain:

Tool Compatibility In – All

Tool Compatibility Out

This field is a list of brands that this tool is allowed to connect to and engineer. Simply stated, "This is the list of brands that I can engineer". Tridium's VYKON products contain:

Tool Compatibility Out – All

As long as VYKON branded products are purchased by the end user any Tridium Certified (TCP) system integrator can provide support for the end user without the need for the owner to be involved in the licensing process. For more information on Niagara Connectivity and Security visit our website library at: http://www.vykon.com/cs/library/white_papers

Management Contacts:
Scott Boehm
Director, VYKON Automation Energy Security
Sboehm@tridium.com

Ed Merwin
Director, VYKON Automation Energy Security
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Appendix B – Tridium Niagara 3.8 BACnet PICS

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TRIDIUM NIAGARA AX 3.8
BACnet PICS

BACnet Protocol Implementation Conformance Statement

Date: August 31, 2016
Vendor Name: Tridium
Product Name: Niagara AX BACnet Integration
Product Model Number: Tridium JACE models
Application Software Version: 3.8.112 or higher
Firmware Revision: 3.8.112.1 or higher
BACnet Protocol Revision: 7

Product Description:
Niagara AX provides the ability to view, monitor, and control BACnet devices over IP, raw Ethernet, or MS/TP media. Devices, points, schedules, alarms, and logs can be learned and managed from Niagara AX. In addition, Niagara points, schedules, histories, and alarming can be exposed to BACnet for monitor and control by foreign BACnet clients.

BACnet Standardized Device Profile (Annex L):

☐ **BACnet Advanced Operator Workstation (B-AWS)**
☐ **BACnet Operator Workstation (B-OWS)**
☐ **BACnet Operator Display (B-OD)**
☒ **BACnet Building Controller (B-BC)**
☐ **BACnet Advanced Application Controller (B-AAC)**
☐ **BACnet Application Specific Controller (B-ASC)**
☐ **BACnet Smart Sensor (B-SS)**
☐ **BACnet Smart Actuator (B-SA)**

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Additional BACnet Interoperability Building Blocks Supported (Annex K):

Data Sharing DS-RP-A, B DS-RPM-A, B DS-WP-A, B DS-WPM-A, B DS-COV-A, B DS-COVU-A, B DS-V-A DS-M-A DS-COVP-B	**Device & Network Management** DM-DDB-A, B DM-DOB-A, B DM-DCC-B DM-RD-B DM-TS-B DM-UTC-B DM-LM-A, B DM-BR-B DM-ANM-A DM-ADM-A DM-ATS-A DM-MTS-A
Alarm & Event Management AE-N-A, -I-B AE-ACK-A, B AE-ASUM-B AE-ESUM-B AE-INFO-B AE-VN-A AE-VM-A	**Trending** T-VMT-A, I-B, -E-B T-ATR-A, B T-V-A
Scheduling SCHED-A, I-B, -E-B SCHED-VM-A SCHED-WS-I-B	**Network Management** NM-CE-A

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Segmentation Capability:

Feature	Supported	Window size
Transmit Segmented Messages	yes	10
Receive Segmented Messages	yes	any

Standard Object Types Supported:

- The CreateObject and DeleteObject services are not supported, so no objects are dynamically creatable or deletable through BACnet service requests, although these objects are dynamically creatable and deletable through Niagara.
- No general range restrictions exist; however, certain specific applications may have specific range restrictions.
- All potentially available properties are listed for each object type.
- Optional properties are listed in *italics*. Not all instances support all optional properties.
- Writable properties are listed in **bold**. Any range limitations are expressed in parentheses following the property name.

Notes from Table

1. The File_Size property of File objects is only writable if the underlying system file is changeable.
2. The Setpoint property of Loop objects is writable only if the setpoint is not linked from within Niagara.
3. The Recipient_List property of the Notification Class object will maintain entries that are internally configured within Niagara.
4. The List_Of_Object_Property_References property of the Schedule object will maintain entries that are internally configured within Niagara.
5. The Priority_For_Writing property of Schedule objects is not important for internal Niagara operation, as the priority at which a point is commanded is determined by the input to which the Schedule output is linked.
6. These Trend Log object properties are not writable if the backing history for the exported Trend Log is a Niagara-generated history. If the history is created as a BACnet Trend Log, then they are writable.
7. Trend Logs in Niagara use internal triggering and are either COV or Interval. So the Log_Interval property cannot be written from BACnet.

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Object Type	Properties	
Analog Input	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Units *Min_Pres_Value* *Max_Pres_Value*	*Resolution* ***COV_Increment*** ***Time_Delay*** ***Notification_Class*** ***High_Limit*** ***Low_Limit*** ***Deadband*** ***Limit_Enable*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Analog Output	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Units *Min_Pres_Value* *Max_Pres_Value* *Resolution*	Priority_Array **Relinquish_Default** ***COV_Increment*** ***Time_Delay*** ***Notification_Class*** ***High_Limit*** ***Low_Limit*** ***Deadband*** ***Limit_Enable*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Analog Value	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** Units *Priority_Array* ***Relinquish_Default***	***COV_Increment*** ***Time_Delay*** ***Notification_Class*** ***High_Limit*** ***Low_Limit*** ***Deadband*** ***Limit_Enable*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Object Type	Properties	
Binary Input	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Polarity ***Inactive_Text*** ***Active_Text***	*Change_Of_State_Time* ***Change_Of_State_Count*** (0) *Time_Of_State_Count_Reset* ***Elapsed_Active_Time*** (0) *Time_Of_Active_Time_Reset* ***Time_Delay*** ***Notification_Class*** ***Alarm_Value*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Binary Output	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Polarity ***Inactive_Text*** ***Active_Text*** *Change_Of_State_Time* ***Change_Of_State_Count*** (0)	*Time_Of_State_Count_Reset* ***Elapsed_Active_Time*** (0) *Time_Of_Active_Time_Reset* ***Minimum_Off_Time*** ***Minimum_On_Time*** Priority_Array **Relinquish_Default** ***Time_Delay*** ***Notification_Class*** *Feedback_Value* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Binary Value	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** ***Inactive_Text*** ***Active_Text*** *Change_Of_State_Time* **Change_Of_State_Count** *(0)* *Time_Of_State_Count_Reset*	***Elapsed_Active_Time*** (0) *Time_Of_Active_Time_Reset* ***Minimum_Off_Time*** ***Minimum_On_Time*** *Priority_Array* ***Relinquish_Default*** ***Time_Delay*** ***Notification_Class*** ***Alarm_Value*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Object Type	Properties	
Calendar	Object_Identifier **Object_Name** Object_Type	***Description*** Present_Value **Date_List**
Device	Object_Identifier Object_Name Object_Type System_Status Vendor_Name Vendor_Identifier Model_Name Firmware_Revision Application_Software_Revision ***Location*** ***Description*** Protocol_Version Protocol_Revision Protocol_Services_Supported Protocol_Object_Types_Supported Object_List Max_APDU_Length_Accepted	Segmentation_Supported *Max_Segments_Accepted* *Local_Time* *Local_Date* *UTC_Offset* *Daylight_Savings_Status* *APDU_Segment_Timeout* APDU_Timeout Number_Of_APDU_Retries *Max_Master* *Max_Info_Frames* Device_Address_Binding Database_Revision *Configuration_Files* *Last_Restore_Time* ***Backup_Failure_Timeout*** *Active_COV_Subscriptions*
File (Stream Access Only)	Object_Identifier **Object_Name** Object_Type ***Description*** File_Type	**File_Size**[1] Modification_Date **Archive** Read_Only File_Access_Method

