

## 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.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Mechanical sleeve seals.
  - 5. Sleeves.
  - 6. Escutcheons.
  - 7. Grout.
  - 8. HVAC Demolition.
  - 9. Equipment installation requirements common to equipment sections.
  - 10. Painting and finishing.
  - 11. Concrete bases.
  - 12. 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, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

#### 1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

#### 1.5 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

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.

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. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

## 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. Manufacturers: Subject to compliance with requirements, provide products by 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. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAgl, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
  1. CPVC Piping: ASTM F 493.
  2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

#### 2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  1. Manufacturers:
    - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  1. Manufacturers:
    - a. Thompson Plastics, Inc.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
  1. Manufacturers:
    - a. NIBCO INC.
    - b. NIBCO, Inc.; Chemtrol Div.

## 2.5 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: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

- 1. Manufacturers:

- a. Capitol Manufacturing Co.
- b. Central Plastics Company.
- c. Eclipse, Inc.
- d. Epco Sales, Inc.
- e. Hart Industries, International, Inc.
- f. Watts Industries, Inc.; Water Products Div.
- g. Zurn Industries, Inc.; Wilkins Div.

- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

- 1. Manufacturers:

- a. Capitol Manufacturing Co.
- b. Central Plastics Company.
- c. Epco Sales, Inc.
- d. Watts Industries, Inc.; Water Products Div.

Dielectric-Flange Kits: 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.

- 2. Manufacturers:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

- 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.

- E. Dielectric Couplings: 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).

- 1. Manufacturers:

- a. Calpico, Inc.
  - b. Lochinvar Corp.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  - 1. Manufacturers:
    - a. Perfection Corp.
    - b. Precision Plumbing Products, Inc.
    - c. Sioux Chief Manufacturing Co., Inc.
    - d. Victaulic Co. of America.

## 2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## 2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
  - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
  - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 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. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
    - g. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
    - h. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
    - i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
  - 2. Existing Piping: Use the following:
    - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
    - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
    - f. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
    - g. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
    - h. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, 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.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, 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).
    - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
    - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      - 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 Section "Joint Sealants" for materials and installation.
- Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
  - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
  - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten

bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- S. 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 Section "Penetration Firestopping" for materials.
- T. Verify final equipment locations for roughing-in.
- U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 3.3 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.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
  2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.4 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.
  2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### 3.5 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.

### 3.6 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.

### 3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

### 3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### 3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.10 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 230500

## SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Flexible, ball-joint, packed expansion joints.
2. Slip-joint packed expansion joints.
3. Expansion-compensator packless expansion joints.
4. Flexible-hose packless expansion joints.
5. Metal-bellows packless expansion joints.
6. Rubber packless expansion joints.
7. Grooved-joint expansion joints.
8. Pipe loops and swing connections.
9. Alignment guides and anchors.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

- C. Welding certificates.
- D. Product Certificates: For each type of expansion joint, from manufacturer.
- E. Maintenance Data: For expansion joints to include in maintenance manuals.

## 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. ASME Boiler and Pressure Vessel Code: Section IX.

## PART 2 - PRODUCTS

### 2.1 PACKLESS EXPANSION JOINTS

- A. Flexible-Hose Packless Expansion Joints:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Flex-Hose Co., Inc.
    - b. Flexicraft Industries.
    - c. Flex Pression Ltd.
    - d. Metraflex, Inc.
    - e. Unisource Manufacturing, Inc.
  - 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
  - 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
  - 4. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
    - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
  - 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.
    - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.
  - 6. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Carbon-steel fittings with threaded end connections.



- a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
- 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon-steel fittings with flanged end connections.
  - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.
- 8. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon-steel fittings with flanged end connections.
  - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.
- 9. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with flanged end connections.
  - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.

## 2.2 ALIGNMENT GUIDES AND ANCHORS

### A. Alignment Guides:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adscro Manufacturing LLC.
  - b. Advanced Thermal Systems, Inc.
  - c. Flex-Hose Co., Inc.
  - d. Flexicraft Industries.
  - e. Flex-Weld, Inc.
  - f. Hyspan Precision Products, Inc.
  - g. Metraflex, Inc.
  - h. Senior Flexonics Pathway.
  - i. Unisource Manufacturing, Inc.
  - j. U.S. Bellows, Inc.
- 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

### B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

### PART 3 - EXECUTION

#### 3.1 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- D. Install rubber packless expansion joints according to FSA-NMEJ-702.
- E. Install grooved-joint expansion joints to grooved-end steel piping

#### 3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

- D. Install expansion loops at every 100 ft. minimum.
- E. Metraflex mechanical expansion can be substituted per manufacturers recommendations for distance or every 100 ft. Whichever requirement is more stringent.

### 3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

## SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.

#### 1.3 SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

## 2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Smith, Jay R. Mfg. Co.
  - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.
  - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Stainless steel.
  - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

## 2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Presealed Systems.

- C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

## 2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
  - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
  - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

### 3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
  - 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
  - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
  - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

### 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:
  - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.
2. Exterior Concrete Walls below Grade:
  - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
1. Concrete Slabs-on-Grade:
  - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
2. Concrete Slabs above Grade:
  - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.
3. Interior Partitions:
  - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517



## SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### 1.3 SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

#### 2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type with spring cups.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    - f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    - g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
  - 2. Escutcheons for Existing Piping:
    - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
    - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
    - f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. New Piping: One-piece, floor-plate type.
  - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

## SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Bimetallic-actuated thermometers.
  - 2. Thermowells.
  - 3. Dial-type pressure gages.
  - 4. Gage attachments.
  - 5. Test plugs.
  - 6. Test-plug kits.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of meter and gage, from manufacturer.
- C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- 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. Ashcroft Inc.
  - 2. Ernst Flow Industries.
  - 3. Marsh Bellofram.
  - 4. Miljoco Corporation.
  - 5. Nanmac Corporation.
  - 6. Noshok.
  - 7. Palmer Wahl Instrumentation Group.

8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Terrice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.
13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.

- B. Standard: ASME B40.200.
- C. Case: Liquid-filled non mercury and sealed type(s); stainless steel with 3-inch (76-mm) nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C).
- E. Connector Type(s): Union joint, adjustable angle rigid, back and rigid, bottom, with unified-inch screw threads.
- F. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
- H. Window: Laminated safety glass
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

## 2.2 THERMOWELLS

- A. Thermowells:
1. Standard: ASME B40.200.
  2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
  3. Material for Use with Copper Tubing: CNR or CUNI.
  4. Material for Use with Steel Piping: CRES.
  5. Type: Stepped shank unless straight or tapered shank is indicated.
  6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
  7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
  8. Bore: Diameter required to match thermometer bulb or stem.
  9. Insertion Length: Length required to match thermometer bulb or stem.
  10. Lagging Extension: Include on thermowells for insulated piping and tubing.

11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

## 2.3 PRESSURE GAGES

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

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Ernst Flow Industries.
  - d. Flo Fab Inc.
  - e. Marsh Bellofram.
  - f. Miljoco Corporation.
  - g. Noshok.
  - h. Palmer Wahl Instrumentation Group.
  - i. REOTEMP Instrument Corporation.
  - j. Tel-Tru Manufacturing Company.
  - k. Terice, H. O. Co.
  - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - m. Weiss Instruments, Inc.
  - n. WIKA Instrument Corporation - USA.
  - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled non-mercury type(s); cast aluminum or stainless steel 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Laminated safety glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

## 2.5 TEST PLUGS

- 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. Flow Design, Inc.
  - 2. Miljoco Corporation.
  - 3. National Meter, Inc.
  - 4. Peterson Equipment Co., Inc.
  - 5. Sisco Manufacturing Company, Inc.
  - 6. Trerice, H. O. Co.
  - 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - 8. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- F. Core Inserts: Neoprene self-sealing rubber.

## 2.6 TEST-PLUG KITS

- 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. Flow Design, Inc.
  - 2. Miljoco Corporation.
  - 3. National Meter, Inc.
  - 4. Peterson Equipment Co., Inc.
  - 5. Sisco Manufacturing Company, Inc.
  - 6. Trerice, H. O. Co.
  - 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - 8. Weiss Instruments, Inc.

- B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
- F. Carrying Case: Metal or plastic, with formed instrument padding.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- E. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- F. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- G. Install test plugs in piping tees.
- H. Install thermometers in the following locations:
  - 1. As indicated on plans, details and schematic diagrams.
- I. Install pressure gages in the following locations:
  - 1. As indicated on plans, details and schematic diagrams.
  - 2. Inlet and outlet of each hydronic zone.



### 3.2 CONNECTIONS

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

### 3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be the following:
  - 1. Test plug with neoprene self-sealing rubber inserts.
- B. Thermometer stems shall be of length to match thermowell insertion length.

### 3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Heating, Dual Temp Piping: 20 to 240 deg F (0 to 150 deg C)

### 3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
  - 1. Liquid-filled, non-mercury direct-mounted, metal case.

### 3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi (0 to 600 kPa).

END OF SECTION 230519

## SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Bronze angle valves.
  - 2. Bronze ball valves.
  - 3. Iron ball valves.
  - 4. Bronze swing check valves.
  - 5. Iron swing check valves.
  - 6. Bronze gate valves.
  - 7. Iron gate valves.
  - 8. Bronze globe valves.

- B. Related Sections:

- 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
  - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

#### 1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. Compliance to SED Manual of Planning

#### 1.4 SUBMITTALS

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

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and weld ends.
  - 3. Set gate and globe valves closed to prevent rattling.
  - 4. Set ball valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems as lifting or rigging points.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  - 1. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.

- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
  - 1. Gate Valves: With rising stem.
  - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Solder Joint: With sockets according to ASME B16.18.
  - 3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Nonmetallic Disc:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. American Valve, Inc.
    - b. NIBCO INC.
    - c. Hammond
    - d. Jenkins
    - e. Stockham
  - 2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 200 psig (1380 kPa).
    - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    - d. Ends: Threaded or solder.
    - e. Stem: Bronze.
    - f. Disc: PTFE or TFE.
    - g. Packing: Asbestos free.
    - h. Handwheel: Malleable iron.

## 2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
  - 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Conbraco Industries, Inc.; Apollo Valves.
- b. Hammond Valve.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded or solder.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

- 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. American Valve, Inc.
  - b. Conbraco Industries, Inc.; Apollo Valves.
  - c. Nibco Inc.
  - d. Sure Flow Equipment Inc.
  - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
  - a. Standard: MSS SP-72.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Split body.
  - d. Body Material: ASTM A 126, gray iron.
  - e. Ends: Flanged.
  - f. Seats: PTFE or TFE.
  - g. Stem: Stainless steel.
  - h. Ball: Stainless steel.
  - i. Port: Full.

2.3 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. NIBCO Inc.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B 61 or ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

2.4 BRONZE SWING CHECK VALVES

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

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

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. NIBCO INC.

2. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or solder.
- f. Disc: PTFE or TFE.

2.5 IRON SWING CHECK VALVES

Class 125, Iron Swing Check Valves with Metal Seats:

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

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

2.6 BRONZE GATE VALVES

Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. NIBCO INC.
  - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded or solder joint.
  - e. Stem: Bronze.
  - f. Disc: Solid wedge; bronze.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron.

2.7 IRON GATE VALVES

Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
2. Description:
  - a. Standard: MSS SP-70, Type I.
  - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - d. Ends: Flanged.
  - e. Trim: Bronze.
  - f. Disc: Solid wedge.
  - g. Packing and Gasket: Asbestos free.

## 2.8 BRONZE GLOBE VALVES

Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.
  - c. NIBCO INC.
  - d. Red-White Valve Corporation.
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
  - d. Ends: Threaded or solder joint.
  - e. Stem: Bronze.
  - f. Disc: PTFE or TFE.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron.

## 2.9 IRON GLOBE VALVES

Class 125, Iron Globe Valves:



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
2. Description:
  - a. Standard: MSS SP-85, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - d. Ends: Flanged.
  - e. Trim: Bronze.
  - f. Packing and Gasket: Asbestos free.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

#### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.

- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Lift Check Valves: With stem upright and plumb.

### 3.3 ADJUSTING

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

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball, butterfly, or gate valves.
  - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
  - 3. Throttling Service except Steam: Globe valves.
  - 4. Pump-Discharge Check Valves:
    - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
    - b. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
- D. DUAL- TEMP VALVE SCHEDULE
  - A. Pipe NPS 2 (DN 50) and Smaller:
    - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
    - 2. Ball Valves: Two piece, full port, bronze with bronze trim.
    - 3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
    - 4. Bronze Globe Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 3 (DN 65 to DN 75): Class 150.
3. Iron, Single-Flange Butterfly Valves, NPS 4 to NPS 12 (DN 100 to DN 300): 200 CWP, EPDM seat, ductile-iron disc.
4. Iron Swing Check Valves: Class 125, metal seats.
5. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125.

END OF SECTION 230523

## SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

- B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.

#### 1.3 DEFINITIONS

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

#### 1.4 PERFORMANCE REQUIREMENTS

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

- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

## 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers.
  - 2. Pipe stands.
  - 3. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail fabrication and assembly of trapeze hangers.
  - 2. Design Calculations: Calculate requirements for designing trapeze hangers.
- D. Welding certificates.

## 1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:

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

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

## 2.2 TRAPEZE PIPE HANGERS

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

## 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa)] minimum compressive strength and vapor barrier.

- D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa)] minimum compressive strength.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 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.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.5 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
  - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 2. Base: Stainless steel.
  - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
  - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
  - 2. Bases: One or more; plastic.
  - 3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## 2.6 EQUIPMENT SUPPORTS

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

## 2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.



- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.
- H. Pipe Stand Installation:
  - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. 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.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. 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 (DN 65) 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.
- N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- P. Insulated Piping:
  - 1. Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
  - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
  - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
  - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
  - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
  - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
  - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 METAL FABRICATIONS

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

- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections. Section "High-Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports or metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel pipe hangers attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. 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 (DN 15 to DN 750).
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), 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 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), 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 (DN 20 to DN 200).
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
  - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
  - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  - 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 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) 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 (DN 25 to DN 750), from two 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 24 (DN 65 to DN 600), 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 (DN 50 to DN 1050) 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 (DN 50 to DN 600) 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 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- L. 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 (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.
- M. 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-joint 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 (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529



## SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Valve tags.
  - 5. Warning tags.

#### 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. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.



## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

#### A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm), Stainless steel, 0.025-inch (0.64-mm), Aluminum, 0.032-inch (0.8-mm), or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

#### D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### 2.2 WARNING SIGNS AND LABELS

#### A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

- B. Letter Color: Black.
- C. Background Color: Yellow.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 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 (38 mm) high.

## 2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
  - 1. Tag Material: Brass, 0.032-inch (0.8-mm), Stainless steel, 0.025-inch (0.64-mm), Aluminum, 0.032-inch (0.8-mm), or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches (100 by 178 mm).
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

## 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 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

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

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

- 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 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Dual Temp Piping:
  - a. Background Color: Black.
  - b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  1. Valve-Tag Size and Shape:
    - a. Dual Temp: 1-1/2 inches (38 mm) round.
  2. Valve-Tag Color:
    - a. Dual Temp: Natural.
  3. Letter Color:
    - a. Dual Temp: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

### PART 1 - GENERAL

#### 1.1 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. Balancing Air Systems:
  - 2. Constant-volume air systems
  - 3. Balancing Hydronic Piping Systems:
    - a. Variable-flow hydronic systems.