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Object Type	Properties	
Loop	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** Output_Units Manipulated_Variable_Reference Controlled_Variable_Reference Controlled_Variable_Value Controlled_Variable_Units Setpoint_Reference **Setpoint**[2] Action ***Proportional_Constant***	*Proportional_Constant_Units* ***Integral_Constant*** *Integral_Constant_Units* ***Derivative_Constant*** *Derivative_Constant_Units* ***Bias*** ***Maximum_Output*** ***Minimum_Output*** Priority_For_Writing ***COV_Increment*** ***Time_Delay*** *Notification_Class* ***Error_Limit*** *Event_Enable* *Acked_Transitions* *Notify_Type* *Event_Time_Stamps*
Multi-state Input	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service**	Number_Of_States ***State_Text*** ***Time_Delay*** ***Notification_Class*** ***Alarm_Values*** *Fault_Values* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Multi-state Output	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** *Device_Type* Status_Flags Event_State *Reliability* **Out_Of_Service** Number_Of_States	***State_Text*** Priority_Array **Relinquish_Default** ***Time_Delay*** ***Notification_Class*** *Feedback_Value* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Object Type	Properties	
Multi-state Value	Object_Identifier **Object_Name** Object_Type Present_Value ***Description*** Status_Flags Event_State *Reliability* **Out_Of_Service** Number_Of_States	***State_Text*** *Priority_Array* ***Relinquish_Default*** ***Time_Delay*** ***Notification_Class*** ***Alarm_Values*** *Fault_Values* *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*
Notification Class	Object_Identifier **Object_Name** Object_Type ***Description***	Notification_Class **Priority** **Ack_Required** **Recipient_List**[3]
Schedule	Object_Identifier **Object_Name** Object_Type ***Description*** **Effective_Period** ***Weekly_Schedule*** ***Exception_Schedule***	**Schedule_Default** **List_Of_Object_Property_References**[4] **Priority_For_Writing**[5] Status_Flags Reliability **Out_Of_Service**
Trend Log	Object_Identifier **Object_Name** Object_Type ***Description*** **Log_Enable**[6] ***Start_Time*** ***Stop_Time*** *Log_DeviceObjectProperty* ***Log_Interval***[6, 7] *COV_Resubscription_Interval* *Client_COV_Increment* Stop_When_Full Buffer_Size	Log_Buffer **Record_Count** (0)[6] Total_Record_Count *Notification_Threshold* *Records_Since_Notification* *Last_Notify_Record* Event_State ***Notification_Class*** *Event_Enable* *Acked_Transitions* ***Notify_Type*** *Event_Time_Stamps*

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Data Link Layer Options:

☒ BACnet IP, (Annex J)
☒ BACnet IP, (Annex J), Foreign Device
☒ ISO 8802-3, Ethernet (Clause 7)
☐ ANSI/ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ ANSI/ATA 878.1, RS-485 ARCNET (Clause 8), baud rate(s) _____
☒ MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400, 76800
☐ MS/TP slave (Clause 9), baud rate(s): _____
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s):_____
☐ Point-To-Point, modem, (Clause 10), baud rate(s): _____
☐ LonTalk, (Clause 11), medium: _____
☐ Other:

Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☒Yes ☐ No

Networking Options:

☒ Router, Clause 6 – Routing configurations: Ethernet-IP, Ethernet-MS/TP, IP-MS/TP
☐ Annex H, BACnet Tunneling Router over IP
☒ BACnet/IP Broadcast Management Device (BBMD)
Does the BBMD support registrations by Foreign Devices? ☒ Yes ☐ No

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☒ ANSI X3.4	☐ IBM™/Microsoft™ DBCS	☒ ISO 8859-1
☒ ISO 10646 (UCS-2)	☐ ISO 10646 (UCS-4)	☐ JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:
This product supports communications between BACnet and any third-party system to which Niagara can connect. Contact Tridium for a list of supported protocols.

Appendix C – BACnet Testing Laboratories Product Listing

BACnet Testing Laboratories Product Listing

This product has been tested at a qualified BACnet Testing Laboratory and found to comply with all the necessary interoperability requirements in place on the published test date. This listing represents the tested capability of the Listed Product. For information on additional functionality that was not covered in the test process, refer to the Manufacturer's PICS statement on the BI website.

Listing Information

Vendor		Listing Status
Tridium, Inc. 3951 Westerre Parkway, Suite 350 Richmond, VA 23233 USA		Listed Product
Test Requirements	BACnet Protocol Revision	Date Tested
Requirements as of July 2009	Revision 7 (135-2008)	July 2011

Product Name	Model Number(s)	Software Version
Niagara AX Supervisor with BACnet B-AWS	S-AX-AWS	3.6.35

Device Profiles

Profile	Model Numbers
BACnet Advanced Workstation (B-AWS)	S-AX-AWS

BIBBs Supported

Data Sharing	ReadProperty-A	DS-RP-A
	ReadProperty-B	DS-RP-B
	ReadPropertyMultiple-A	DS-RPM-A
	ReadPropertyMultiple-B	DS-RPM-B
	WriteProperty-A	DS-WP-A
	WriteProperty-B	DS-WP-B
	WritePropertyMultiple-A	DS-WPM-A
	WritePropertyMultiple-B	DS-WPM-B
	COV-A	DS-COV-A
	View-A	DS-V-A
	Advanced View-A	DS-AV-A
	Modify-A	DS-M-A
	Advanced Modify-A	DS-AM-A

Alarm and Event Management	Alarm and Event-Notification-A	AE-N-A
	Alarm and Event-ACK-A	AE-ACK-A
	Alarm and Event-View Notifications-A	AE-VN-A
	Alarm and Event-Advanced View Notifications-A	AE-AVN-A
	Alarm and Event-View and Modify-A	AE-VM-A
	Alarm and Event-Advanced View and Modify-A	AE-AVM-A
	Alarm and Event-Alarm Summary View-A	AE-AS-A
	Alarm and Event-Event Log View and Modify-A	AE-ELVM-A

Scheduling	Scheduling-View and Modify-A	SCHED-VM-A
	Scheduling-Advanced View and Modify-A	SCHED-AVM-A
	Scheduling-Weekly Schedule-A	SCHED-WS-A

Trending	Trending-View-A	T-V-A
	Trending-Advanced View and Modify-A	T-AVM-A
	Automated Trend Retrieval-A	T-ATR-A

Device and Network Management	Dynamic Device Binding-A	DM-DDB-A
	Dynamic Device Binding-B	DM-DDB-B
	Dynamic Object Binding-A	DM-DOB-A
	Dynamic Object Binding-B	DM-DOB-B
	Automatic Device Mapping-A	DM-ADM-A
	Automatic Network Mapping-A	DM-ANM-A
	Time Synchronization-A	DM-TS-A
	Time Synchronization-B	DM-TS-B
	UTC Time Synchronization-A	DM-UTC-A
	UTC Time Synchronization-B	DM-UTC-B
	Automatic Time Synchronization–A	DM-ATS-A
	Manual Time Synchronization–A	DM-MTS-A
	DeviceCommunicationControl-A	DM-DCC-A
	DeviceCommunicationControl-B	DM-DCC-B
	ReinitializeDevice-A	DM-RD-A
	ReinitializeDevice-B	DM-RD-B
	Backup and Restore-A	DM-BR-A
	Restart-A	DM-R-A
	Object Creation and Deletion-A	DM-OCD-A
	List Manipulation-A	DM-LM-A
	List Manipulation-B	DM-LM-B

Object Type Support

Device		

Data Link Layer Options

Media	Options
BACnet/IP (Annex J)	BBMD
Ethernet	

Networking Options

Networking Functionality	Media
Router	BACnet/IP (Annex J) – Ethernet

Character Set Support

ANSI X3.4 ISO 10646 (UCS-2)

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Chilled water piping.
2. Condensate-drain piping

1.03 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled Water Piping: 150 psig at 150 deg F.
2. Condensate-Drain Piping: 200 deg F.

1.04 SUBMITTALS

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

1. Hydronic piping and fillings.
2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
3. Hydronic specialties.

B. Shop Drawings: Details indicating major piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Qualification Data: For Installer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

G. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International, Inc.
    b. S. P. Fittings; a division of Star Pipe Products.
    c. Victaulic Company of America.

E. Copper or Bronze Pressure-Seal Fittings:

1. Available Manufacturers: Subject to compliance with requirements, a manufacturer offering products that may be incorporated into the Work include, but not limited to, Stadler-Viega.
2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).

F. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

1. Available Manufacturers: Subject to compliance with requirements, a manufacturer offering products that may be incorporated into the Work include, but not limited to, T-DRILL Industries, Inc.

G. Wrought-Copper Unions: ASME B16.22.

2.02 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.03 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

D. Dielectric Flanges:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Calpico, Inc.
   b. Lochinvar Corporation.

2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.04 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Gerand Engineering Co.
   e. Griswold Controls.
   f. Taco.

2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

2.05 AIR CONTROL DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

2.06 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40 and 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Hydronic (chilled water) piping, aboveground, NPS 2 (DN 50) and smaller, may be any of the following:

1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered, brazed or pressure-seal joints.
2. Schedule 40 steel pipe; Class 125, cast-iron, 150, malleable-iron, 250, cast-iron or 300, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints (as required for system operating pressures).

B. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type K (A), annealed-temper copper tubing with soldered or flared joints.

3.02 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install throttling-duty, calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

3.03 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings. All offsets, fittings, valves, and accessories required by these specifications, but not specifically indicated or shown shall be furnished and installed as required for system installation.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tees or tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to manufacturers installation instructions.

Q. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).

S. Reducing fittings shall be used in preference to straight fittings and reducers where possible to eliminate unnecessary joints. Branch connections shall be made by the use of tees or any approved pipe fitting. Weld-o-lets and thread-o-lets may be used in steel piping when the branch size is less than one-half the main size. Eccentric type reducers shall be used in horizontal piping to eliminate air pockets. Either eccentric or concentric reducers may be used in vertical piping. Tapping of "blind" flanges is expressly prohibited.

3.04 CUTTING, FITTING AND PATCHING

A. Perform all cutting and drilling of masonry, steel, wood or iron work and all fitting necessary for the proper installation of all piping systems.

B. No cutting or drilling of the structure, of any kind, shall be done without first obtaining permission from the Architect. All cutting and drilling shall be done under the supervision of the General Contractor in strict accordance with instructions furnished by the Architect.

C. All patching and finishing shall be the responsibility of the Contractor whose cutting or drilling makes such patching and finishing necessary. Patching and finishing shall be done by workman skilled in the trade affected (masonry, plastering, painting, etc.).

3.05 INTERIOR PIPING

A. Install piping parallel to building walls and floors unless indicated otherwise. Arrange piping in groups as neatly as possible and at proper levels, spacing, etc., to avoid interference with other trades, such as electrical, plumbing, heating, ventilating, and structural.

B. Assemble and install piping without undue stresses and strains. Make provisions for expansion, contraction, and structural settlement. Building structural members shall not be weakened or impaired by cutting or notching, unless adequate provision is made with the approval of the Architect for carrying the structural load.

C. Furnish and maintain in a clean and protected condition all piping materials, including valves, fittings, and accessories. Clean the inside of all piping materials of dirt, dust, and other foreign material. Protect installed materials from damage and foreign objects with plugs, caps, or covers.

D. Install valves, traps, operating devices, etc., in a place or position which is accessible for servicing or install access panels, chain operated valves, etc., as required to provide for easy maintenance and use.

3.06 JOINTING METHODS

A. Threading. Threads shall be concentric with the outside of the pipe and conform to ANSI B2.1. Apply an approved lubricant or threading tape on male threads only and make joints full and tight. Cross-threaded joints shall be re-threaded and re-made. All burrs and cuttings shall be removed and piping shall be reamed or filed out to not less than the original diameter.

B. Soft Soldering. Tubes and fittings shall be cleaned bright, fluxed, heated until solder is drawn into the joint by capillary attraction and the joint is tight. Soft solder composition shall be 95-5 tin-antimony, Englelhard Corp. "Silvabrite 100" or equal, lead-free, ASTM B-32. Flux requirements shall be in strict accordance with manufacturer's recommendations.

3.07 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
3. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
4. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).

3.08 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

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

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.09 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.10 ADDITIONAL COMPONENT INSTALLATION

A. Thermometers. For permanent mounting in piping smaller than 4" nominal diameter, the thermometers shall be installed only at 90^{o} angles in piping with wells pointing in direction of flow and pipe size shall be increased to provide original free flow area. Immerse 2" minimum in liquids. Wells shall be of same material as piping.

B. Where reducing fittings and reducers are used and where the ordinary fittings would cause an air pocket, eccentric reducers shall be used. No bushings will be allowed in fittings for reducing sizes.

C. All horizontal runs of water piping shall be run level except condensate drain piping, which shall be pitched at 1/8" per foot, minimum.

D. Install pressure gauges where indicated. Provide a tee handle cock for shutoff.

E. Pressure And Temperature Test Plugs.

1. Install pressure and temperature test plugs where indicated and at the following locations:
   a. Inlets and outlets to all control valves.
   b. Inlets and outlets of all strainers 2" and larger.

F. Install manual air vents where indicated and at the high points where pipe drops in direction of flow as required to properly vent the piping systems.

G. Install automatic air vents at locations indicated.

H. Install unions or flanged connections and valves at each piece of equipment for isolation and/or repair. Always install unions or flanges so that tube pull, coil removal, equipment removal, etc., may be accomplished without removal of any fixed piping.

I. Install dielectric unions or flanged insulating unions at connections of dissimilar metals. Also, at points where piping enters building such unions are to be installed.

J. On all strainers provide nipple and gate valve for blowdown. Provide threaded nipple and cap on discharge side of gate valve.

K. Valves to be soldered or welded shall be disassembled prior to heating. Allow to cool before reassembling.

L. Install flexible connectors in piping where indicated and at all connections to equipment containing rotating equipment such as cooling towers, pumps, etc.

3.11 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

D. Inspection And Testing :
1. All tests shall be made in the presence of representatives of the Architect. The Contractor shall notify the Architect and all administrative authorities having jurisdiction over the tests three working days before the tests are to be made. Tests required for individual piping system shall be performed in accordance with each piping system subsection of these Specifications.
2. After piping has been installed and before application of insulation, backfilling, or painting of lines, all piping shall be subjected to pressure and leak tests witnessed by the Architect. Concealed work shall remain uncovered until required tests have been completed, but if necessary, tests on portions of the work may be made and concealed after being proved satisfactory. Before any test is applied, all equipment and instruments shall be disconnected and the lines blanked off. Equipment which is designed and constructed to withstand the test pressure being applied may be left connected during tests, subject to approval by the Architect.
3. In the absence of other requirements, piping systems shall be tested at a pressure of one and one-half times the maximum system operating pressure.
4. All exposed pipes, fittings, valves, and joints shall be carefully examined during the test. Defective joints or connections shall be re-made or repaired. Any cracked or damaged pipe, fitting, valves, or other defective material discovered under test shall be removed and replaced.
5. After completion and acceptance of the required tests, all valves in the system shall be closed and all equipment and connections used in the test work shall be removed and all openings required in the test work closed in an approved manner.
6. The Contractor shall furnish the necessary piping, valves, and other required equipment to complete the required tests unless otherwise indicated.
7. At the time of final inspection of the work performed under the Contract, the piping systems shall be complete in every respect and in perfect operating condition. All surplus materials of every character resulting from the work of this section shall have been removed. Any defects discovered subsequent to final inspection shall be corrected.

E. At such times as the Architect may direct and before connecting up to equipment, the Contractor shall cap up all openings in the piping and make a complete inspection and test of piping. The Contractor shall notify the Architect in advance so that he can witness the test. A hydrostatic test shall be applied to all parts of the piping systems before concealing any piping. With all openings tightly closed introduce water into the systems until the pressure is 100 pounds per square inch. Without further introduction of water the pressure shall not drop more than 2 pounds per square inch in two hours. Tests may be run in sections if so desired. After the tests have been made all leaks shall be repaired until all such piping shows tight.

END OF SECTION

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

1.03 PERFORMANCE REQUIREMENTS

A. Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and International Building Code’s seismic requirements.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004. No insulation surfaces shall contact air stream.

D. Carefully coordinate duct construction, color, painting, location, etc. with the Architectural drawings, Architect, and construction manager. Submit all ductwork features before fabrication, ordering, etc. The exposed ductwork is an architectural feature of this facility.

1.04 SUBMITTALS

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

1. Adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Factory- and shop-fabricated ducts and fittings.
2. Fittings.
3. Reinforcement and spacing.
4. Seam and joint construction.
5. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports and seismic restraints.

D. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

C. TDC/TDF FORMED-ON FLANGES: Formed-on flanges (TDC/TDF/T25A-25B) will be accepted. Formed on flanges shall be constructed as SMACNA T-25 flanges whose limits are defined on Page 1.36, 1995 SMACNA Manual, Second Edition. Formed-on flanges are not allowed beyond 42” wide ductwork, or above 2” w.g. No other duct construction pertaining to formed-on flanges will be accepted.

D. FUNCTIONAL CRITERIA: Construct rectangular ductwork to meet all functional criteria defined in Section VII, of the SMACNA “HVAC Duct Construction Standards, Metal and Flexible" 1995 First Edition. All ductwork must comply with local, state and federal code requirements.

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Finishes for Surfaces Exposed to View: Mill phosphatized. Ductwork shall also be paint grip for field painting.

2.03 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches (76 mm); 4 inches (102 mm); and 6 inches (152 mm)-dependant on duct size.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.04 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Generally comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

H. Flexible connections shall be provided at all connections between ducts and equipment such as fans or air handling units.

I. All offsets, fittings, and accessories required by the Contract Documents but not specifically indicated shall be furnished and installed in strict accordance with the Specifications.

3.02 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

D. Repair or replace damaged sections and finished work that does not comply with these requirements.

E. Remove or hide duct (or shop) installation tags.

3.03 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.04 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection. In addition, locate hangers as follows:

D. Hangers Exposed to View: Threaded rod and angle or channel supports. The use of cable hangers is prohibited. Conceal hangers: The use of cable hangers is prohibited.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.07 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive 2-inch wg.

C. Return Ducts:

1. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Negative 3-inch wg.

D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

    a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    b. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

        1) Radius-to Diameter Ratio: 1.5.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
    c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

END OF SECTION

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Utility set fans.

1.3 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Aerovent; a Twin City Fan Company.

2. Carnes Company HVAC.
3. Hartzell Fan, Inc.
4. Industrial Air; a division of Lau Industries, Inc.
5. JencoFan; Div. of Breidert Air Products.
6. Loren Cook Company.
7. Madison Manufacturing.
8. New York Blower Company (The).
9. Penn Ventilation.
10. Quietaire Corporation.
11. Trane.

B. Description: **Direct or Belt**-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

C. Housing: Fabricated of **galvanized** steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: **Steel or Aluminum**.
2. Blade Type: **Backward inclined or Forward curved**.

E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

F. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, [**L_{50} of 200,000 hours**] [**L_{10} of 80,000 hours**] <**Insert life**>.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: **1.5**.
2. Motor Pulleys: Adjustable pitch for use with motors through **5** hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

H. Accessories:

1. Inlet and Outlet: Flanged.
2. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.

3. Access Door: Gasketed door in scroll with latch-type handles.
4. Drain Connections: NPS 3/4 (DN 20) threaded coupling drain connection installed at lowest point of housing.
5. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
6. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper

thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION 233423

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Constant-air-volume, single-zone air-handling units.

1.3 SUBMITTALS

A. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

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

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

1.5 COORDINATION

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

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.6 EXTRA MATERIALS

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

1. Filters: Two set(s) for each air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Buffalo Air Handling.
   2. Carrier Corporation; a member of the United Technologies Corporation Family.
   3. Dunham-Bush, Inc.
   4. Engineered Air.
   5. Mammoth Inc.
   6. McQuay International
   7. Trane; American Standard Inc.
   8. YORK International Corporation.

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:

   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   2. Casing Joints: Sheet metal screws or pop rivets.
   3. Sealing: Seal all joints with water-resistant sealant.
   4. Factory Finish for Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

B. Casing Insulation and Adhesive:

   1. Materials: ASTM C 1071.
   2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.

      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
      c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.

   3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:

    a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
    b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:

    a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
    b. Gasket: Neoprene, applied around entire perimeters of panel frames.

4. Locations and Applications:

    a. Fan Section: Doors and access panels.
    b. Access Section: Doors.
    c. Coil Section: Inspection and access panel.
    d. Filter Section: Doors large enough to allow periodic removal and installation of filters.

D. Condensate Drain Pans:

1. Fabricated with minimum one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.

    a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2004.
2. Single-wall, stainless-steel sheet.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

2.3 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

    a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
    b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

C. Internal Vibration Isolation]: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

D. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
5. Mount unit-mounted disconnect switches on exterior of unit.

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, extended-surface type.
2. Thickness: 2 inches.
3. Merv (ASHRAE 52.2): 8.
4. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
5. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

C. Combination Filter and Mixing Section:

1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent or throwaway filters.
2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.6 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig (2070 kPa) according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases using elastomeric pads. Secure units to anchor bolts installed in concrete bases.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Comb coil fins for parallel orientation.
7. Install new, clean filters.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm
2. Measure and record motor electrical values for voltage and amperage.

3.6 ADJUSTING

A. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

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

END OF SECTION 237313

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section applies to all work specified in Division 26.

B. Provide all required materials, labor, equipment, installation, fabrication and testing required for a complete, safe, and fully operational system. System shall include all required materials and features whether specified or shown on drawings or not to comply with applicable codes and authorities having jurisdiction.

C. The electrical installation shall be made in strict conformance with the latest edition and supplements in force at the time of bid opening of the National Electrical Code, the Rules and Regulations of the Kentucky Building Code, the applicable Standards of the National Fire Protection Association, and applicable requirements of the Occupational Safety and Health Act of the United States Department of Labor. All materials and equipment employed shall be approved by and bear the label of Underwriters' Laboratories, Inc., where such labeling is made available by any manufacturer for said materials or equipment. All codes and regulations applicable shall be considered as jointly governing and the requirements of either and all will prevail. If it occurs that Drawings conflict with any applicable code, then this Contractor shall immediately bring same to attention of Architect or his representative for resolution.

1.3 DESCRIPTION OF DOCUMENTS

A. The Drawings are generally diagrammatic and indicate the general design and arrangement of the proposed work. Do not scale drawings for the exact location of equipment and work. The exact routing of circuits and final location of all the electrical equipment, and other systems, unless specifically dimensioned on the Drawings, shall be subject to building and structural conditions, grid systems, and work of other trades involved in the construction, and subject to the approval of the Architect. The Contractor shall familiarize himself with the Contract Documents, and shall be responsible for the final location of his particular equipment to suit field conditions encountered and to avoid interferences with other trades' work, without extra cost to the Owner or the Architect. The Contractor shall visit the job site to determine the job conditions. The Architect reserves the right to make minor changes in equipment

locations at any time prior to rough-in of the electrical work without incurring any additional costs.

B. Where sizes are not provided for material and equipment, the material and equipment shall be sized in accordance with the latest addition of the National Electrical Code and in accordance with the manufacturer's recommendations.

1.4 DEFINITIONS

A. The term "finished space" shall mean any space designated for the general or specific use of the occupants.

B. The term "concealed space" shall mean all furred spaces, pipe chases, spaces above finished ceilings, crawl spaces, and other areas not generally accessible to the occupants.

C. The term "electrical space" as used in this division of the specifications shall mean any space designated primarily for the installation of electrical equipment.

D. "Provide" - Furnish and install the specific item, equipment, and/or system.

E. "Furnish" - Supply the specific item, equipment, and/or system.

F. "Install" - Set in position and adjust for use the specific item, equipment, and/or system unless otherwise specifically noted to be installed by others.

G. "Concealed" - Hidden from sight in walls, chases, furred spaces, above ceilings, underground, in concrete, etc.

H. "Exposed" - Not hidden from sight.

I. "Work" - Labor and installation, including materials, equipment, and systems required for completion of all portions of the project.

1.5 CODES AND STANDARDS

A. Following is a list of abbreviations for codes and standards which are referred to in the Specifications. Where such reference is made, the code or standard becomes a part of these Specifications as if the code or standard were included herein. Reference is always to the latest edition of the code or standard unless otherwise specifically noted.