#### 1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

#### 1.4 SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.

- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

#### 1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.
- B. TAB Conference: Meet with Engineer on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Coordination and cooperation of trades and subcontractors.
    - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

#### 1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

- B. 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.

## 1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.

- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare 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, smoke, and fire 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.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in 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 for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- 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. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

### 3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

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

1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical 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 the 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.
  3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.
  4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  6. Obtain approval from [Architect] [Owner] [Construction Manager] [Commissioning Authority] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  7. 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 mode 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 airflow of submain and branch ducts.
    - 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. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. 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 air 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 air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch 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.

### 3.6 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 the 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 liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for

differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

- a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from [Architect] [Owner] [Construction Manager] [Commissioning Authority] and comply with requirements in Division 23 Section "Hydronic Pumps."
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
  - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presettings.
- E. 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.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. 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.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

- J. Check settings and operation of each safety valve. Record settings.

### 3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

### 3.9 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Efficiency rating.
  5. Nameplate and measured voltage, each phase.
  6. Nameplate and measured amperage, each phase.
  7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### 3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
1. Entering- and leaving-water temperature.
  2. Water flow rate.
  3. Water pressure drop.
  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.
- B. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
  2. Airflow.
  3. Entering- and leaving-air temperature at full load.
  4. Voltage and amperage input of each phase at full load and at each incremental stage.
  5. Calculated kilowatt at full load.
  6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

### 3.11 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

### 3.12 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  2. Air Outlets and Inlets: Plus or minus 10 percent.
  3. Heating-Water Flow Rate: Plus or minus 10 percent.
  4. Cooling-Water Flow Rate: Plus or minus 10 percent.

### 3.13 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  1. Pump curves.
  2. Fan curves.
  3. Manufacturers' test data.
  4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:



1. Title page.
  2. Name and address of the TAB contractor.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Terminal units.
  6. Balancing stations.
  7. Position of balancing devices.
- E. Apparatus-Coil Test Reports:
1. Coil Data:
    - a. System identification.
    - b. Location.



- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch (mm) o.c.
- f. Make and model number.
- g. Face area in sq. ft. (sq. m).
- h. Tube size in NPS (DN).
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Average face velocity in fpm (m/s).
- c. Air pressure drop in inches wg (Pa).
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Water flow rate in gpm (L/s).
- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).
- o. Inlet steam pressure in psig (kPa).

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches (mm), and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
  - a. Total airflow rate in cfm (L/s).
  - b. Total system static pressure in inches wg (Pa).
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg (Pa).
  - e. Suction static pressure in inches wg (Pa).

G. Air-Terminal-Device Reports:

1. Unit Data:
  - a. System and air-handling unit identification.
  - b. Location and zone.
  - c. Apparatus used for test.
  - d. Area served.
  - e. Make.
  - f. Number from system diagram.
  - g. Type and model number.
  - h. Size.
  - i. Effective area in sq. ft. (sq. m).
2. Test Data (Indicated and Actual Values):
  - a. Air flow rate in cfm (L/s).
  - b. Air velocity in fpm (m/s).
  - c. Preliminary air flow rate as needed in cfm (L/s).
  - d. Preliminary velocity as needed in fpm (m/s).
  - e. Final air flow rate in cfm (L/s).
  - f. Final velocity in fpm (m/s).
  - g. Space temperature in deg F (deg C).

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
  - a. System and air-handling-unit identification.
  - b. Location and zone.
  - c. Room or riser served.
  - d. Coil make and size.
  - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
  - a. Air flow rate in cfm (L/s).
  - b. Entering-water temperature in deg F (deg C).
  - c. Leaving-water temperature in deg F (deg C).
  - d. Water pressure drop in feet of head or psig (kPa).
  - e. Entering-air temperature in deg F (deg C).
  - f. Leaving-air temperature in deg F (deg C).

I. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure water flow of at least 5 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Verify that balancing devices are marked with final balance position.
  - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Owner.
3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

### 3.16 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

## SECTION 230719 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
  - 1.
  - 2. Dual-service heating and cooling piping, indoors.
- B. Related Sections:
  - 1. Division 23 Section "Unit Ventilators."

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 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.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

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

#### 1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 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. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- 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-Degree 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.
- F. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
  - 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. Knauf Insulation; Permawick Pipe Insulation.
- b. Owens Corning; VaporWick Pipe Insulation.

## 2.2 INSULATING CEMENTS

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

- 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. Ramco Insulation, Inc.; Super-Stik.

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

- 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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

## 2.3 ADHESIVES

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

### B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

- 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. Aeroflex USA, Inc.; AeroSeal.
  - b. Armacell LLC; Armaflex 520 Adhesive.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
  - d. K-Flex USA; R-373 Contact 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).
- 3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

### C. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. 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).
  3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
  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).
  3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.
- E. 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 Corning Corporation; 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; Polyco VP 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).
  3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic

Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
  - 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    - b. Eagle Bridges - Marathon Industries; 501.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    - d. Mon-Eco Industries, Inc.; 55-10.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
  - 3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
  - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
  - 5. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
  - b. Eagle Bridges - Marathon Industries; 550.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
  - d. Mon-Eco Industries, Inc.; 55-50.
  - e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  4. Solids Content: 60 percent by volume and 66 percent by weight.
  5. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    - c. Vimasco Corporation; 713 and 714.
  3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
  5. Color: White.

## 2.6 SEALANTS

- A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
  2. Permanently flexible, elastomeric sealant.
  3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
  4. Color: White or gray.
  5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  6. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic

Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

B. 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Eagle Bridges - Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
  - d. Mon-Eco Industries, Inc.; 44-05.
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 (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants 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 Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 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 (Minus 40 to plus 121 deg C).
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED JACKETS

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

- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
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. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

## 2.9 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. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches (75 mm).
  3. Thickness: 11.5 mils (0.29 mm).
  4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. 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. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

C. 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. ABI, Ideal Tape Division; 488 AWF.
  - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
  - c. Compac Corporation; 120.
  - d. Venture Tape; 3520 CW.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

## 2.10 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
  - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

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

Wire: 0.080-inch (2.0-mm) nickel-copper alloy

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. C & F Wire.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
  - 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.



- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm) o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) 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.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
  4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape

insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.7 INSTALLATION OF MINERAL-FIBER INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe 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 (25 mm), 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.

### 3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
  1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations

of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

### 3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
  2. Underground piping.
  3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Dual-Service Heating and Cooling, 40 to 200 Deg F (5 to 93 Deg C):
1. NPS 12 (DN 300) and Smaller: Insulation shall be the following:
    - a. Cellular Glass: 2 inches (50 mm) thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) thick.
  2. NPS 14 (DN 350) and Larger: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches (50 mm) thick.

END OF SECTION 230719

## SECTION 230900 – INSTRUMENTATION AND CONTROL 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.

#### 1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. An Energy Performance Contract recently installed by Technical Building Services, Inc., shall be the basis of design. The district requires a continuation of the existing EMS to be installed by this contractor and TBS, Inc. Contact: Don Jurusik – Tel: 518-885-9300.

#### 1.3 DEFINITIONS

- A. BACnet: A data communication protocol for building automation and control networks.
- B. DDC: Direct digital control.
- C. I/O: Input/output.
- D. MS/TP: Master slave/token passing.
- E. PC: Personal computer.
- F. PID: Proportional plus integral plus derivative.
- G. RTD: Resistance temperature detector.

#### 1.4 SYSTEM PERFORMANCE

- A. Comply with the existing BMS performance requirements.

#### 1.5 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
  2. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- 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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
  2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  3. Wiring Diagrams: Power, signal, and control wiring.
  4. Details of control panel faces, including controls, instruments, and labeling.
  5. Written description of sequence of operation.
  6. Schedule of dampers including size, leakage, and flow characteristics.
  7. DDC System Hardware:
    - a. Wiring diagrams for control units with termination numbers.
    - b. Schematic diagrams and floor plans for field sensors and control hardware.
    - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
  8. Controlled Systems:
    - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    - c. Written description of sequence of operation including schematic diagram.
    - d. Points list.
- C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with BACnet.
- E. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- F. Samples for Verification: For each color required, of each type of thermostat or sensor cover.
- G. Qualification Data: For installer.
- H. Field quality-control test reports.



- I. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Maintenance instructions and lists of spare parts for each type of control device.
  - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
  - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
  - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
  - 5. Calibration records and list of set points.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. 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.
- C. Comply with ASHRAE 135 for DDC system components.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

#### 1.8 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

#### 1.9 EXTRA MATERIALS

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

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique controller, thermostat and positioning relay.
2. Maintenance Materials: Two thermostat adjusting key(s).

## 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. Manufacturers: Subject to compliance with requirements, provide products compatible with the existing TBS (Technical Building Services) Building Management System.

### 2.2 DDC EQUIPMENT

- A. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
  - a. Global communications.
  - b. Discrete/digital, analog, and pulse I/O.
  - c. Monitoring, controlling, or addressing data points.
3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
1. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
2. BACnet Compliance: Control units shall use BACnet communications through IP protocol.

- B. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
  6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
  7. Universal I/Os: Provide software selectable binary or analog outputs.
- C. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
  2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
  3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- D. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
  2. Maximum response time of 10 nanoseconds.
  3. Minimum transverse-mode noise attenuation of 65 dB.
  4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

## 2.3 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
1. Alarm Condition: Indicating light flashes and horn sounds.
  2. Acknowledge Switch: Horn is silent and indicating light is steady.
  3. Second Alarm: Horn sounds and indicating light is steady.
  4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
  5. Contacts in alarm panel allow remote monitoring by independent alarm company.

## 2.4 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
  - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
  - 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig (21 to 90 kPa).
  - 2. Proportional band shall extend from 2 to 20 percent for 5 psig (35 kPa).
  - 3. Authority shall be 20 to 200 percent.
  - 4. Air-supply pressure of 18 psig (124 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
  - 5. Gages: 2-1/2 inches (64 mm) in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

## 2.5 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
  - 1. Manufacturers:
    - a. BEC Controls Corporation.
    - b. Ebtron, Inc.
    - c. Heat-Timer Corporation.
    - d. I.T.M. Instruments Inc.
    - e. MAMAC Systems, Inc.
    - f. RDF Corporation.
  - 2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
  - 3. Wire: Twisted, shielded-pair cable.

4. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Exposed.
  - b. Set-Point Indication: Exposed.
  - c. Thermometer: Concealed.
  - d. Color: White
  - e. Orientation: Vertical.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. Pressure Transmitters/Transducers:

1. Manufacturers:
  - a. BEC Controls Corporation.
  - b. General Eastern Instruments.
  - c. MAMAC Systems, Inc.
  - d. ROTRONIC Instrument Corp.
  - e. TCS/Basys Controls.
  - f. Vaisala.
2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
  - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
  - b. Output: 4 to 20 mA.
  - c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
  - d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

D. Room Sensor Cover Construction: Manufacturer's standard locking covers.

- a. Set-Point Adjustment: Exposed.
- b. Set-Point Indication: Exposed.
- c. Thermometer: Concealed.
- d. Color: White
- e. Orientation: Vertical

E. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base
3. Adjusting Key: As required for calibration and cover screws.

## 2.6 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
  1. Manufacturers:
    - a. BEC Controls Corporation.
    - b. I.T.M. Instruments Inc.

## 2.7 THERMOSTATS

### A. Manufacturers:

1. Erie Controls.
2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
3. Heat-Timer Corporation.
4. Sauter Controls Corporation.
5. tekmar Control Systems, Inc.
6. Theben AG - Lumilite Control Technology, Inc.

### B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:
  - a. Time of day.
  - b. Actual room temperature.
  - c. Programmed temperature.
  - d. Programmed time.
  - e. Duration of timed override.
  - f. Day of week.
  - g. System mode indications include "heating," "off," "fan auto," and "fan on."

## 2.8 ACTUATORS

### A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).



5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
  6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers:
    - a. Belimo Aircontrols (USA), Inc.
    - b.
  2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
  3. Dampers: Size for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
    - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
    - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
    - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
    - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
  4. Coupling: V-bolt and V-shaped, toothed cradle.
  5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
  7. Power Requirements (Two-Position Spring Return): 24-V ac.
  8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).
  11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).

## 2.9 DAMPERS

- A. Manufacturers:
1. Air Balance Inc.
  2. Don Park Inc.; Autodamp Div.



3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

## 2.10 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

### 3.2 INSTALLATION

- A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and existing software to achieve sequence of operation specified.

- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches (1530 mm) above the floor.
  - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
  - 1. Entrances.
  - 2. Public areas.
  - 3. Where indicated.
- E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- H. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

### 3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
  - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 2. Install exposed cable in raceway.
  - 3. Install concealed cable in raceway.
  - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  - 2. Test and adjust controls and safeties.
  - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 4. Pressure test control air piping at 30 psig (207 kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
  - 5. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
  - 6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
  - 7. Test each point through its full operating range to verify that safety and operating control set points are as required.
  - 8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  - 9. Test each system for compliance with sequence of operation.
  - 10. Test software and hardware interlocks.
- C. DDC Verification:
  - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
  - 2. Check instruments for proper location and accessibility.
  - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
  - 4. Check instrument tubing for proper fittings, slope, material, and support.
  - 5. Check installation of air supply for each instrument.
  - 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
  - 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
  - 8. Check temperature instruments and material and length of sensing elements.
  - 9. Check control valves. Verify that they are in correct direction.
  - 10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
  - 11. Check DDC system as follows:

- a. Verify that DDC controller power supply is from emergency power supply, if applicable.
  - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
  - c. Verify that spare I/O capacity has been provided.
  - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.5 ADJUSTING

A. Calibrating and Adjusting:

- 1. Calibrate instruments.
- 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
- 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
- 4. Control System Inputs and Outputs:
  - a. Check analog inputs at 0, 50, and 100 percent of span.
  - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
  - c. Check digital inputs using jumper wire.
  - d. Check digital outputs using ohmmeter to test for contact making or breaking.
  - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
- 5. Flow:
  - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
  - b. Manually operate flow switches to verify that they make or break contact.
- 6. Pressure:
  - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
  - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- 7. Temperature:
  - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
  - b. Calibrate temperature switches to make or break contacts.
- 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

### 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 230900

## SECTION 232113 - HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Dual-temperature heating and cooling water piping.
  - 2. Condensate-drain piping.
  - 3. Blowdown-drain piping.
  - 4. Air-vent piping.
  - 5. Safety-valve-inlet and -outlet piping.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
  - 1. Dual-Temperature Heating and Cooling Water Piping: at 200 deg F (93 deg C).
  - 2. Condensate-Drain Piping: 150 deg F (66 deg C).
  - 3. Blowdown-Drain Piping: 200 deg F (93 deg C).
  - 4. Air-Vent Piping: 200 deg F (93 deg C).
  - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Plastic pipe and fittings with solvent cement.
  - 2. Pressure-seal fittings.
  - 3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
  - 4. Air control devices.
  - 5. Chemical treatment.
  - 6. Hydronic specialties.
- B. Shop Drawings: Detail, at 1/4 (1:50) scale, the 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.

#### 1.5 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.

#### 1.6 EXTRA MATERIALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
- B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

## PART 2 - PRODUCTS

### 2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Copper or Bronze Pressure-Seal Fittings
  - 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. 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).
- C. Wrought-Copper Unions: ASME B16.22.

### 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Class 125 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Unions: ASME B16.39; Class 150 as indicated in Part 3 "Piping Applications" Article.
- D. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Class 125; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- G. Mechanical couplings and water piping only. Must be use in dual-service heating and cooling.



## 2.3 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.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.4 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 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).

E. Dielectric Nipples:

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. Perfection Corporation; a subsidiary of American Meter Company.
  - b. Precision Plumbing Products, Inc.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Victaulic Company of America.
2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.5 VALVES

- A. 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).

D. Diaphragm-Operated, Pressure-Reducing 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. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - d. Conbraco Industries, Inc.
  - e. Spence Engineering Company, Inc.
  - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless Steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Diaphragm-Operated Safety 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. Amtrol, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - d. Conbraco Industries, Inc.
  - e. Spence Engineering Company, Inc.
  - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.

7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Stainless Steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Automatic Flow-Control 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. Flow Design Inc.
  - b. Griswold Controls.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig (1207 kPa).
9. Maximum Operating Temperature: 200 deg F (93 deg C).

2.6 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. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
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: 240 deg F (116 deg C).

C. Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
4. Gage Glass: Full height with dual manual shutoff valves, [3/4-inch- (20-mm-)] <Insert dimension> diameter gage glass, and slotted-metal glass guard.

D. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig (1207 kPa).
3. Maximum Operating Temperature: Up to 300 deg F (149 deg C).

## 2.7 CHEMICAL TREATMENT

- A. Bypass Chemical Feeder: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- B. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

## 2.8 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] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Dual-temperature heating and cooling water piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:
1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
- B. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 (DN 65) and larger shall be any of the following:
1. Schedule 40 black steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- C. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- D. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- E. Air-Vent Piping:
1. Inlet: Outlet: Type L (B), annealed-temper copper tubing with soldered or flared joints.
  2. Outlet: Type L (B), annealed-temper copper tubing with soldered or flared joints.
- F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

### 3.2 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 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.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure. Refer to expansion tank schedules for fill pressures.

### 3.3 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.
- 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.
- 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 groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- M. 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.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- 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 flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- S. 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).
- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

### 3.4 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. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. 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. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
  - 2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 1/4 inch (6.4 mm).



3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
  4. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
  5. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (10 mm).
  6. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (10 mm).
  5. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
  6. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 1/2 inch (13 mm).
  7. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 5/8 inch (16 mm).
  8. NPS 10 (DN 250): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4 inch (19 mm).
  9. NPS 12 (DN 300): Maximum span, 23 feet (7 m); minimum rod size, 7/8 inch (22 mm).
- E. 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).
  5. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
  6. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
- F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

### 3.5 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. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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.

- G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

### 3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install automatic air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches (1200 mm) above the floor. Install feeder in minimum NPS 3/4 (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 (DN 20) pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

### 3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

### 3.8 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. Upon 100% completion of piping system, subject piping system shall be hydrostatically tested at a pressure that is not less than 1.5 times the system's working pressure and held for 48 hours minimum. 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 48 hours, 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. Coordinate testing with CxA and specification sheet 230593

D. 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, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 238223 - UNIT VENTILATORS (Provided by Owner, Installed by this contractor)

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 WORK INCLUDED

- A. Unit Ventilators shall be provided by the owner (per the submittal provided) and installed by this contractor – The contractor shall install packaged unit ventilator systems provided by the owner, of the capacities, performance, and configuration, as indicated in the unit schedule. Each unit shall be complete with factory furnished components and accessories as shown in the plans and as specified herein.
- B. Electrical work required as an integral part of the temperature control work is indicated on the mechanical drawings, and is the responsibility of the HVAC contractor to hire the services of a temperature control contractor and/or system integrator contractor to provide a complete system to perform the sequence of operation shown, or as described in this specification. The full sequence of operation must be provided and installed by this contractor for all trades.
- C. Control valves, damper actuators, sensors and controllers to be provided by the HVAC contractor or his ATC sub-contractor to be installed in the field or his shop.

1.3 SUBMITTALS

- A. Submit schedule for all types, sizes and accessories. Schedule shall include certified performance data, room locations and all operating data.
- B. See shop drawings for all units including all dimensional information, construction details, installation details, required opening sizes, roughing locations for piping and electrical work and accessory equipment. Equipment must meet specifications. Where deviations from the specifications exist, they must be identified. Coordinate existing conditions with the owner supplied Unit Ventilators.
- C. Provide field wiring diagrams for all electrical power and temperature control field-wiring connections.
- D. Provide complete operating and maintenance instruction manuals and unit specific replacement parts lists.

#### 1.4 QUALITY ASSURANCE

- A. Unit ventilators shall be listed by Underwriters Laboratories Inc. (U.L.) for the United States and Canada.
- B. Motors shall conform to the latest applicable requirements of NEMA, IEEE, ANSI, and NEC standards.
- C. Unit ventilation rate to be certified and tested per Air Conditioning and Refrigeration Institute (ARI) standard 840.
- D. Unit to be certified and labeled compliant with the seismic design provisions of the International Building Code (IBC) Chapter 16 and independent test agency requirements of Chapter 17.

### PART 2 - PRODUCTS – UNIT VENTILATORS

#### 2.1 CABINETS AND CHASSIS

- A. Unit frames shall be of unitized, welded construction, with structural elements aligned in an assembly jig prior to welding, to insure proper dimensions, rigidity, and squareness. Frames assembled with mechanical fasteners shall not be acceptable.
- B. Internal sheet metal parts shall be constructed of galvanized steel to inhibit corrosion.
- C. Exterior cabinet panels shall be fabricated from furniture grade steel of not less than 16 gauge steel with no sharp edges and no unsightly screw heads and shall receive an electro-statically applied powder paint, and be oven baked with environmentally friendly thermosetting urethane powder finish to provide a high quality appearance. Finish color shall be as selected by Architect from manufacturer's standard colors.
- D. The interior areas of the unit ventilator shall be insulated for sound attenuation and to provide protection against condensation of moisture on or within the unit. The unit shall be provided with an ultra-quiet sound package consisting of acoustically matched low speed fans to fan housing, sound barrier insulation material (non-fiberglass) adhered to the bottom underside of the unit top panel, sides of the fan section and sound absorbing insulation (non-fiberglass) material applied to the unit front panel.
- E. Units shall be constructed so that testing and troubleshooting can be accomplished in the end pockets of operating units, without affecting the normal air flow patterns through the unit.
- F. Each unit shall be provided with a non-fused power interrupt switch that disconnects the main power to the unit for servicing or when the unit is to be shut down for an extended period of time. The fan motor and controls shall have the hot line(s) protected by factory installed cartridge type fuse(s).
- G. The manufacturer shall have published cataloged sound data available for the engineer's review. Sound data shall have been conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32. Sound test data shall be based on standard cfm at standard air (fixed density of air

at 70F) in accordance with ARI procedures based upon ARI 350. The engineer shall have the right to reject equipment not conforming to the specified manufacturer's sound data, as a minimum. Sound levels shall not exceed those shown below:

Octave Band and Center Frequency (Hz)								
UNIT CFM	Speed	2 125	3 250	4 500	5 1000	6 2000	7 4000	8 8000
750	High	57.4	51.8	52.5	52.6	51.2	46.9	35.2
	Med.	50.1	44.9	45.6	44.8	42.8	34.2	19.9
	Low	45.6	40.4	40.8	39.1	35.7	24.4	12.0
1000	High	57.0	52.8	53.9	53.7	51.5	46.8	35.9
	Med.	52.9	48.6	50.2	49.6	46.5	40.1	27.9
	Low	49.4	45.4	47.0	45.5	42.0	33.6	20.7
1250	High	62.4	55.2	55.7	55.3	54.4	49.7	38.5
	Med.	59.3	52.1	52.5	51.7	50.4	44.0	31.8
	Low	55.6	48.6	49.1	47.2	45.6	37.1	24.0
1500	High	63.8	56.6	58.0	58.2	56.4	52.4	41.9
	Med.	58.4	51.3	52.7	52.4	49.5	43.5	30.5
	Low	54.8	47.6	49.4	47.5	44.2	36.2	21.5
Sound Power Levels - dB re 10-12 watt								

- Test data based on a valve control unit having 3 rows of coil and no outdoor air. Sound Power data may vary based on the type of unit, number of coil rows and other external factors.

## 2.2 FLOOR UNITS

- A. Floor mounted units shall have an integral pipe tunnel for convenient crossover of piping and a built-in metal wire raceway from right end compartment to left end compartment to contain any line voltage electrical wiring separate from the air stream. Line voltage wiring shall not be touchable in the air stream of the unit during normal maintenance procedures of oiling bearings or motors. Unit shall come standard with a factory installed and wired disconnect switch.
- B. Unit top surface shall be supplied with a charcoal bronze textured finish, to resist scuffing, reduce glare and help hide fingerprints. Unit top shall have two access doors, one at each end (for access to motor and bearings for easy servicing). The front and ends shall be available in a selection of architecturally pleasing colors by the manufacturer, for selection by the Architect.
- C. Unit discharge grille shall be constructed of continuous rounded edge steel bars to provide 10 degree vertical deflection. A 1/4" painted, galvanized mesh screen shall be provided beneath the discharge grille to protect against objects being dropped through the discharge grille.
- D. The unit top and grille shall be of a modular construction so that it is removable for service and maintenance.
- E. The unit front surface shall be comprised of three separate removable panels. The controls and piping shall be accessible without removing the entire front panel. Panels shall be secured to the unit with recessed, tamper resistant, Allen head fasteners. Slots for flat head screwdrivers shall not be acceptable as tamper resistant.

- F. An extended cabinet depth unit, 21 7/8" deep, shall incorporate a full adapter back with closed pipe tunnel with the same features of the standard cabinet depth units with the additional capability of bringing in fresh air from 1" to 28" from the floor. The unit top, back and vertical adapter back partitions shall be insulated and sealed to form a thermal barrier. The vertical and horizontal insulated metal extensions shall have a 1" wide compressible gasket to form an airtight seal between the wall and the unit. A field removable horizontal support plate between the unit bottom and top to achieve the 1" to 28" fresh air access shall not be acceptable.

## 2.3 COILS

- A. Coil assembly shall be of a modular construction so that it is removable from the front of the unit.
- B. All coils shall be installed in a draw through position to assure uniform air distribution over the full-face area of the coil, and an even unit discharge temperature.
- C. All heating and cooling coils shall be constructed with copper tubes and mechanically bonded aluminum corrugated plate type fins. All coils shall have aluminum individual unshared fin surfaces. An air break shall exist between coils.
- D. Water heating and cooling coils shall be furnished with a threaded drain plug at the lowest point and a manual air vent at the high point of the coil. A factory installed low temperature freeze stat shall be provided on the leaving edge of the water heating coil in a wave-like configuration to sense multiple locations and shall react to possible freezing conditions. The unit-mounted controls shall incorporate this device.

## 2.4 DRAIN PAN

- A. All units shall have a drain pan constructed of corrosion resistant, composite material and shall be insulated. A drain outlet shall be provided on both ends of the pan. The drain hand of connection shall be easily field reversed by relocating the cap to the opposite end.
- B. The drain pan shall be able to be sloped in either direction for proper condensate removal.
- C. Drain shall be provided with a secondary, overflow drain connection on both ends of the pan.

## 2.5 FANS AND MOTOR

- A. The fan and motor assembly shall be of a low speed design to assure maximum quietness and efficiency.
- B. Fans shall be double-inlet, forward-curved, centrifugal type with offset aerodynamic blades. Fans and shaft shall be statically and dynamically balanced as an assembly in the unit before shipment.



- C. Fan housings shall be constructed of galvanized steel incorporating logarithmic expansion for quiet operation. Fan and motor assembly shall be of the direct drive type. Belt drive fans shall not be allowed.
- D. Motors shall be 115 volt, single phase, 60 Hz, NEMA electronically commutated motor (ECM), plug-in type with auto reset internal thermal overload device designed specifically for unit ventilator operation. Motors shall be located out of the conditioned air stream.
- E. All components of the fan/motor assembly shall be removable from the top of floor-mounted units.
- F. Units shall have sleeve type motor and fan shaft bearings , and shall not require oiling more than annually. All bearings shall be located out of the airstream. Bearings in the air stream are not acceptable.
- G. Motor speed shall be controlled by factory mounted multi-tap transformer for three (3) speeds, HIGH-MEDIUM-LOW-OFF (not accessible from the exterior of the unit). Fan motor and controls shall each have hot leg protected by a factory installed cartridge fuse.

## 2.6 FACE & BYPASS DAMPER

- A. Each unit shall be provided with a factory-installed face and by-pass damper, constructed of aluminum. The long sealing surfaces of the damper shall seal positively against stops fitted with extruded EPDM rubber seals. Face and bypass dampers without sealing edges to prevent air bypass shall not be acceptable. The damper ends shall have blended mohair seals along the ends glued to the damper end for a positive seal. Plastic clip-on brush end seals shall not be acceptable as an end seal. The unit design shall incorporate the face and bypass damper to prevent coil surface wiping and be before the fan in a draw-thru configuration. The face and by-pass damper shall be arranged to have a dead air space to minimize heat pick-up in the by-pass position.

## 2.7 OUTDOOR & ROOM DAMPERS

- A. Each unit shall be provided with separate room air and outdoor air dampers.
- B. The room air damper shall be two-piece, double-wall construction fabricated from aluminum, and be counterbalanced against backpressure to close by gusts of wind pressure, thereby preventing outdoor air from blowing directly into the room.
- C. The outdoor air damper shall be two piece, double wall construction fabricated from galvanized steel, with ½" thick, 1½ lb. density glassfiber insulation encapsulated between the welded blade halves for rigidity and to inhibit corrosion. The outdoor air damper shall have additional foam insulation on the exterior surface damper blade and on the ends of the outdoor air chamber. A single blade damper, which can be twisted and will leak air, will not be considered.
- D. Dampers shall be fitted with blended mohair seals along all sealing edges. Pressure adhesive sponge neoprene or plastic clip-on brush type sealers for damper seals are not acceptable. Rubber



type gasket using pressure adhesive for fastening to metal and exposed to the outside air is not acceptable.

- E. Dampers shall use the turned-metal principle on long closing ends with no metal-to-metal contact for proper sealing.
- F. The damper shaft shall be mechanically fastened to the blade, and shall operate in bearings made of nylon or other material which does not require lubrication.

## 2.8 FILTER

- A. Each unit ventilator shall be equipped with a one-piece filter located to provide filtration of the return air/outdoor air mixture, in lieu of separate filters for each air stream. The entire filter surface must be useable for filtration of 100% room air or 100% of outdoor air. The filter shall be easily accessible from the front, and removable in one piece without removal of the unit return air damper stop. The unit shall ship with a factory installed 1" thick fiberglass, single-use type.