ANSI - American National Standards Institute, Inc.
NFPA - National Fire Protection Association
ASTM - American Society for Testing and Materials
NBS - National Bureau of Standards
NEMA - National Electrical Manufacturers Association
UL - Underwriters' Laboratories, Inc.
NEC - National Electrical Code
NESC - National Electrical Safety Code

IPCEA - Insulated Power Cable Engineers Assn.
IEEE - Institute of Electrical and Electronics Engineers
OSHA - Occupational Safety and Health Act
IES - Illuminating Engineering Society
JIC - Joint Industrial Council

1.6 GUARANTEES AND WARRANTIES

A. This Contractor shall guarantee all equipment, apparatus, materials, and workmanship entering into the Contract to be the best of its respective kind, and shall replace all parts at his expense which are defective within one year from final acceptance of the work by the Architect. Items of equipment which may have longer guarantees shall have warranties and guarantees completed, in order, and in effect at the time of final acceptance of the work by the Architect. This Contractor shall furnish all such warranties and guarantees at the time of final acceptance of the work.

B. All work that is not installed in accordance with the Contract Documents shall be repaired or replaced at the direction of the Architect.

1.7 SUBMITTAL

A. Submittals shall be made in accordance with Submittals paragraph in Division 1.

B. Submittal data shall include specification data, such as metal gauges, finishes, optional accessories; even though such equipment and materials may be as specified. In addition, the submittal data shall include performance (certification) data, wiring diagrams where applicable, accurate dimensional data, and a recommended spare parts list. Outline or dimensional drawings alone are not acceptable.

C. No roughing-in or connections shall be done until accepted equipment submittals are in the hands of the Contractor. It shall be this Contractor's responsibility to obtain accepted drawings and to make all connections in the neatest and most workmanlike manner possible. This Contractor shall coordinate with all other Contractors having any connections or roughing-in to the equipment.

D. In general, normal catalog information (with the particular items underlined or otherwise denoted as being the submitted item) will be accepted as submittal data. Installation, operating and maintenance instructions must be that information specifically applicable to the items furnished, which is ordinarily supplied with the equipment to the Owner, for any modifications indicated. Wiring diagrams must be correct for the application. Generalized wiring diagrams, showing alternate methods of connection, will not be acceptable unless all unrelated sections are marked out. Submittal data sheets which indicate several different model numbers, figure numbers, optional accessories, or installation arrangements shall be clearly marked to indicate the specific items of equipment being furnished. Samples and certificates shall be furnished as requested. Submittal data must be complete for each piece of equipment; piecemeal data will not be processed.

E. It shall be noted that acceptance of shop drawings by the Architect applies only to general design, arrangement, type, capacity, and quality. Such acceptance does not relieve the Contractor of the responsibility for furnishing the proper equipment.

F. Corrections or comments made on the submittals during the Architect's review do not relieve the Contractor from compliance with the Drawings and Specifications. The Architect's review of submittals is only for general conformance with design concept and general compliance with the information given in the Contract Documents. The Contractor's responsibility includes, but is not limited to, conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner.

1.8 SUBSTITUTIONS

A. When this Contractor requests approval of substitute materials and/or equipment, except where under formal alternate proposal, it shall be understood that such substitution, if approved, will be made without cost to the Owner and Architect, regardless of changes. In all cases where substitutions affect other trades, the Contractor offering such substitutions shall reimburse all affected contractors for all necessary changes in their work.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance data shall be submitted in accordance with the requirements of Division “GENERAL REQUIREMENTS”.

1.10 RECORD DRAWINGS

A. This Contractor shall submit to the Owner Record Drawings. Drawings shall be identified with the Contractor’s name, the date, and title “RECORD DRAWINGS” on the paper copies.

1.11 PROJECT CONDITIONS

A. Interruption of Existing Electrical Services: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electrical services.
2. Indicate method of providing temporary electric service. Contractor is responsible for providing all temporary electrical services.
3. Do not proceed with interruption of electrical service without Architect’s written permission.

4. Comply with NFPA 70E.

1.12 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways and cables will be clear of obstructions and of the working and access space of other equipment.

B. The Contractor shall coordinate with all other contractors in locating conduit, boxes, and equipment in order to avoid conflict with all other trades' work. No extra compensation will be allowed to cover the cost of relocating conduit, boxes, or other electrical equipment found encroaching on space required by others.

PART 2 - PRODUCTS

2.1 GENERAL

A. Material and equipment shall be furnished as specified in this section and each individual electrical section of these Specifications and shall be in strict accordance with applicable ANSI, NBS, ASTM, NESC, NEMA, IEEE, IPCEA, UL, NEC, OSHA and NFPA standards, codes, and specifications. Applicable codes, standards, and manufacturers' products referred to in these Specifications shall establish minimum requirements for materials and equipment furnished for this installation.

B. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Bolting shall be carbon steel conforming to ASTM A-307 with heavy hexagonal nuts.

2.3 Angles, Channels, Beams, Bars and Rods shall be steel conforming to ASTM A-36 as applicable.

2.4 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

    a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
    b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Any electrical box, device, conduit, or enclosure installed in any fire rated column, wall, or ceiling shall not reduce the fire rating of said column or wall. The Contractor providing the device, box, conduit, or enclosure shall provide the required material to maintain the fire rating of the column, wall, or ceiling.

G. At penetrations of fire walls provide fire barrier penetration sealing system. The sealing system shall have a 3 hour rating when tested in accordance with the provisions of ASTM E-119. Installation of penetration sealing systems shall be in accordance with manufacturer's instructions.

H. Provide cover plates where conduit and raceways pass through ceiling or walls and are exposed in finished rooms. Flanges shall fit snugly and shall be sized to cover the openings. All escutcheons shall be chromium plated wing type with fastening screws.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, etc., penetrate, concrete or masonry walls, or fire-rated wall assemblies.

B. Concrete Walls: Install sleeves for penetrations unless core-drilled.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated wall assemblies.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

I. Fire-Rated-Assembly Penetrations: Maintain fire rating of walls, partitions and ceilings at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

J. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves. Seal space around sleeves weather-proof with grout.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

3.4 EQUIPMENT CONNECTION AND WIRING

A. Unless specifically noted otherwise on the Drawings or elsewhere in the Specifications, all wiring and all equipment connections shall be provided by the Electrical Contractor.

B. The Electrical Contractor shall furnish and install all disconnect switches, NEC circuit protection, motor controllers, relays, and devices as required for all equipment to provide complete and operable electrical systems, unless the items are specifically noted elsewhere as being provided with, or as part of, the equipment.

C. Electrical Contractor shall verify horsepower, voltage, phase, starting requirements, quantity of wires, and wattage of all equipment which requires electrical connections before equipment purchase or rough-in, and shall install feeders, branch circuits, and motor starting equipment and protection which are suitable in all respects for connection to, and operation with, the equipment furnished. Exact location of all equipment which requires electrical connection shall be verified with the equipment installer before rough-in.

3.5 EQUIPMENT INSTALLATION

A. All equipment shall be installed at locations indicated and oriented so as to be easily accessible.

B. Assembly and installation of equipment shall be in strict accordance with manufacturer's installation instructions. Equipment shall be securely anchored in place. Care shall be exercised to correctly orient equipment before securing in place.

C. Equipment Mounting.

1. All equipment with moving parts shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission unless otherwise specified, and in addition, shall be isolated from external connections such as piping and raceways by means of flexible connectors, vibration absorbers, or other approved means.

D. Equipment Pads and Grouting

1. Electrical Contractor shall furnish and install concrete pads for all equipment requiring same provided by Electrical Contractor.
2. Floor-mounted equipment or equipment mounted on grade shall be provided with a suitable concrete pad. Each pad shall have suitable hold-down bolts in pipe sleeves, of sufficient number to properly secure the apparatus. Hold-down bolts shall be located by template prepared from actual measurement of the equipment or from certified drawings furnished by the Equipment Manufacturer. Hold-down bolts shall be set in wrought iron pipe sleeves 3/4 inch larger than the bolts to facilitate alignment of equipment.
3. Pads, unless otherwise directed, shall extend 4 inches above the finished floor or finished grade unless noted otherwise, and shall be securely anchored so that vibration or stresses cannot cause lateral movement. Unless noted otherwise, install dowel rods on 18 inch centers around full perimeter of base.
4. Where grouting is required, equipment shall be set to level by use of wedges where no jack screws are provided. After grout has set up, the supporting jack screws or wedges shall be removed and the holes left by removal of the wedges shall be dry packed.
5. Maintain minimum clearances and workspace at equipment according to manufacturer’s written instructions and NFPA 70.

E. Cutting, Fitting, and Patching

1. The Electrical Contractor shall do all cutting and drilling of masonry, steel, wood, or iron work and all fitting necessary for the proper installation of all electrical equipment and materials included in the Specifications or governed thereby.
2. No cutting or drilling of the structure, of any kind, shall be done without first obtaining permission from the Architect. All cutting and drilling shall be done under the supervision of the Contractor in strict accordance with instructions furnished by the Architect.
3. All patching and finishing shall be done by workmen skilled in the trades involved.

3.7 PERMITS, CERTIFICATES, LAWS AND ORDINANCES

1. The Electrical Contractor shall, at his own expense, procure all permits, certificates, and licenses required of him by law for the execution of his work. He shall comply with all Federal, State, and local laws, ordinances, rules and regulations relating to the performance of the work.
2. Following completion, a certificate of approval shall be secured from the local code enforcement authority and delivered to the Architect.

3.8 INSPECTION

A. The Electrical Contractor shall, at his own expense, furnish electrical inspection as required by the local code enforcing agency, when applicable. The Contractor shall notify the Electrical Inspector in writing upon the start of the job and a copy of the notice shall be sent to the Architect. The Contractor shall furnish certificates of final approval by the Electrical Inspection Bureau and final payment shall be withheld until he has presented the Architect with the aforementioned certificates of approval.

3.9 PAINTING

A. Refinish surfaces marred or damaged by electrical work to original or specified condition.

B. Replace marred or discolored factory, multiple coat, baked on finish surfaces. Minor inconspicuous scratches may be “touched-up”.

C. The following items do not require painting.

1. Equipment with a factory baked on finish.
2. Receptacle and switch cover plates.
3. Faceplates of instruments, equipment, and control panels.

END OF SECTION

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 This section specifies the material, installation, and performance requirements for the wiring systems which operate at 600 volts or less.

1.2 Reference to manufacturers by name, make or catalog number shall be interpreted as establishing a minimum standard of quality and shall not be construed as limited competition. If only one manufacturer's product is acceptable, it will be so stated.

1.3 All quantities of each item of specified material and equipment shall be provided by one manufacturer.

PART 2 MATERIAL AND EQUIPMENT

2.1 The wire and cable as specified herein shall be in accordance with the standards and codes applicable to the types of wire being used.

2.2 Insulated Conductors.

A. Conductors shall be the types listed herein.

1. Building wires shall be types THHN, THWN, and XHHW.

B. Conductors No. 8 and smaller shall be solid. Larger conductors shall be stranded.

C. Type THHN shall be 600 volts, heat resistant thermoplastic insulated, nylon jacketed, single conductor copper cable and shall be rated 90 degrees C maximum conductor temperature in damp and dry locations.

D. Type THWN shall be 600 volts, heat and moisture resistant thermoplastic insulated, nylon jacketed single conductor copper cable and shall be rated 75 degrees C maximum conductor temperature in wet and dry locations.

E. Type XHHW shall be 600 volts, cross-linked synthetic polymer insulated, single conductor copper cable and shall be rated 90 degrees C maximum conductor temperature in damp and dry locations and shall be rated 75 degrees C maximum conductor temperature in wet locations.

2.3 Wire connectors shall have a flame retardant thermoplastic shell and plated steel, square wire springs. Connectors shall be rated 105 degrees C. Wire connectors shall be Thomas & Betts "Freespring" series or equal.

2.4 Cable ties shall be self-locking nylon type. Cable ties shall be Thomas & Betts series 13-239 or equal.

2.5 Wire and cable shall be manufactured with material selection tests as described in ASTM D3291 and EN 50497 to prevent plasticizer exudation from PVC insulated and sheathed cables.

2.6 Electrical tape shall be 7 mil flame retardant vinyl. Tape shall be rated 105 degrees C. Electrical tape shall be 3M “Super 33+” or equal.

PART 3 INSTALLATION

3.1 Branch circuit and feeder conductors shall not be smaller than #12 AWG.

3.2 Control circuit conductors shall not be smaller than #14 AWG.

3.3 Feeder conductors and #8 and larger insulated conductors used for branch circuits shall be type THWN or XHHW.

3.4 Control circuit conductors shall be type THWN or XHHW.

3.5 All joints between conductors shall be made with wire connectors. Splices shall be in boxes and shall be accessible.

3.6 No wiring shall be pulled until construction is such that there is no danger of moisture entering open raceways. Protect all openings with caps or plugs until final connections are made. Conduit shall be swabbed clean before pulling conductors.

3.7 No thermoplastic conductors shall be pulled through raceways at ambient temperatures below 33^{o}F.

3.8 All insulated bushings shall be installed before pulling conductors.

3.9 All wiring in panel gutters, pull boxes, and other accessible enclosures shall be tied and bundled with cable ties.

3.10 Wiring shall be installed continuously between terminal points indicated or dictated by field conditions without intermediate splices or taps unless specifically authorized by the Engineer. Splices shall be made only in junction or terminal boxes.

3.11 Feeder cables shall be spliced only at tap points. Splices of any other nature shall not be permitted.

3.12 Conductors shall not be subject to pulling tension in excess of 50 percent of yield strength of conductor. Pulling lugs shall be attached to conductor with a sleeve or grip over the cable sheath to prevent slipping the insulation.

3.13 Where terminals and splices are taped with insulation tape, apply a minimum of two layers of electrical tape, half-lapped.

PART 4 SHOP DRAWINGS AND RELATED SUBMITTALS.

4.1 Submittals shall be made in accordance with paragraph “SUBMITTAL” of Section 260500.

4.2 Corrections or comments made on the shop drawings during the Engneer's review do not relieve the Contractor from compliance with the Drawings and Specifications. The Engineer's review of shop drawings is only for general conformance with design concept and general compliance with the information given in the Contract Documents. The Contractor's responsibility includes, but is not limited to, conforming and

correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner.

4.3 Shop drawings consisting of manufacturer's catalog data shall be submitted on the following:

A. Wire, each type.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. Include The following:

   a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
      1) Test wells
      2) Ground rods.
      3) Grounding arrangements and connections for separately derived systems.

   b. Instructions for periodic testing and inspection of grounding features at test wells grounding connections for separately derived systems based on NFPA 70B.
      1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      2) Include recommended testing intervals.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning & Grounding.
7. ILSCO.
8. O-Z/Gedney; a brand of Emerson Industrial Automation.
9. Robbins Lightning, Inc.
10. SIEMENS Industry, Inc.; Energy Management Division.
11. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

H. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

I. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

J. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

K. Straps: Solid copper, copper lugs. Rated for 600 A.

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

M. Water Pipe Clamps:
   1. Mechanical type, two pieces with zinc-plated or stainless-steel bolts.
      a. Material: Tin-plated aluminum.
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad, sectional type; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 GROUNDING SEPARATELY DERIVED SYSTEMS

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

3.3 EQUIPMENT GROUNDING

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

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Flexible raceway runs.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

C. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at ground test wells. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, ground rod, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 This section specifies the material, installation, and performance requirements for the following:

A. Electrical metallic tubing (EMT)

B. Flexible conduit

C. Outlet boxes, junction boxes, and pull boxes

D. Fittings

E. Hangers

1.2 Reference to manufacturers by name, make, or catalog number shall be interpreted as establishing a minimum standard of quality and shall not be construed as limited competition. If only one manufacturer's product is acceptable, it will be so stated.

1.3 All quantities of each item of specified material and equipment shall be provided by one manufacturer.

PART 2 MATERIAL AND EQUIPMENT

2.1 Conduit.

A. All exposed and concealed conduit shall be EMT unless noted otherwise.

B. All metallic conduit shall be tubular mild steel, circular in cross section, and of uniform wall thickness. Aluminum conduit will not be permitted.