## 2.9 UNIT VENTILATOR OPTIONS / ACCESSORIES

### A. Draft/Stop Window-Down Draft Protection

- 1. The floor mounted unit ventilators shall be designed for use with, and provided with Draft/Stop window down draft protection system, installed continuously under the sill. Unit ventilators shall be designed to accommodate either Draft/Stop wall enclosures or Draft/Stop accessory cabinets.
- 2. Where accessory cabinets are indicated, the window down draft protection system shall be an integral part of the storage cabinets.

### B. Classroom Matching Accessories

- 1. Furnish and install in accordance with manufacturer's printed instructions, matching accessories: shelf cabinets and filler sections, where indicated on the plans. Colors to match the unit ventilator. All accessory section to be with draft-stop system where the unit ventilator is so indicated. Shelving lengths to be field measured by the factory representative.
- 2. Cabinets are shipped fully assembled. Base and Side panels are constructed of 18-ga. cold-rolled steel. Side panels have seven adjustable slots to support shelves and additional 12 ga. steel internal side supports that are welded for additional vertical rigidity. Bottom base is supported by two 14 ga. horizontal continuous angles the length of the cabinet. Two support bases are fabricated from 14-ga. steel and four adjustable feet allowing for a 1" vertical adjustment.

One fully adjustable shelf from 16-ga. steel is supported by a 16 ga. continuous welded angle for additional strength. Each cabinet is supplied with front and side adjustable floor kick plates to conceal cabinet legs and a back wall F-channel from 18-ga. steel to support the length of the cabinet and deliver a uniform continuous appearance. All cabinet parts are

cleaned and phosphatized prior to applying a baked on polyester powder coat finish.

#### Laminate Top

Laminate tops are assembled to the base cabinet. Fabricated from 1" high quality particleboard with a large variety of colors. Laminate Top includes Pencil Proof Anodized

Aluminum Grill w/ Opposed Damper (grill to be clear anodized 204-R finish)

#### ACCESSORIES

##### End Covers

1" Standard End Panels can be installed to finish off cabinets when needed. End panels are fabricated from 18-ga. furniture quality cold-rolled steel. Internal 16 ga. steel side stiffeners are welded for additional support. Top corners are sanded to remove all blemishes prior to being cleaned. End panels will be cleaned and phosphatized prior to applying a baked on polyester powder coat finish to match cabinets.

##### Fill-In Sections

Filler sections are available in 12", 18" or 24" wide. Filler sections come with side and top F-channels to hide field cut sections. Filler sections tops are fabricated from 16-ga. furniture quality cold-rolled steel. Filler sections are designed to be cut in the field and include required angels and hardware for a proper installation. Filler sections will be cleaned and phosphatized prior to applying a baked-on polyester powder coat finish to match cabinets.

- C. Outdoor Air Intake Louver: Outdoor air intake louver shall be provided by unit ventilator manufacturer except as otherwise noted on the drawings.

1. Masonry wall intake louver shall be constructed with horizontal chevron type blades. Provide weep holes in the louver frame and ½" square mesh bird screen on the interior side. Expanded metal is not acceptable. Louver shall be fabricated of mill finish AQ5005 aluminum. The intake assembly and frame shall be 16 ga. horizontal chevron type aluminum blades in a 12 ga. frame, with clear anodized finish. 1" flange with minimum 50% free air.

#### 2.10 Basis of Design:

- A. By Daikin.

- B. Acceptable Alternates:

1. With approval only. Submit detailed listing of all variations in form, fit, or function, in addition to specified submittal data for approval within 10 days of NTP. Equipment or manufacturers not listed in this specification shall not be acceptable or approved for installation. Provide required information as specified in "Substitution Procedures."

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all equipment in strict accordance with manufacturer's instructions and so as to be compatible with the intent of the respective system performance requirement.
- B. The System Integrator/Controls contractor shall be responsible for the integration of all factory provided unit mounted controls and unit communications as required/specified for unit integration into the Building Automation System and proper unit operation.
- C. Contractor shall clean each unit and accessory section of construction dust and debris, prior to turning systems over to the owner.
- D. Contractor shall install clean filters in each unit at time of system commissioning, and shall deliver to the owner one complete set of spare filters, and one spare motor of each type used in the project.
- E. System Integrator/Controls contractor shall be responsible for the integration of all factory provided unit mounted controls and unit communications as required/specified for unit integration into the Building Automation System and proper unit operation.
- F. Installer shall engage the services of manufacturer's factory trained service technician to provide check, test, and start-up of each unit ventilator system.
- G. Contractor shall provide one-year warranty for furnishing parts and labor for replacing any part of the unit ventilator or accessory sections, which becomes defective in operation. Unit ventilator manufacturer's representative shall maintain a local stock of replacement parts to support the systems specified herein.
- H. Contractor shall submit a completed "Check Test and Start Sheet" for each Unit Ventilator installed for verification of proper installation and start up.
- I. Coordinate startup with CxA and specification sheet 230593.

END OF SECTION 238223



# **SUBMITTAL DATA**

## **Rev01**

for

North Salem CSD MSHS

230 June Road

North Salem, NY 10560

**FOR REFERENCE**

Prepared by

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3/7/2022



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## DAIKIN UNIT VENTILATORS

Qty	Tag	Model Number	Description
2	UV-1: F-213, F-211	UAHF9H10	Ceiling Face and Bypass Unit Ventilator
3	UV-2: F-206, F-208, F-212	UAVS9H15	Floor Face and Bypass Unit Ventilator
3	UV-3: F-205, F-207, F-209	UAVS9H15	Floor Face and Bypass Unit Ventilator
1	UV-4: F-204	UAHF9H107	Ceiling Face and Bypass Unit Ventilator

### UNIT DESCRIPTION

- Face and Bypass Dampers
- ECM Multi-speed Motor
- Voltage 115/60/1
- 4 Row CHW/HW Coil
- Controls Field Installed by Others
- UV-1 Front Discharge with Flanges
- UV-1 RA Bottom Grill OA Top Duct Collar
- Disconnect Switch
- Stainless Steel Drain Pan
- UV-2,3 21 7/8" Top Bar Grille Full Back Closed Tunnel
- 6" Side Panels
- Return Air Bottom Front/OA Rear
- Airflow Meter

### WARRANTY & START UP

- 1 Year Parts Warranty Only – 18 months from shipment and 12 months from start up

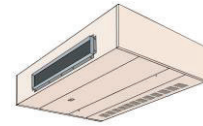
### NOT INCLUDING / NOTES

- Any Additional Startup, Training, Assistance or Commissioning
- Reassembly or Disassembly Supervision
- Rigging, Setting, or Storage of HVAC Equipment
- Secondary Drain Pans, Condensate Pumps or Leak Detectors
- Any Controllers, Controls, Wiring or BMS Integration
- Factory or Field Mounted End Devices, Controls or Sensors
- Actuators, Motorized Dampers
- Spare Filter Sets
- Valves / Valve Packages
- Smoke Detectors
- Unit Mounts or Vibration Isolators
- Specialty Coils/Coil Coatings
- Reheat Coils
- Humidifiers
- Air Blenders
- Extended Parts Warranty
- Labor Warranty

### NOTES

- Handing to be confirmed prior to release (Handing is determined by looking at front of unit)
- UV in room F-205 updated to UV-3

## Technical Data Sheet for UV-1 Right



Job Information		Technical Data Sheet
Job Name	North Salem CSD MSHS	
Date	3/1/2022	
Submitted By	Scott Shufflebotham	
Software Version	07.90	
Unit Tag	UV-1 Right: F-213, F211	

Unit Overview			
Model Number	Model Type	Cooling Coil Type	Heating Coil Type
UAHF9H10	Face & Bypass	2-Pipe CW / HW	2-Pipe CW / HW
Arrangement	Control Type	Cooling Coil Hand	Heating Coil Hand
Horizontal, Ceiling Mounted, Bottom Grille Return Air, Top Duct Collar OA	Field Mounted Controls (By Others)	Right Hand Cooling	Right Hand Heating

Physical			
Unit Length	Unit Depth	Unit Height	Weight
36.00 in	76.00 in	16.62 in	465 lb

Electrical				
Voltage	Minimum Voltage	Maximum Voltage	Total Unit MCA	Maximum Fuse Size
115/60/1 V/Hz/Phase	104 v	126 v	6.3 A	15 A

Fan					
Performance					
Fan Motor	Speed	Air Volume CFM	External Static Pressure inH <sub>2</sub> O	Motor Power HP	Fan Full Load Current A
ECM, 3-Speed	Low	800	0.00	0.333	5.00

Chilled Water Coil					
Performance					
Capacity		Air Temperature			
Total Btu/hr	Sensible Btu/hr	Entering		Leaving	
		Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F
30560	19714	80.9	67.2	58.2	54.8
Number of Rows	Fluid				
	Temperature		Type	Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O
	Entering °F	Leaving °F			
4	45.0	55.2	Water	6.00	4.33
Fluid Connections					
Supply		Return		Condensate	
7/8 inch		7/8 inch		7/8 inch	

## Technical Data Sheet for UV-1 Right

### Hot Water Coil

Performance				
Total Capacity Btu/hr	Air Temperature Dry Bulb		Fluid Temperature	
	Entering °F	Leaving °F	Entering °F	Leaving °F
88927	40.0	142.5	180.0	141.3
Fluid				
Type	Flow Rate gpm		Pressure Drop ft H <sub>2</sub> O	
Water	4.60		2.55	

### Warranty

Type	
Extended:	None

### AHRI Certification



Certified in accordance with the AHRI Unit Ventilator Certification Program, which is based on AHRI Standard 840/841. Certified units may be found in the AHRI Directory at [www.ahridirectory.org](http://www.ahridirectory.org).

### Notes

### Accessories

Part Number	Description
GCA402048	Flanges for 36" Length Unit (w/Plenum) H/S10

Certified Drawing		AHF-36-102J
Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin		Group: <b>Unit Ventilator</b>
		Type: <b>Basic Unit Data</b>
		Date: <b>May 2018</b>

## Daikin Classroom Model AHF 36" Deep Ceiling Unit Ventilator – Arrangements AT & AH – Front Discharge, Series H07, H10, H13, H15, V07, V10, V13, V15

### Standard Features

- UL/cUL listed
- AHRI Certified chilled water performance. Unit ventilation rate certified and tested per Air Conditioning, Heating and Refrigeration (AHRI) standard 840.
- Institutional quality cabinet with durable, baked alkyd enamel paint finish on exterior panels and discharge grille. (Double deflection grilles have clear anodized aluminum finish).
- Welded chassis constructed from galvanized steel
- Three bottom panels, two of which are hinged, for ease of service access and handling. Single panel access to filter and controls.
- Removable bar discharge grille (AT - arrangement).
- All access panels have positive positioning threaded fasteners operated with 5/32" hex wrench
- Anti blow through room air damper.
- Rigid, double wall, insulated outdoor air damper made from welded galvanized steel, with mohair end and damper seals in turned over edges.
- Standard galvanized or optional stainless steel drain pan. Drain pan connections C/L located 4"(10mm) above unit bottom. Hand of connection and direction of slope is field selectable.
- Room air fan shaft has oilable sleeve bearings for quietness and long life.
- Low speed room air fan constructed of injection molded polypropylene for precise, smooth, quiet performance.
- Electrically Commutated Motor (ECM) available for applications with External Static Pressures (ESP) up to 0.45 (112 Pa).
- UL/cUL listed individual fusing of fan motor and controls.
- EC motor controlled for 3 speeds, high-medium-low and off. Optional variable speed motor available.
- MicroTech® controls (optional) state of the art "MicroTech" unit controller is a stand alone microprocessor based DDC control device that is pre-engineered, pre-programmed, pre-tested and factory installed. It provides correct sequence of operations and the advantage of one source responsibility.
- Steam coils equipped with vacuum breaker.
- Manual air vent and drain plug on water coils.
- Throwaway filter(s) factory installed in unit.
- Heating only units can be adapted for future air conditioning.

### Physical Data

Unit Series			H07 / V07	H10 / V10	H13 / V13	H15 / V15
Nominal Airflow - cfm (L/s)			750 (354)	1000 (472)	1250 (590)	1500 (708)
Fan Data	Number of Fans		2	3	4	4
	Size	Dia. in. (mm)	8.12 (206)	8.12 (206)	8.12 (206)	8.12 (206)
		Width - in. (mm)	8.25 (210)	8.25 (210)	8.25 (210)	8.25 (210)
Filter Data	(Qty) Size	in. (Nominal)	(1) 10 × 36½ × 1	(1) 10 × 48½ × 1	(1) 10 × 60½ × 1	(2) 10 × 36½ × 1
		(mm)	254 × 927 × 25	254 × 1232 × 25	254 × 1537 × 25	254 × 927 × 25
	Area	Ft. <sup>2</sup> (m <sup>2</sup> )	2.54 (.24)	3.37 (.31)	4.2 (.39)	5.08 (.47)
*Approx. Shipping Weight lb. (kg)	Discharge Air Arrangement	AT, AH	385 (179)	465 (211)	540 (245)	620 (281)
Coil Water Volume Gal. (Ltrs)	1-Row Coil		.25 (0.95)	.31 (1.17)	.38 (1.44)	.44 (1.67)
	2-Row Coil		.45 (1.70)	.57 (2.16)	.69 (2.61)	.82 (3.10)
	3-Row Coil		.64 (2.42)	.82 (3.10)	1.01 (3.82)	1.19 (4.50)
	4-Row Coil		.83 (3.14)	1.08 (4.09)	1.32 (5.00)	1.57 (5.94)
	5-Row Coil		1.03 (3.90)	1.34 (3.90)	1.64 (6.21)	1.95 (7.38)

\* Approximate weights based on Face & Bypass damper controlled unit with 4-row cooling coil, 2-row hot water coil and MicroTech® Controls.

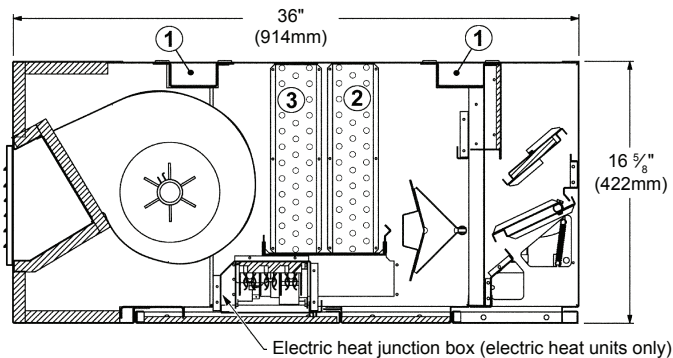




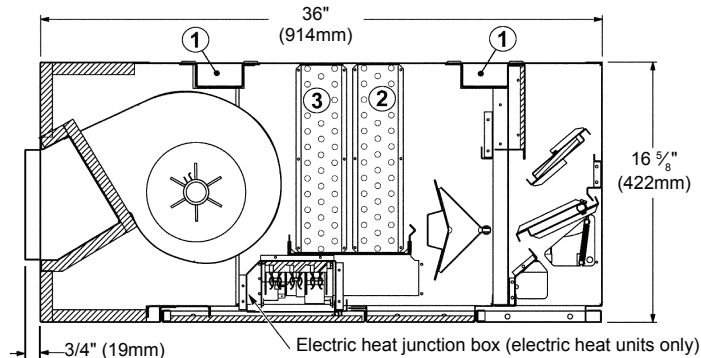
# Daikin Classroom Model AHF 36" Deep Ceiling Unit Ventilator – Arrangements AT & AH – Front Discharge, Series H07, H10, H13, H15, V07, V10, V13, V15

## Unit Cross Sections

### Arrangement AT - Double Deflection Grille



### Arrangement AH - Duct Collar



## Face & Bypass Damper Control

### Single Coil Unit

- ① Raceway for factory wiring (Single & two coil unit)
- ② Hot Water, Chilled Water or CW/HW (2-pipe), None
- ③ None, Steam

### Two Coil Units

- ② Hot water                      ② Chilled water
- ③ Chilled water                ③ Electric or Steam

- ② Hot water
- ③ Direct expansion

## Duct System Considerations

### Duct Design for Noise and Vibration Control

Proper acoustics is often a design requirement for schools. Most of the problems that are associated with HVAC generated sound can be avoided by properly selecting and locating the components of the system. There are some general do's and don'ts:

The following suggestions are required to reduce the amount of sound and noise due to vibration that reaches the occupied room:

- Use flexible duct connections.
- Make the discharge duct the same size as the unit discharge opening for the first five feet.
- Line the first 5 feet of the supply duct.
- Make two 90-degree turns in the supply and return ducts.
- Keep duct velocity low and follow good duct design procedures.
- Mount and support the ductwork independent of the unit.
- Line the first five feet of the return duct.
- Locate the return air intake away from the unit discharge.
- Provide multiple discharges.
- Restrict use of high pressure drop flexible ducting.
- Size the outdoor air and return air ducts to handle 100% of the total cfm to accommodate economizer or morning warm-up operation.