C. Electrical metallic tubing (EMT) shall be galvanized on the outside by the electro-galvanizing process. The interior surface shall have a zinc, enamel, or other suitable corrosion-resistant coating. Electrical metallic tubing shall conform with the requirements of Underwriter's Laboratories Standard UL 797, ANSI C80.3, and Federal Specification WW-C-563.

D. Flexible Conduit.

1. Flexible steel conduit shall be of the single strip type, mild steel, continuous length of uniform weight and thickness.
2. The steel strip shall be galvanized by the hot dip process and then shaped into interlocking convolutions.
3. Liquid tight flexible steel conduit shall have a neoprene jacket.
4. Flexible steel conduit shall conform with the requirements of Underwriter's Laboratories Standard UL 1 and Federal Specification WW-C-566.
5. Liquid tight flexible steel conduit shall conform with the requirements of Underwriters' Laboratories Standard UL 360.

2.2 Outlet Boxes, Junction Boxes, and Pull Boxes.

A. Outlet boxes shall be manufactured of stamped steel with a hot dipped galvanized finish and shall have a minimum depth of 1-1/2 inches.

B. Boxes in concrete construction shall be approved concrete type.

C. Weatherproof outlet boxes shall be cast malleable iron type with threaded hubs and vellumoid gasket.

D. Junction boxes shall be square stamped steel with a blank cover. Pull boxes shall be manufactured of code gauge steel with either a hinged or screw type cover.

E. Outlet boxes and junction boxes shall conform with the requirements of Underwriters' Laboratories Standard 514 and NEMA Standard OS 1.

F. Pull boxes shall conform with the requirements of Underwriters' Laboratories Standard UL 50.

2.3 Conduit Fittings.

A. Electrical Metallic Tubing (EMT).

1. Couplings and Connectors for EMT shall be compression type. Set screw type fittings are not permitted.
2. Compression type EMT couplings shall be zinc plated steel or malleable iron. Compression type EMT couplings shall be Thomas & Betts series 5120 or approved equal.
3. Compression type EMT connectors shall be zinc plated steel or malleable iron. Compression type connectors shall have a nylon insulated throat and shall have a hardened steel locknut. Compression type EMT connectors shall be Thomas & Betts series 5123 or approved equal.

B. Flexible Conduit.

1. Straight connectors shall be zinc plated steel or malleable iron. Connectors shall be the squeeze type, shall have an insulated throat, and shall have a hardened steel locknut. Straight connectors shall be OZ/Gedney series C and 24 or approved equal.
2. EMT to flexible conduit connector shall be zinc plated steel or malleable iron. Connectors shall be the compression type on the EMT end and squeeze type on the flexible conduit end. EMT to flexible conduit connectors shall be OZ/Gedney series 9050 or approved equal.

C. Liquid Tight Flexible Conduit.

1. Straight connectors shall be zinc plated steel or malleable iron. Connectors shall be the compression type, shall have a sealing ring and insulated throat, and shall have a hardened steel locknut. Straight connectors shall be Thomas & Betts series 5331 or approved equal.
2. Sealing gaskets shall consist of an oil resistant and moisture resistant rubber seal bonded to a stainless steel retainer. Sealing gaskets for liquid tight flexible conduit fittings shall be Thomas & Betts series 5262 or approved equal.

2.4 Hangers.

A. One hole straps for electrical metallic tubing shall be steel and shall be Thomas & Betts series 4159 or equal.

B. Conduit clamps shall be steel and shall be Steel City series 6H or equal.

C. Conduit beam clamps shall be Thomas & Betts series 690 or equal.

D. Beam clamps shall be zinc plated malleable iron, shall have hardened steel cup-point set screw, shall be tapped in base and back, and shall be Steel City series 500 or equal.

E. Adjustable beam clamps shall be steel and shall be Thomas & Betts series 700, or equal.

F. Trapeze hangers, fabricated from standard steel channel sections, hanger rods, support clamps, and conduit clamps shall be Unistrut P-1000 with pipe clamps P-1100 and P-1400 series, or equal.

PART 3 INSTALLATION

3.1 Conduit.

A. Metallic conduit shall be electrical metallic tubing unless specified otherwise.

B. Flexible Metal Conduit.

1. Final connection to all motors and other equipment subject to movement or vibration shall be made with flexible metal conduit. Length of flexible conduit shall not exceed 36 inches.
2. Flexible metal conduit in wet locations shall be the liquid tight type.

C. The minimum conduit size shall be 3/4 inch.

D. Conduit shall be run with smooth, easy bends. Exposed conduit shall be run parallel or perpendicular to walls, ceilings, beams, and columns. Concealed conduit may be run at angles other than parallel or perpendicular to building lines but shall be grouped in a neat and workmanlike manner. Dissimilar angles and crisscross arrangement will not be acceptable.

E. Conduit bends and elbows shall be long-sweep, large radii when required by cable manufacturer.

F. Conduit, whether concealed or exposed, shall be adequately supported in accordance with the National Electrical Code requirements and good practice. Conduit shall be securely fastened in place within 3 feet of each outlet box, junction box, cabinet, or fitting and shall be supported at least every 10 feet.

G. Single runs of conduit shall be fastened to walls with one-hole straps or conduit clamps and to beams or trusses with beam clamps.

H. Parallel runs of conduit shall be grouped and fastened to walls with wall brackets of steel channel or knee-braced angles and to beams and trusses with adjustable beam clamps or trapeze hangers.

I. Trapeze hangers shall be supported by steel rods of sufficient diameter to support conduit from joists or concrete construction. Where desired or required, conduit may be double mounted on trapeze hangers. Wherever possible, conduit shall be top mounted on trapeze hangers with each conduit individually clamped to trapeze hangers.

J. Where conduits are run vertically, approved riser clamps, brackets, or other means shall be utilized to support conduit at 8'-0" center to center, maximum.

K. No conduit shall be supported by the equipment to which it is connected.

L. For concrete construction, utilize adjustable concrete inserts for fasteners except that expansion anchors shall be used for heavy loading conditions and power driven devices may be used for light loading conditions. Utilize beam clamps for fastening to steel joists and beams.

M. Perforated band iron, piano wire, or steel wire hangers will not be permitted as conduit hangers or supports. Conduit shall not be hung from wire supporting ceiling grid systems.

N. Conduit shall not be secured directly to other piping. Conduit parallel with or crossing uninsulated hot water or steam pipes shall be separated from them by 12 inches if parallel, or 6 inches if crossing. Where these lines are insulated, conduit parallel with or crossing under them shall clear the insulated surface by 2 inches.

O. All conduit shall be swabbed and cleaned before pulling wire.

P. Metallic conduit systems shall be electrically continuous in their entirety.

Q. All conduit shall be capped before concrete is poured.

3.2 Outlet Boxes, Pull Boxes, and Junction Boxes.

A. Outlet boxes shall be provided for all devices.

B. Pull boxes or junction boxes shall be provided at all points of splicing and tapping.

C. Square cornered boxes shall be provided in block and brick wall construction.

D. Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry block and with screws or welded studs on steel work.

E. Threaded studs driven in by powder charge and provided with lock washers and nuts, or nail-type nylon anchors, may be used in lieu of wood screws, expansion shields or machine screws.

F. Outlet boxes in lay-in ceilings shall be supported by bar hangers anchored to the ceiling construction.

G. Connections between outlet boxes on the opposite sides of a wall shall be made with conduit employing the use of two 90 degree bends from box to box.

3.3 Fittings

A. Fittings shall be installed in all raceways at terminating points, couplings, and expansion joints.

B. In wet locations, a sealing bushing shall be provided between the enclosure and the locknut on the exterior of the box.

C. When terminating liquid tight flexible conduit in a sheet metal enclosure, provide a sealing gasket between the connector and the box.

D. Expansion fittings with bonding jumpers shall be provided at concrete expansion joints.

PART 4 SHOP DRAWINGS AND RELATED SUBMITTALS.

4.1 Submittals shall be made in accordance with paragraph “SUBMITTALS” of Section 260500.

4.2 Corrections or comments made on the shop drawings during the Architect's review do not relieve the Contractor from compliance with the Drawings and Specifications. The Architect's review of shop drawings is only for general conformance with design concept and general compliance with the information given in the Contract Documents. The Contractor's responsibility includes, but is not limited to, confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner.