### NOTICE

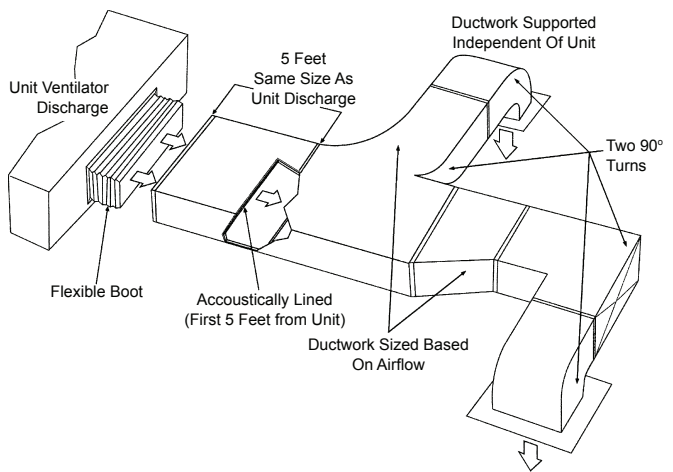
If a supply air duct with improper duct work is placed too close to the unit discharge, it will result in substantial noise. Avoid such forms of connections when designing ductwork where sound attenuation is critical. The following illustrations show suggested duct considerations per SMACNA and ASHRAE.

Sound control applies to the return side of the duct design as well as the supply side. The bottom-right illustration suggests installation of an intake/return-air duct. Note the return air opening, the sizing and changes in direction of the ductwork. The outdoor air intake and insulated duct work illustration on the next page suggests installation of outside air ducting.

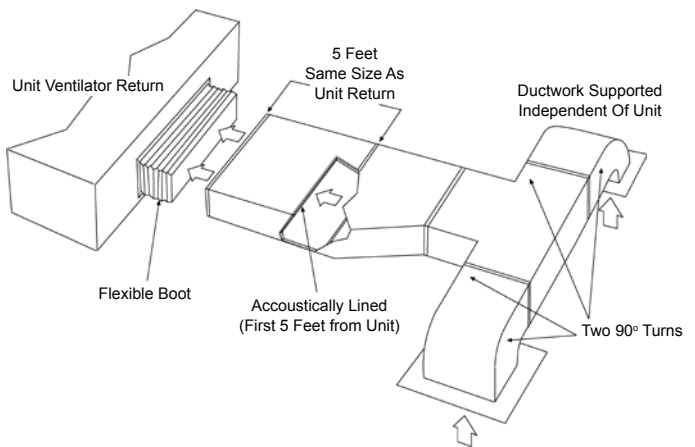
### NOTICE

These are general suggestions and offered only to stress their importance; however, there are additional important factors that must be considered. Assistance in the design of ductwork can be found in the ASHRAE Handbook and SMACNA publications, as well as other recognized authorities.

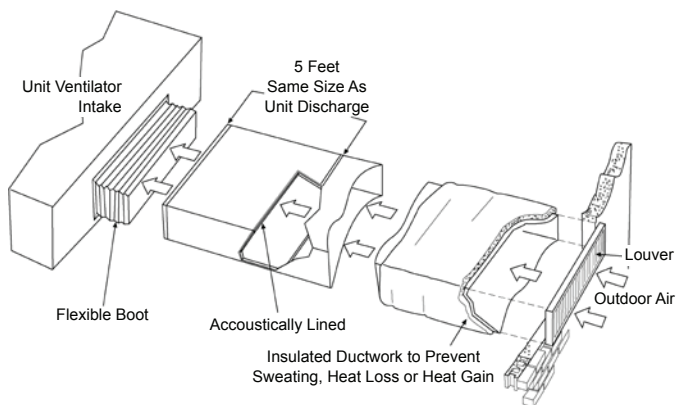
### Discharge Air Duct Work



### Intake/Return Air Duct Work



### Outdoor Air Intake and Insulated Duct Work



# Certified Drawing

AHF-AH36-108J

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

Group: Unit Ventilator

Type: Inlet Air Arrangement

Date: May 2018

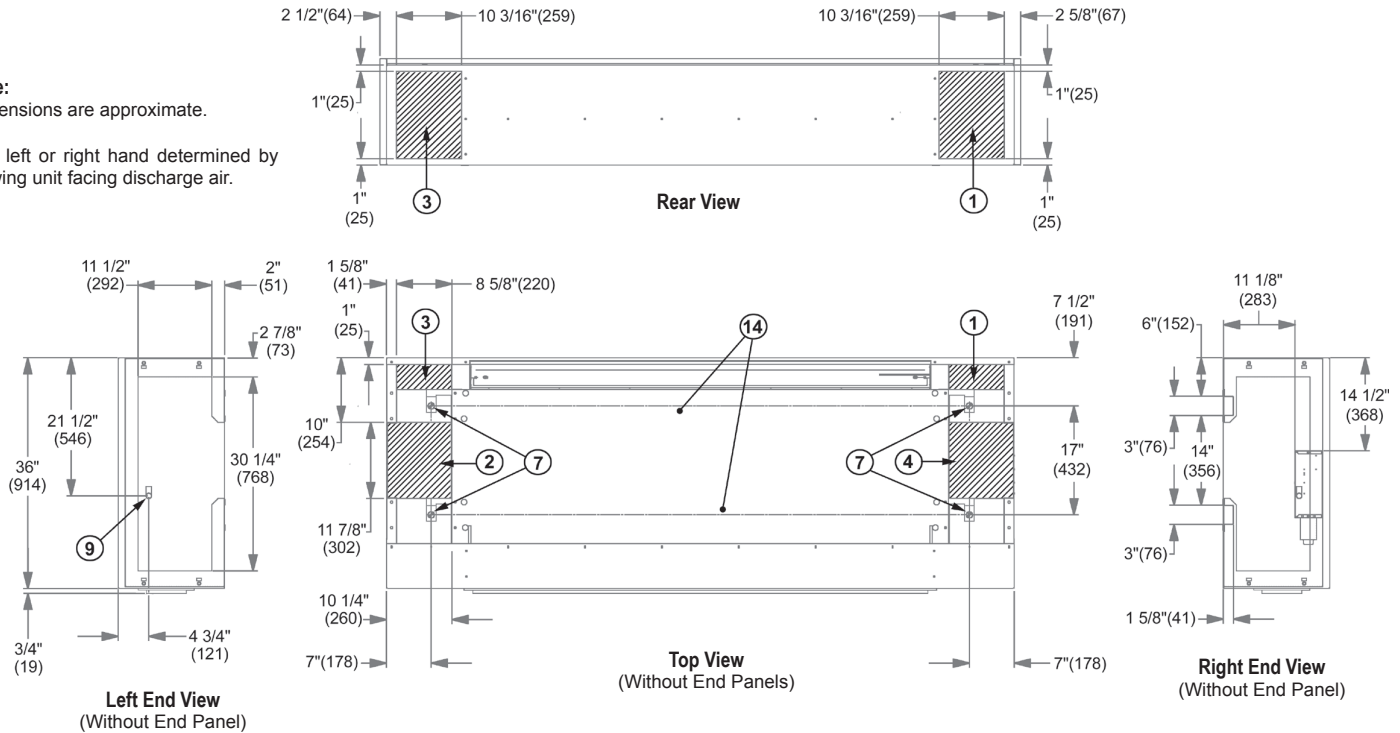
## Daikin Classroom Ceiling Unit Ventilator

### Model AHF – Air Arrangement AH – 36" Deep Unit Front Discharge With Duct Collar

#### Note:

Dimensions are approximate.

Unit left or right hand determined by viewing unit facing discharge air.



#### Component Description

- 1 Rear Entry Area – RH
- 2 Top Entry Area – LH
- 3 Rear Entry Area – LH
- 4 Top Entry Area – RH
- 5 Fan Motor
- 6 Electrical Connection Box
- 7 7/8" (22mm) Diameter Ceiling Mounting Holes
- 8 Duct Collar
- 9 Condensate Drain (Same end as cooling coil)
- 10 Return Air Grille (Optional)
- 11 End Panels
- 12 Bottom Hinged Access Panel (Filter & Controls)
- 13 Bottom Hinged Access Panel (Motor & End Bearing)
- 14 Wire Raceways
- 15 MicroTech Controller (UVC)

#### Piping

- Piping Entry – Left Hand Coil 1 or 2  
Piping Entry – Right Hand Coil 3 or 4

#### Electrical – Main Power Wiring

- Wiring Entry 3 or 4  
Wiring Connection (Non-Electric Heat) - 6

#### Note:

Electrical box location in right hand end will vary based on control and motor options selected.

#### Dimensions

Unit Size	Dim. "A"	MM	Dim. "C"	MM
H07 / V07	62	1575	36	914
H10 / V10	74	1880	48	1219
H13 / V13	86	2184	60	1524
H15 / V15	98	2489	72	1829



## Duct System Considerations

### Duct Design for Noise and Vibration Control

Proper acoustics is often a design requirement for schools. Most of the problems that are associated with HVAC generated sound can be avoided by properly selecting and locating the components of the system. There are some general do's and don'ts:

The following suggestions are required to reduce the amount of sound and noise due to vibration that reaches the occupied room:

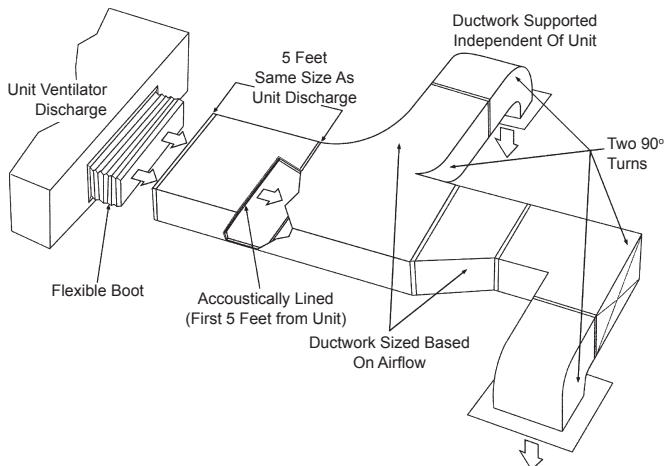
- Use flexible duct connections.
- Make the discharge duct the same size as the unit discharge opening for the first five feet.
- Line the first 5 feet of the supply duct.
- Make two 90-degree turns in the supply and return ducts.
- Keep duct velocity low and follow good duct design procedures.
- Mount and support the ductwork independent of the unit.
- Line the first five feet of the return duct.
- Locate the return air intake away from the unit discharge.
- Provide multiple discharges.
- Restrict use of high pressure drop flexible ducting.
- Size the outdoor air and return air ducts to handle 100% of the total cfm to accommodate economizer or morning warm-up operation.

### NOTICE

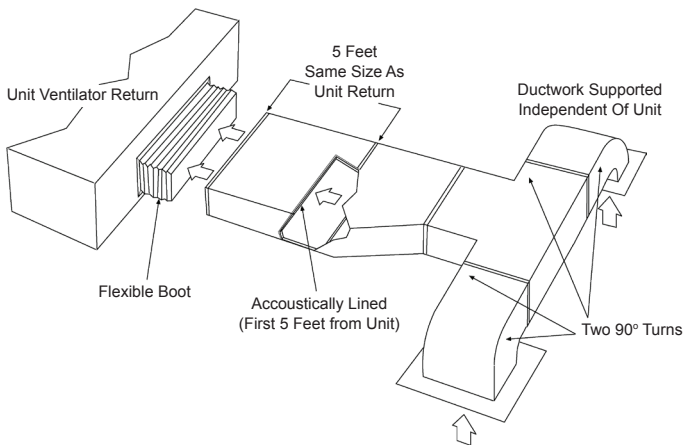
If a supply air duct with improper duct work is placed too close to the unit discharge, it will result in substantial noise. Avoid such forms of connections when designing ductwork where sound attenuation is critical. The following illustrations show suggested duct considerations per SMACNA and ASHRAE.

Sound control applies to the return side of the duct design as well as the supply side. The top-right illustration suggests installation of a intake/return-air duct. Note the return air opening, the sizing and changes in direction of the ductwork. The outdoor air intake and insulated duct work illustration at the lower-right suggests installation of outside air ducting.

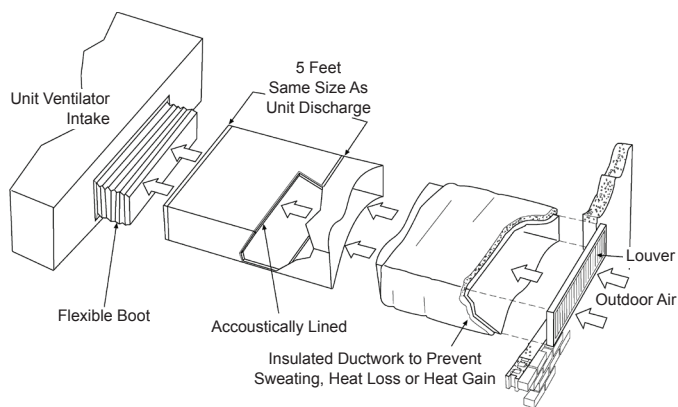
### Discharge Air Duct Work



### Intake/Return Air Duct Work



### Outdoor Air Intake and Insulated Duct Work



### NOTICE

These are general suggestions and offered only to stress their importance; however, there are additional important factors that must be considered. Assistance in the design of ductwork can be found in the ASHRAE Handbook and SMACNA publications, as well as other recognized authorities.



# Certified Drawing

AHF-H\_C-103J

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

Group: **Unit Ventilator**

Type: **Basic Unit Data**

Date: **May 2018**

## Daikin Classroom Ceiling Unit Ventilator Model AHF

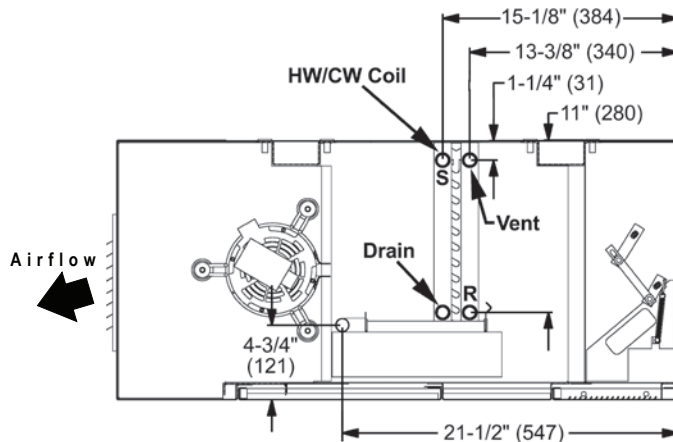
### Coil Connections - Heating and Cooling

#### Chilled Water and Heating Coil Unit

##### Chilled/Hot Water 2-pipe Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.

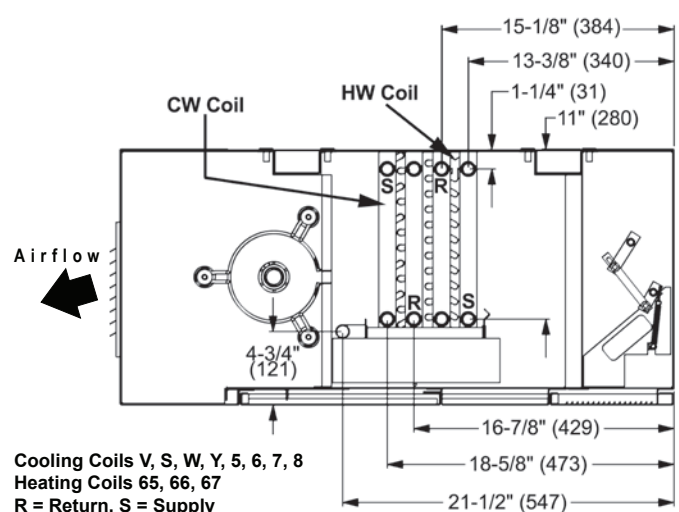


Coils U, D, E, F, 1, 2, 3, 4  
R = Return, S = Supply

##### Chilled Water and Hot Water Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.

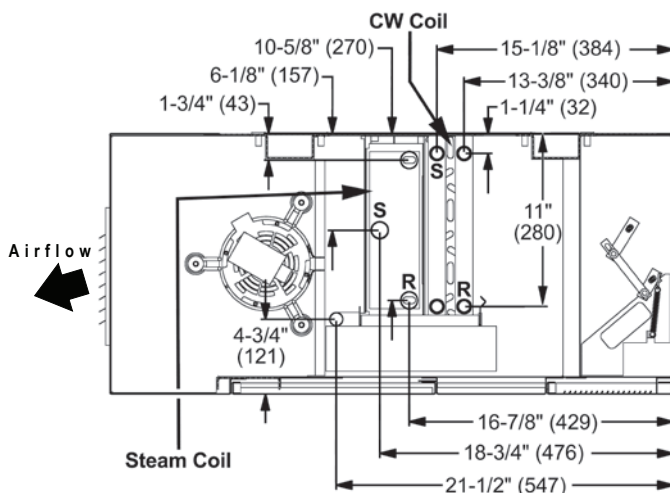


Cooling Coils V, S, W, Y, 5, 6, 7, 8  
Heating Coils 65, 66, 67  
R = Return, S = Supply

##### Chilled Water and Steam Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.

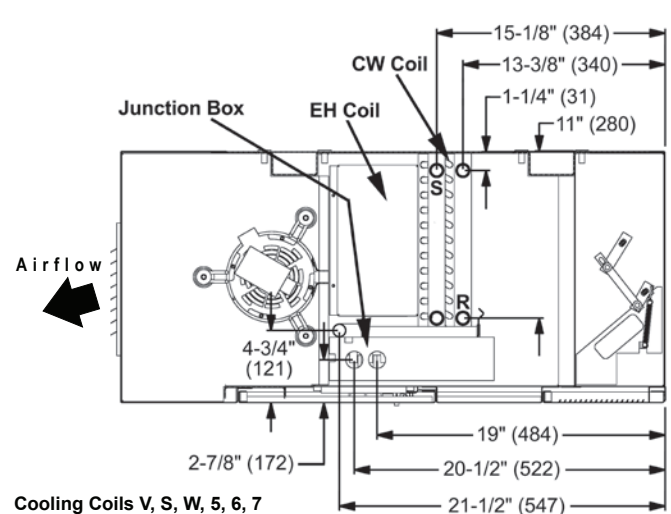


Cooling Coils V, S, 5, 6  
Heating Coils 68, 69  
R = Return, S = Supply

##### Chilled Water (1st Position) and Electric Heating Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.



Cooling Coils V, S, W, 5, 6, 7  
Heating Coil 12, 13  
R = Return, S = Supply  
EH = Electric Heat

Note: Electric heating coil power connections are right end only. Junction box has 1" (25mm) and 2" (51mm) (trade size) knockouts, 10 1/2" (267mm) from right end of the unit.

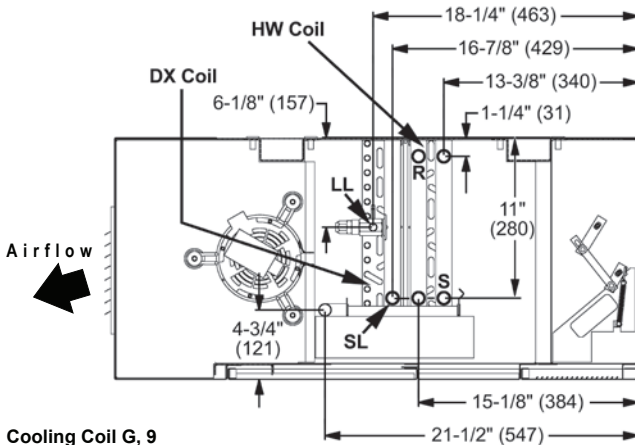




## Direct Expansion (DX) and Heating Coil

### Direct Expansion with Hot Water Unit (Right-hand) (Dimensions are the same for Left-hand unit)

**Note:** Connection hand is determined by facing discharge air grille.



Cooling Coil G, 9  
Heating Coils 65, 66, 67  
R = Return, S = Supply  
LL = Liquid Line, SL = Suction Line

**Note:** Direct Expansion (DX) coils have female sweat connections.  
Interconnecting tubing is by others. See table below for correct tubing sizes.

### Heat/Cool Coil Position/Combinations In Air Stream

First Position in Air Stream	Second Position in Air Stream
U, D, E, F, 1, 2, 3, 4	00
65, 66, 67	V, S, G, 5, 6, 9
65, 66	W, 7
65	Y, 8
G, 9, 68, 69	G, 9, 68, 69
V, S, W, 5, 6, 7	12, 13
V, S, 5, 6, 65, 66, 67	G, 9, 68, 69

#### Heating Coils

65 = 1-Row Hot Water Coil  
66 = 2-Row Hot Water Coil  
67 = 3-Row Hot Water Coil  
68 = Low Capacity Steam Coil  
69 = High Capacity Steam Coil  
12 = Low Electric Heat Coil  
13 = High Electric Heat Coil  
00 = None

#### Cooling Coils

U or 1 = 2-Row CW/HW 2-pipe Coil  
D or 2 = 3-Row CW/HW 2-pipe Coil  
E or 3 = 4-Row CW/HW 2-pipe Coil  
F or 4 = 5-Row CW/HW 2-pipe Coil  
V or 5 = 2-Row CW Coil  
S or 6 = 3-Row CW Coil  
W or 7 = 4-Row CW Coil  
Y or 8 = 5-Row CW Coil  
G or 9 = Direct Expansion Coil

### Coil Water Capacities (Gallons/Liters)

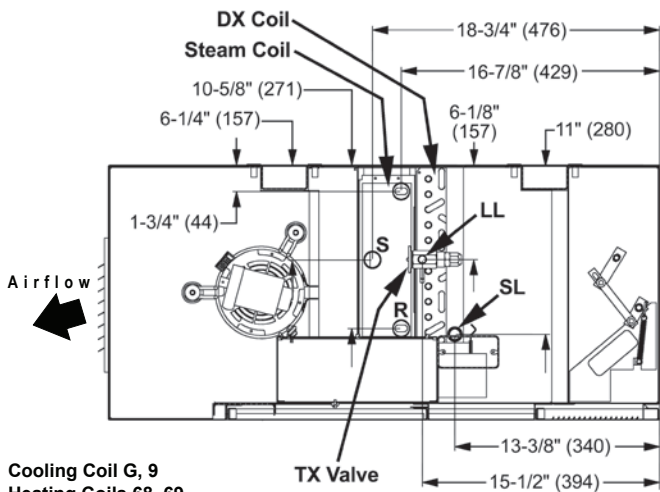
Coil Rows	Unit Series				
	H07 / V07	H10 / V10	H13 / V13	H15 / V15	H20 / V20
	Gallons (Liters)				
1 Row	0.25 (0.95)	0.31 (1.17)	0.38 (1.44)	0.44 (1.67)	0.44 (1.67)
2 Row	0.45 (1.70)	0.57 (2.16)	0.69 (2.61)	0.82 (3.10)	0.82 (3.10)
3 Row	0.64 (2.42)	0.82 (3.10)	1.01 (3.82)	1.19 (4.50)	1.19 (4.50)
4 Row	0.83 (3.14)	1.08 (4.09)	1.32 (5.00)	1.57 (5.94)	1.57 (5.94)
5 Row	1.03 (3.90)	1.34 (5.07)	1.64 (6.21)	1.95 (7.38)	1.95 (7.38)

#### Notes:

- All coils have the same end supply and return connections.
- All water connections are  $\frac{7}{8}$ " I.D. (female) sweat and all steam coils are  $1\frac{1}{8}$ " (female) sweat connections. All coil connections terminate 9" (229mm) from the end of the unit.
- Steam coils have a factory installed pressure equalizing valve and a 24" (610mm) long pressure equalizing line which terminates in a  $\frac{1}{2}$ " M.P.T. fitting.
- Steam/hot water connections may be same end as cooling coil connections, but they are recommended to be opposite end to facilitate piping. (Must be opposite end when using MicroTech® controls.)
- Condensate connection is same end as cooling coil connections, but is field reversible. Drain can be sloped in field.
- All dimensions are approximated.

### Direct Expansion and Steam Unit (Right-hand) (Dimensions are the same for Left-hand unit)

**Note:** Connection hand is determined by facing discharge air grille.



Cooling Coil G, 9  
Heating Coils 68, 69  
R = Return, S = Supply  
LL = Liquid Line, SL = Suction Line

**Note:** Direct Expansion (DX) coils have female sweat connections.  
Interconnecting tubing is by others. See table below for correct tubing sizes.

### Suction Line and Liquid Line Dimensions

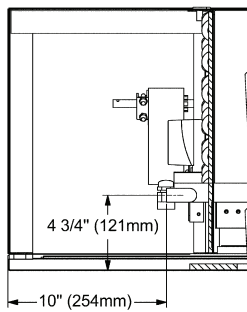
Unit Series	H07 / V07	H10 / V10	H13 / V13	H15 / V15	H20 / V20
	Dimensions are O.D. in inches (mm)				
Suction Line	3/4 (19)	3/4 (19)	7/8 (22)	7/8 (22)	7/8 (22)
Liquid Line	1/4 (6)	1/4 (6)	3/8 (10)	3/8 (10)	3/8 (10)



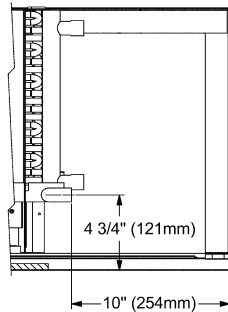
## Condensate Drain – All Units

Dimensions Exclude 1"(25mm) End Panel

Condensate Drain – 7/8" (22mm) I.D. x 1/8" (3mm) Wall, Flexible PVC Tubing



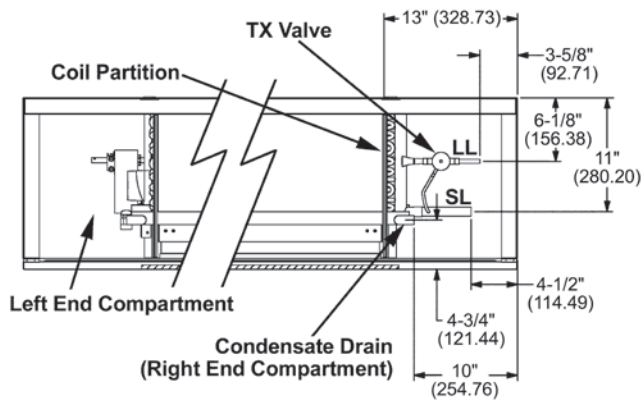
**Front View**  
**Left End Compartment**



**Front View**  
**Right End Compartment**

## Condensate Drain and DX Connection

Dimensions Exclude 1"(25mm) End Panel



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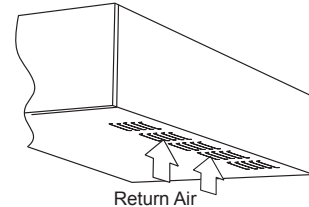
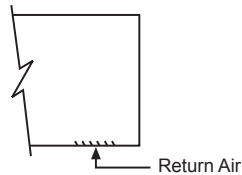
Group: **Unit Ventilator**

Type: **Basic Unit Data**

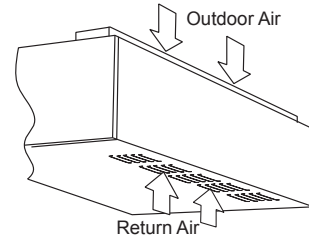
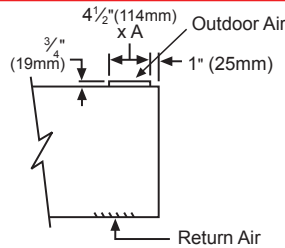
Date: **July 2018**

## Daikin Classroom Ceiling Unit Ventilator Model AHF, AHV, AHR and AHB Inlet Air Arrangements (Check Arrangement That Applies)

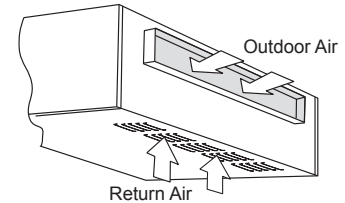
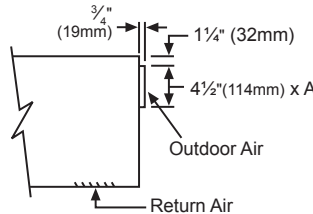
- ☐ **Arrangement 25**  
Recirculating Room Air  
(No Room Air/Outside Air Dampers)



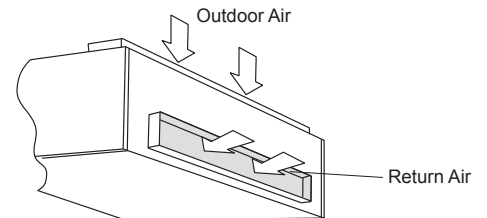
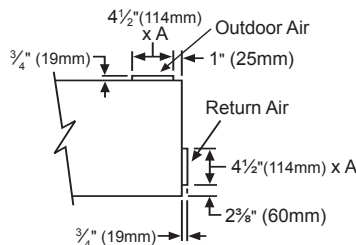
- ☐ **Arrangement 26**  
Return Air Bottom Grille/Outdoor Air  
Top Duct Collar



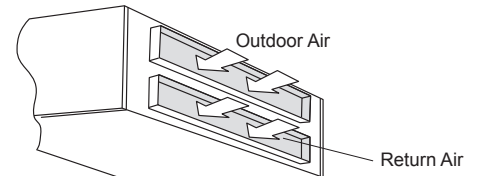
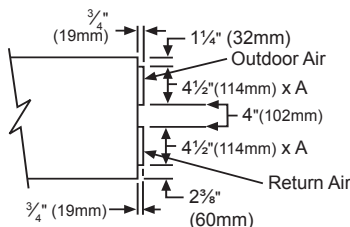
- ☐ **Arrangement 27**  
Return Air Bottom Grille/Outdoor Air  
Rear Duct Collar



- ☐ **Arrangement 28**  
Return Air Rear Duct Collar/Outdoor Air  
Top Duct Collar



- ☐ **Arrangement 29**  
Return Air Rear Duct Collar/Outdoor Air  
Rear Duct Collar



### Dimensions

Unit Series		07	10	13	15	20
A	inches	36	48	60	72	72
	mm	914	1219	1524	1829	1829

### Notes:

- For all recessed applications (full or partial) it is necessary to carefully examine both the inlet air and the discharge air physical locations. This must be done for each location individually and in combination with each other to ensure they are compatible with the specific installation.
- Duct collars shipped loose for field installation not by Daikin Applied.
- It is important also to verify there is sufficient clearance to open and remove the bottom access panels and end panels for routine maintenance.
- All dimensions approximated.