4.3 Shop drawings consisting of manufacturer's catalog data shall be submitted on the following:

A. Conduit, each type.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, multifunction monitor, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power wiring.

C. Panelboard Schedules: For installation in panelboards.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NECA 407.

B. Store panel in indoor dry location to avoid condensation and outdoor exposure.

1.6 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels per NEC.

1.8 WARRANTY

A. Manufacturer’s Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

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

1.9 EXTRA MATERIALS

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

1. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets as indicated.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

7. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Incoming Mains Location: Top and bottom. Contractor shall be responsible for coordination of feeder entry point.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals series rated system not acceptable. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings not less than 14,000 A rms symmetrical.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. ABB.
3. Square D; a brand of Schneider Electric.
4. Siemens Energy.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Provide door-in-door feature with continuous hinge along edge.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: As indicated on Drawings.

E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers as indicated on Drawings.

F. Service- Rated: Labeled for use as service equipment.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. ABB.
3. Square D; a brand of Schneider Electric.
4. Siemens Energy.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as indicated.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Door-in-door feature with continuous hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 INSTRUMENTATION

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three-or four-wire systems and with the following features:

1. Switch-selectable digital display of the following valves with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
c. Phase-to-Neutral Voltage, Three Phase: Plus or minus 0.5 percent.
d. Megawatts: Plus or minus 1 percent.
e. Megavars: Plus or minus 1 percent.
f. Power Factor: Plus or minus 1 percent.
g. Frequency: Plus or minus 0.1 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated valves unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit mounted on distribution panel enclosure.
3. Digital metering shall be capable of communicating with the Building Management System.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount top of trim 72 inches above finished floor unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

I. Top fed panels to be fed from top and bottom so that the panel feeders are not in the side gutters.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads, incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing:

1. Test insulation resistance for each panelboard bus, component, connecting supply and feeder.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Test ground-fault protection equipment for service entrance per NFPA 70.
2. Perform each visual and mechanical inspection and electrical test.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 262813 - FUSES

PART 1 GENERAL

1.1 This section specifies the material, installation, and performance requirements for fuses.

1.2 Reference to manufacturers by name, make, or catalog number shall be interpreted as establishing a minimum standard of quality and shall not be construed as limiting competition. If only one manufacturer's product is acceptable, it will be so stated.

1.3 All fuses shall be provided by one manufacturer.

PART 2 MATERIAL AND EQUIPMENT

2.1 All fuses shall be current limiting with 200,000 amperes interrupting capacity, and shall be certified by Underwriters' Laboratories, Inc., to have interrupting capacities adequate and proper for the system in which they are placed.

2.2 Fuses 600 ampere and smaller shall be Underwriter's Laboratories, Inc., Class RK-5.

A. Class RK-5 fuses shall have standard dimensions, and shall be dual-element, time delay type. Fuses shall be Bussman Type FRN-R or FRS-R, Littelfuse Type FLN-R or FLS-R, or approved equal.

PART 3 INSTALLATION

3.1 No fuses shall be installed in the equipment until the installation is complete, including thorough cleaning, tightening of all electrical connections, and inspection of all ground and grounding conductors. Fuses shall not be shipped installed in equipment and shall not be shipped to job site until equipment and systems are ready to be energized.

3.2 UL Class RK-5 fuses shall be installed in all fusible switches.

3.3 Three spare fuses for each size and type of fuse installed shall be furnished and turned over to the Owner.

3.4 A fuse identification label showing the fuse size and type shall be placed inside the door of each fused switch.

3.5 Provide fuse reducers where fuse clips are spaced larger than the fuse size required.

3.6 After all tests have been completed, all fuses necessary for the complete system shall be installed.

PART 4 SHOP DRAWINGS AND RELATED SUBMITTALS.

4.1 Submittals shall be made in accordance with paragraph "SUBMITTAL" of Section 14010.

4.2 Corrections or comments made on the shop drawings during the Engineer's review do not relieve the Contractor from compliance with the Drawings and Specifications. The Engineer's review of shop drawings is only for general conformance with design concept

and general compliance with the information given in the Contract Documents. The Contractor's responsibility includes, but is not limited to, confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner.

4.3 Shop drawings, consisting of manufacturer's catalog data shall be submitted for Class RK-5 fuses.

END OF SECTION

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case switches.
4. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

C. Field quality-control reports.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. Include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 WARRANTY

A. Manufacturer’s Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.
4. Siemens Energy.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac as required, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Hookstick Handle: Allows use of a hookstick to operate the handle.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. General Electric Company.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; Schneider Electric USA.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, provide breakers with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breakers indicated on the drawings.
2. Electronic Trip Circuit Breakers: Circuit breakers 100A and larger; Microprocessor based trip system with true rms sensing; field-replaceable electronic trip; and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and I^2t response.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs:

a. Mechanical type. Suitable for number, size, trip rating, and conductor material.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable, circuit breaker trip ranges.

END OF SECTION

SECTION 323113
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Posts, rails, and frames.

B. Wire fabric.

C. Manual gates with related hardware.

D. Accessories.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a (Reapproved 2022).

C. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2023.

D. BHMA A156.3 - Exit Devices; 2025.

E. CLFMI CLF-SFR0111 - Security Fencing Recommendations; 2014.

F. FS RR-F-191/1D - Fencing, Wire and Post Metal (Chain-Link Fence Fabric); 1990.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chain Link Fences and Gates:
   1. Master-Halco, Inc; _____: www.masterhalco.com/#sle.
   2. Merchants Metals; _____: www.merchantsmetals.com/#sle.
   3. Substitutions: See Section 016000 - Product Requirements.

2.02 COMPONENTS

A. Line Posts: 1.9 inch (48 mm) diameter.

B. Corner and Terminal Posts: 3-1/2 inch (89 mm) diameter.

C. Gate Posts: 3-1/2 inch (89 mm) diameter.

D. Top and Brace Rail: 1.66 inch (42 mm) diameter, plain end, sleeve coupled.

E. Bottom Rail: 1.66 inch (42 mm) diameter, plain end, sleeve coupled.

F. Gate Frame: 1.66 inch (42 mm) diameter for welded fabrication.

G. Fabric: 2 inch (51 mm) diamond mesh interwoven wire, 6 gauge, 0.1920 inch (4.9 mm) thick, top selvage knuckle end closed, bottom selvage twisted tight.

H. Tension Wire: 6 gauge, 0.1920 inch (4.9 mm) thick steel, single strand.

I. Tie Wire: Aluminum alloy steel wire.

2.03 MATERIALS

A. Posts, Rails, and Frames:
   1. Line Posts: Type I round in accordance with FS RR-F-191/1D.

2. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.

B. Wire Fabric:
1. ASTM A392 zinc coated steel chain link fabric.

2.04 MANUAL GATES AND RELATED HARDWARE

A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches (1,525 mm) high, 3 for taller gates; panic exit device with entry lock..

2.05 LIGHT-DUTY ARCHITECTURAL HARDWARE

A. Exit Devices: Aluminum, 36 inches (914 mm) wide.
1. Performance Criteria: Comply with BHMA A156.3, Grade 1.
2. Provide strike of type recommended by manufacturer for application indicated.
3. Aluminum Finish: 628.
4. Exit bar with entry lock.
a. Cylinder Lock: Match owner's existing keying system.
5. 24" high x 36" wide solid mounting plate.
6. Products:
a. DAC Industries, Inc; 6040 Deluxe exit bar kit: www.dacindustries.com/#sle.
b. Substitutions: See Section 016000 - Product Requirements.

B. Hinge Set: Self-closing, for top and bottom support of swinging gate.
1. Swing Direction: One way.
2. Mounting to Round Fence Post and Gate Frame: Integral clamp.
3. Finish: Galvanized.

2.06 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

2.07 FINISHES

A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot (530 g/sq m).

B. Accessories: Same finish as framing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

3.02 PREPARATION

A. Removal: Obstructions or debris.

3.03 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Position bottom of fabric 2 inches (50 mm) above finished grade.

C. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches (380 mm) on centers.

D. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

END OF SECTION