## Duct System Considerations

### Duct Design for Noise and Vibration Control

Proper acoustics is often a design requirement for schools. Most of the problems that are associated with HVAC generated sound can be avoided by properly selecting and locating the components of the system. There are some general do's and don'ts:

The following suggestions are required to reduce the amount of sound and noise due to vibration that reaches the occupied room:

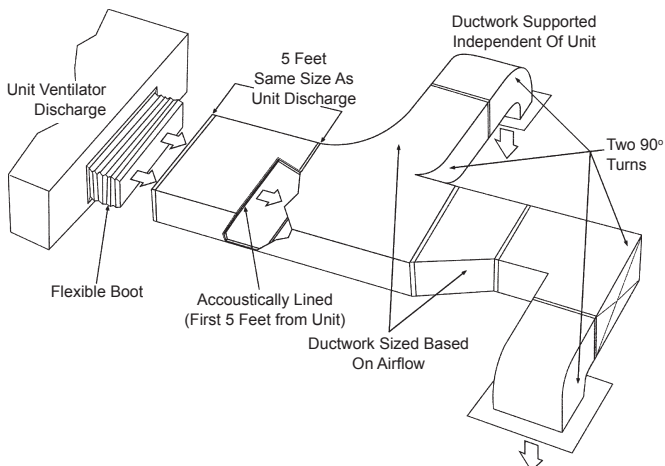
- Use flexible duct connections.
- Make the discharge duct the same size as the unit discharge opening for the first five feet.
- Line the first 5 feet of the supply duct.
- Make two 90-degree turns in the supply and return ducts.
- Keep duct velocity low and follow good duct design procedures.
- Mount and support the ductwork independent of the unit.
- Line the first five feet of the return duct.
- Locate the return air intake away from the unit discharge.
- Provide multiple discharges.
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### NOTICE

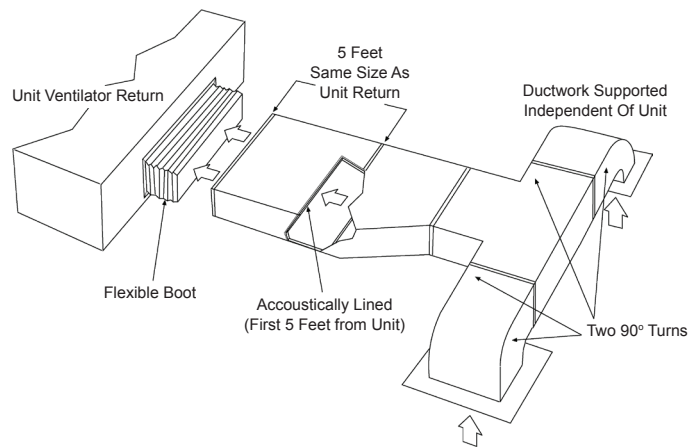
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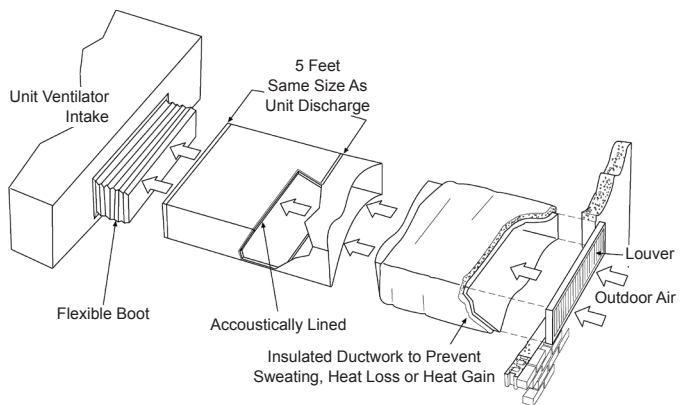
### Discharge Air Duct Work



### Intake/Return Air Duct Work



### Outdoor Air Intake and Insulated Duct Work



### NOTICE

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## Technical Data Sheet for UV-2 Right

Job Information		Technical Data Sheet
Job Name	North Salem CSD MSHS	
Date	3/1/2022	
Submitted By	Scott Shufflebotham	
Software Version	07.90	
Unit Tag	UV-2 Right: F-212, F-208	



Unit Overview			
Model Number	Model Type	Cooling Coil Type	Heating Coil Type
UAVS9H15	Face & Bypass	2-Pipe CW / HW	2-Pipe CW / HW
Arrangement	Control Type	Cooling Coil Hand	Heating Coil Hand
Vertical, Floor Mounted, Type AN Adapter Back	Field Mounted Controls (By Others)	Right Hand Cooling	Right Hand Heating

Physical			
Unit Length	Unit Depth	Unit Height	Weight
98.00 in	21.88 in	30.13 in	600 lb

Electrical				
Voltage	Minimum Voltage	Maximum Voltage	Total Unit MCA	Maximum Fuse Size
115/60/1 V/Hz/Phase	104 v	126 v	6.3 A	15 A

Fan					
Performance					
Fan Motor	Speed	Air Volume CFM	External Static Pressure inH <sub>2</sub> O	Motor Power HP	Fan Full Load Current A
ECM, 3-Speed	Medium	1143	0.00	0.333	5.00

Chilled Water Coil					
Performance					
Capacity		Air Temperature			
Total Btu/hr	Sensible Btu/hr	Entering		Leaving	
		Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F
50417	31226	80.9	67.2	55.7	52.9
Number of Rows	Temperature		Fluid Type	Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O
	Entering °F	Leaving °F			
	45.0	54.2	Water	11.00	7.94
Fluid Connections					
Supply		Return		Condensate	
7/8 inch		7/8 inch		7/8 inch	

Technical Data Sheet for UV-2 Right

Hot Water Coil				
Performance				
Total Capacity Btu/hr	Air Temperature Dry Bulb		Fluid Temperature	
	Entering °F	Leaving °F	Entering °F	Leaving °F
129459	40.0	144.4	180.0	145.0
Fluid				
Type		Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O	
Water		7.40	3.59	
Warranty				
Type				
Extended:		None		
Notes				
Accessories				
Part Number	Description			
106041890	6" End Pnl, Ant Ivory, 21-7/8"D Solid (AV AZ)			

## Technical Data Sheet for UV-2 Left

Job Information		Technical Data Sheet
Job Name	North Salem CSD MSHS	
Date	3/1/2022	
Submitted By	Scott Shufflebotham	
Software Version	07.90	
Unit Tag	UV-2 Left: F-206	



Unit Overview			
Model Number	Model Type	Cooling Coil Type	Heating Coil Type
UAVS9H15	Face & Bypass	2-Pipe CW / HW	2-Pipe CW / HW
Arrangement	Control Type	Cooling Coil Hand	Heating Coil Hand
Vertical, Floor Mounted, Type AN Adapter Back	Field Mounted Controls (By Others)	Left Hand Cooling	Left Hand Heating

Physical			
Unit Length	Unit Depth	Unit Height	Weight
98.00 in	21.88 in	30.13 in	600 lb

Electrical				
Voltage	Minimum Voltage	Maximum Voltage	Total Unit MCA	Maximum Fuse Size
115/60/1 V/Hz/Phase	104 v	126 v	6.3 A	15 A

Fan					
Performance					
Fan Motor	Speed	Air Volume CFM	External Static Pressure inH <sub>2</sub> O	Motor Power HP	Fan Full Load Current A
ECM, 3-Speed	Medium	1143	0.00	0.333	5.00

Chilled Water Coil					
Performance					
Capacity		Air Temperature			
Total Btu/hr	Sensible Btu/hr	Entering		Leaving	
		Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F
50417	31226	80.9	67.2	55.7	52.9
Number of Rows	Fluid				
	Temperature		Type	Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O
	Entering °F	Leaving °F			
4	45.0	54.2	Water	11.00	7.94
Fluid Connections					
Supply		Return		Condensate	
7/8 inch		7/8 inch		7/8 inch	

Technical Data Sheet for UV-2 Left

Hot Water Coil				
Performance				
Total Capacity Btu/hr	Air Temperature Dry Bulb		Fluid Temperature	
	Entering °F	Leaving °F	Entering °F	Leaving °F
129459	40.0	144.4	180.0	145.0
Fluid				
Type		Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O	
Water		7.40	3.59	

Warranty	
Type	
Extended:	None

Notes

Accessories	
Part Number	Description
106041890	6" End Pnl, Ant Ivory, 21-7/8"D Solid (AV AZ)

Certified Drawing		AVS-001J
Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin		Group: <b>Unit Ventilator</b>
		Type: <b>Basic Unit Data</b>
		Date: <b>May 2018</b>

## Daikin Classroom Floor Unit Ventilator Model AVS (J Vintage)

### Standard Features

- UL/cUL listed.
- AHRI Certified chilled water performance. Unit ventilation rate certified and tested per Air Conditioning, Heating and Refrigeration Institute (AHRI) standard 840.
- Institutional quality cabinet with durable, textured, charcoal bronze paint finish on top surface. Oven baked powder paint on all other exterior panels.
- Welded chassis constructed from galvanized steel.
- Two, top hinged doors for access.
- Removable bar discharge grille.
- Three individual front access panels provided for ease of maintenance and service.
- All access panels have positive positioning threaded fasteners operated with 5/32" hex wrench.
- Insulated unit back.
- Built in pipe tunnel.
- Leveling legs.
- Rigid, double wall, insulated outdoor air damper made from welded galvanized steel, with mohair end and damper seals in turned over edges.
- Galvanized steel drain pan (optional stainless steel). Connection handing is field reversible and direction of slant can be field modified.
- Room air fan shaft have oilable sleeve bearings for quietness and long life.
- Low speed room air fan constructed of injection molded polypropylene for precise, smooth, quiet performance.
- Energy efficient 1/4 H.P. permanent split capacitor (PSC) plug-in room air fan motor fits all size units. Located out of air stream.
- Available 1/3 H.P. Electrically Commutated Motor (ECM) available for applications with External Static Pressures (ESP) up to 0.45 (112 Pa).
- UL listed individual fusing of fan motor and controls.
- PSC and EC motor speed controlled by multi-tap transformer, high-medium-low-off speeds. Optional variable speed ECM.
- MicroTech® Controls (Optional) – State of the art MicroTech unit controller is a stand alone microprocessor based DDC control device that is pre-engineered, pre-programmed, pre-tested and factory installed. It provides correct sequence of operations and the advantage of one source responsibility.
- Steam coils equipped with vacuum breaker.
- Manual air vent and drain plug on water coils.
- Throwaway filter(s) factory installed in unit.

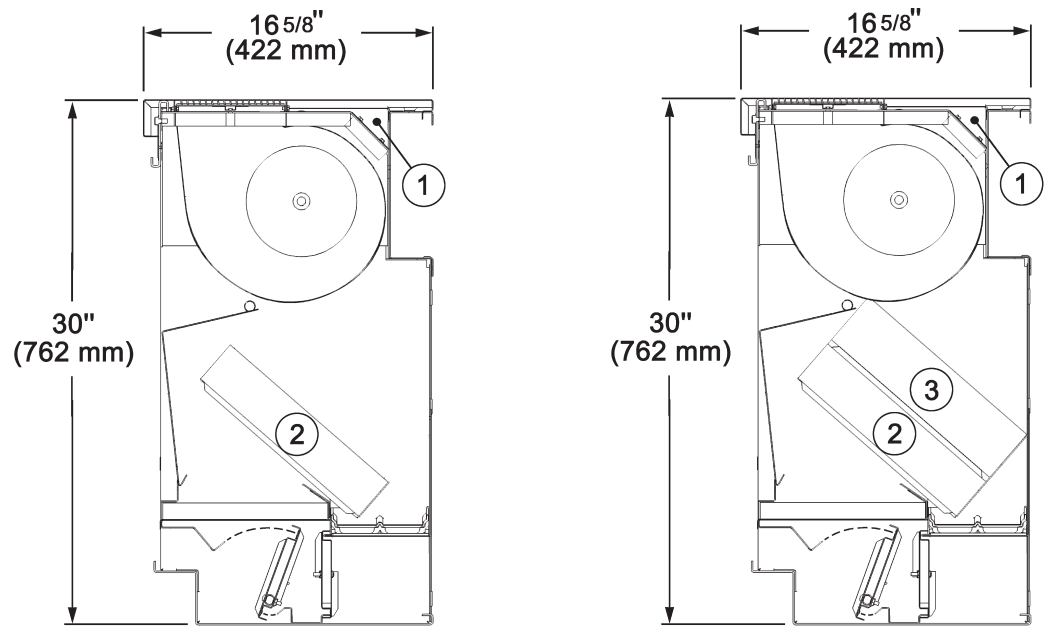
**Table 1: Physical Data**

			S07 / H07 / V07	S10 / H10 / V10	S13 / H13 / V13	S15 / H15 / V15
Nominal Airflow CFM (L/s)			750 (340)	1000 (472)	1250 (590)	1500 (708)
Fan Data	Number of Fans:		2	3	4	4
	Size	Diameter - in (mm)	8.12 (206mm)	8.12 (206mm)	8.12 (206mm)	8.12 (206mm)
		Width- in (mm)	8.25 (210mm)	8.25 (210mm)	8.25 (210mm)	8.25 (210mm)
Filter Data	Nominal Size	in	10 x 36-1/2 x 1	10 x 48-1/2 x 1	10 x 60-1/2 x 1	10 x 36-1/2 x 1
		(mm)	254 x 927 x 25	254 x 1232 x 25	254 x 1537 x 25	254 x 927 x 25
	Area - Ft <sup>2</sup> (m <sup>2</sup> )		2.54 (.24)	3.37 (.31)	4.2 (.39)	5.08 (.47)
	Quantity:		1	1	1	2
Shipping Weight	16-5/8" Deep Units		350 (168)	425 (193)	495 (225)	570 (259)
	21-7/8" Deep Units		370 (163)	445 (202)	525 (238)	600 (272)
Coil Water Volume Gallons (Liters)	1 Row Coil		0.25 (0.95)	0.31 (1.17)	0.38 (1.44)	0.44 (1.67)
	2 Row Coil		0.45 (1.70)	0.57 (2.16)	0.69 (2.61)	0.82 (3.10)
	3 Row Coil		0.64 (2.42)	0.82 (3.10)	1.01 (3.82)	1.19 (4.50)
	4 Row Coil		0.83 (3.14)	1.08 (4.09)	1.32 (5.00)	1.57 (5.94)
	5 Row Coil		1.03 (3.90)	1.34 (5.07)	1.64 (6.21)	1.95 (7.38)



Dimensional Data

AVS Unit Cross Sections  
Face & By-Pass Damper Control



Single Coil Units		Two Coil Units	
1 Raceway for factory wiring 2 Hot Water, Steam, Chilled Water, CW/HW (2-pipe)		<b>Direct Expansion Units (DX)</b>	<b>Chilled Water Units</b>
		1 Raceway for factory wiring 2 Hot Water 3 Direct Expansion	1 Raceway for factory wiring 2 Hot Water 3 Chilled Water
		2 Direct Expansion 3 Steam	2 Chilled Water 3 Electric Heat or Steam



# Certified Drawing

AVS-007J

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

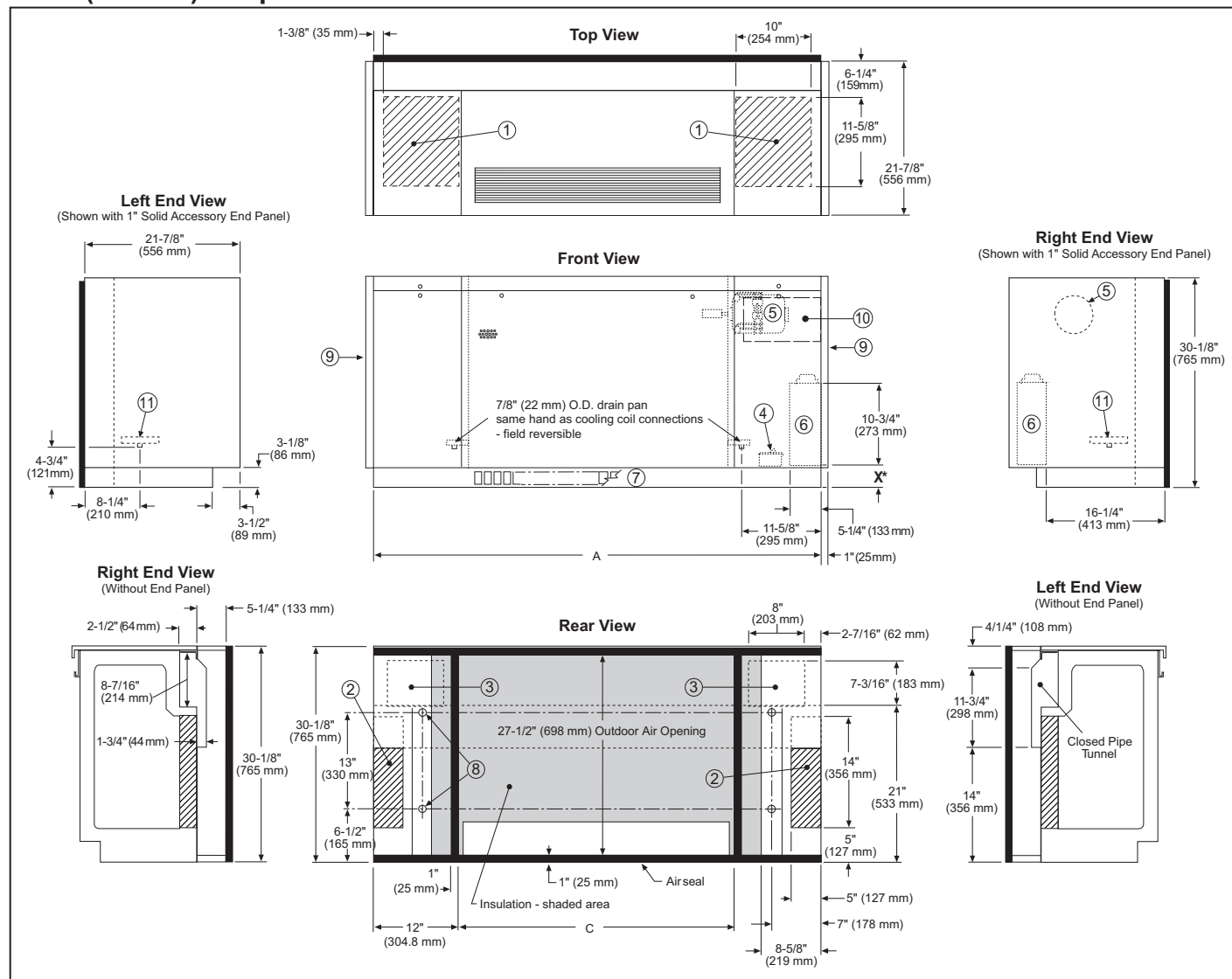
Group: **Unit Ventilator**

Type: **Inlet Air Arrange.**

Date: **May 2018**

## Daikin Classroom Floor Unit Ventilator Model AVS (J Vintage) Arrangement AN – Full Adapter Back, Closed Pipe Tunnel

### 21<sup>7</sup>/<sub>8</sub>" (556mm) Deep Floor Unit – Dimensions



Unit Size	Dimensions in inches (mm)		Drawing Notes ( ①, *, etc.)
	A	C	
S07, H07, V07	62 (1575)	38 (965)	1 Bottom entry within 10" x 11-5/8" (254 mm x 295 mm) area 2 Rear entry area 14" x 5" (356 mm x 127 mm). 3 Opening between pipe tunnel & end compartment. 4 Disconnect Switch for main power wiring. 5 Fan motor. 6 Electrical connection box. 7 Slotted kickplate for return air arrangements; partially open kickplate for draftstop arrangements. 8 (4) - 7/8" (22 mm) diameter holes in back for anchoring unit to wall. 9 Accessory panels not included with unit, order separately as an accessory. 10 Controls location (MicroTech® units only). 11. Galvanized drain pan (optional stainless steel). X = 3.88" for units with MicroTech controls. X = 14.43" for all other control options.
S10, H10, V10	74 (1880)	50 (1270)	
S13, H13, V13	86 (2184)	62 (1575)	
S15, H15, V15	98 (2489)	74 (1880)	





# Certified Drawing

AVS-V-R-B-6in-052

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

Group: **Unit Ventilator**

Type: **End Panel Dimen.**

Date: **May 2018**

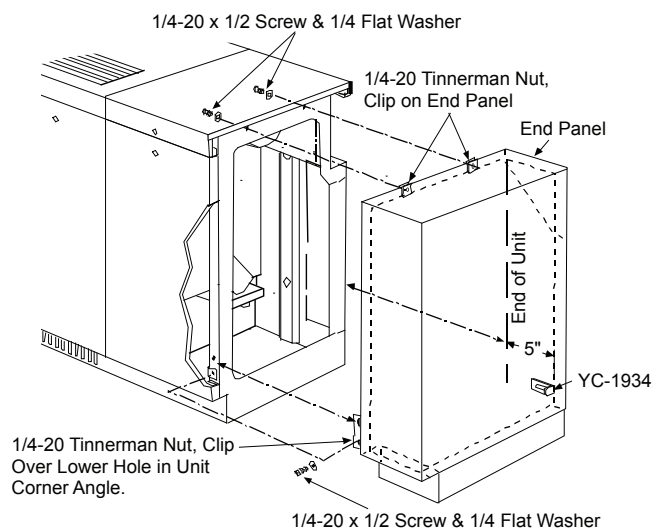
## Daikin Classroom Floor Unit Ventilator 6" End Panel & Enclosure Application Models AVS, AVV, AVR & AVB

Available in: (Check one that applies)

- ☐ Antique Ivory      ☐ Putty Beige      ☐ Cupola White  
☐ Off White      ☐ Soft Gray

**Table 1: 6" (152 mm) End Panel Dimensions (Check one that applies)**

	16-5/8" (422mm) Deep End Panel	21-7/8" (556mm) Deep End Panel	28" (711mm) Deep End Panel
<b>Top View</b>			
<b>End View With No Cut-out</b>			



## Technical Data Sheet for UV-3 Right

Job Information		Technical Data Sheet
Job Name	North Salem CSD MSHS	
Date	3/1/2022	
Submitted By	Scott Shufflebotham	
Software Version	07.90	
Unit Tag	UV-3 Right: F-205	



Unit Overview			
Model Number	Model Type	Cooling Coil Type	Heating Coil Type
UAVS9H15	Face & Bypass	2-Pipe CW / HW	2-Pipe CW / HW
Arrangement	Control Type	Cooling Coil Hand	Heating Coil Hand
Vertical, Floor Mounted, Type AN Adapter Back	Field Mounted Controls (By Others)	Right Hand Cooling	Right Hand Heating

Physical			
Unit Length	Unit Depth	Unit Height	Weight
98.00 in	21.88 in	30.13 in	600 lb

Electrical				
Voltage	Minimum Voltage	Maximum Voltage	Total Unit MCA	Maximum Fuse Size
115/60/1 V/Hz/Phase	104 v	126 v	6.3 A	15 A

Fan					
Performance					
Fan Motor	Speed	Air Volume CFM	External Static Pressure inH <sub>2</sub> O	Motor Power HP	Fan Full Load Current A
ECM, 3-Speed	High	1474	0.00	0.333	5.00

Chilled Water Coil					
Performance					
Capacity		Air Temperature			
Total Btu/hr	Sensible Btu/hr	Entering		Leaving	
		Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F
56006	37463	80.9	67.2	57.5	54.8
Number of Rows	Temperature		Fluid Type	Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O
	Entering °F	Leaving °F			
	45.0	55.2	Water	11.00	7.94
Fluid Connections					
Supply		Return		Condensate	
7/8 inch		7/8 inch		7/8 inch	

Technical Data Sheet for UV-3 Right

Hot Water Coil				
Performance				
Total Capacity Btu/hr	Air Temperature Dry Bulb		Fluid Temperature	
	Entering °F	Leaving °F	Entering °F	Leaving °F
164304	40.0	142.7	180.0	143.5
Fluid				
Type		Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O	
Water		9.00	5.31	
Warranty				
Type				
Extended:		None		
Notes				
Accessories				
Part Number	Description			
106041890	6" End Pnl, Ant Ivory, 21-7/8"D Solid (AV AZ)			

## Technical Data Sheet for UV-3 Left

Job Information		Technical Data Sheet
Job Name	North Salem CSD MSHS	
Date	3/1/2022	
Submitted By	Scott Shufflebotham	
Software Version	07.90	
Unit Tag	UV-3 Left: F-207, F-209	



Unit Overview			
Model Number	Model Type	Cooling Coil Type	Heating Coil Type
UAVS9H15	Face & Bypass	2-Pipe CW / HW	2-Pipe CW / HW
Arrangement	Control Type	Cooling Coil Hand	Heating Coil Hand
Vertical, Floor Mounted, Type AN Adapter Back	Field Mounted Controls (By Others)	Left Hand Cooling	Left Hand Heating

Physical			
Unit Length	Unit Depth	Unit Height	Weight
98.00 in	21.88 in	30.13 in	600 lb

Electrical				
Voltage	Minimum Voltage	Maximum Voltage	Total Unit MCA	Maximum Fuse Size
115/60/1 V/Hz/Phase	104 v	126 v	6.3 A	15 A

Fan					
Performance					
Fan Motor	Speed	Air Volume CFM	External Static Pressure inH <sub>2</sub> O	Motor Power HP	Fan Full Load Current A
ECM, 3-Speed	High	1474	0.00	0.333	5.00

Chilled Water Coil					
Performance					
Capacity		Air Temperature			
Total Btu/hr	Sensible Btu/hr	Entering		Leaving	
		Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F
56006	37463	80.9	67.2	57.5	54.8
Number of Rows	Fluid				
	Temperature		Type	Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O
	Entering °F	Leaving °F			
4	45.0	55.2	Water	11.00	7.94
Fluid Connections					
Supply		Return		Condensate	
7/8 inch		7/8 inch		7/8 inch	

Technical Data Sheet for UV-3 Left

Hot Water Coil				
Performance				
Total Capacity Btu/hr	Air Temperature Dry Bulb		Fluid Temperature	
	Entering °F	Leaving °F	Entering °F	Leaving °F
164304	40.0	142.7	180.0	143.5
Fluid				
Type		Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O	
Water		9.00	5.31	
Warranty				
Type				
Extended:		None		
Notes				
Accessories				
Part Number	Description			
106041890	6" End Pnl, Ant Ivory, 21-7/8"D Solid (AV AZ)			

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

Group: **Unit Ventilator**

Type: **Basic Unit Data**

Date: **May 2018**

## Daikin Classroom Floor Unit Ventilator Model AVS (J Vintage)

### Standard Features

- UL/cUL listed.
- AHRI Certified chilled water performance. Unit ventilation rate certified and tested per Air Conditioning, Heating and Refrigeration Institute (AHRI) standard 840.
- Institutional quality cabinet with durable, textured, charcoal bronze paint finish on top surface. Oven baked powder paint on all other exterior panels.
- Welded chassis constructed from galvanized steel.
- Two, top hinged doors for access.
- Removable bar discharge grille.
- Three individual front access panels provided for ease of maintenance and service.
- All access panels have positive positioning threaded fasteners operated with 5/32" hex wrench.
- Insulated unit back.
- Built in pipe tunnel.
- Leveling legs.
- Rigid, double wall, insulated outdoor air damper made from welded galvanized steel, with mohair end and damper seals in turned over edges.
- Galvanized steel drain pan (optional stainless steel). Connection handing is field reversible and direction of slant can be field modified.
- Room air fan shaft have oilable sleeve bearings for quietness and long life.
- Low speed room air fan constructed of injection molded polypropylene for precise, smooth, quiet performance.
- Energy efficient 1/4 H.P. permanent split capacitor (PSC) plug-in room air fan motor fits all size units. Located out of air stream.
- Available 1/3 H.P. Electrically Commutated Motor (ECM) available for applications with External Static Pressures (ESP) up to 0.45 (112 Pa).
- UL listed individual fusing of fan motor and controls.
- PSC and EC motor speed controlled by multi-tap transformer, high-medium-low-off speeds. Optional variable speed ECM.
- MicroTech® Controls (Optional) – State of the art MicroTech unit controller is a stand alone microprocessor based DDC control device that is pre-engineered, pre-programmed, pre-tested and factory installed. It provides correct sequence of operations and the advantage of one source responsibility.
- Steam coils equipped with vacuum breaker.
- Manual air vent and drain plug on water coils.
- Throwaway filter(s) factory installed in unit.

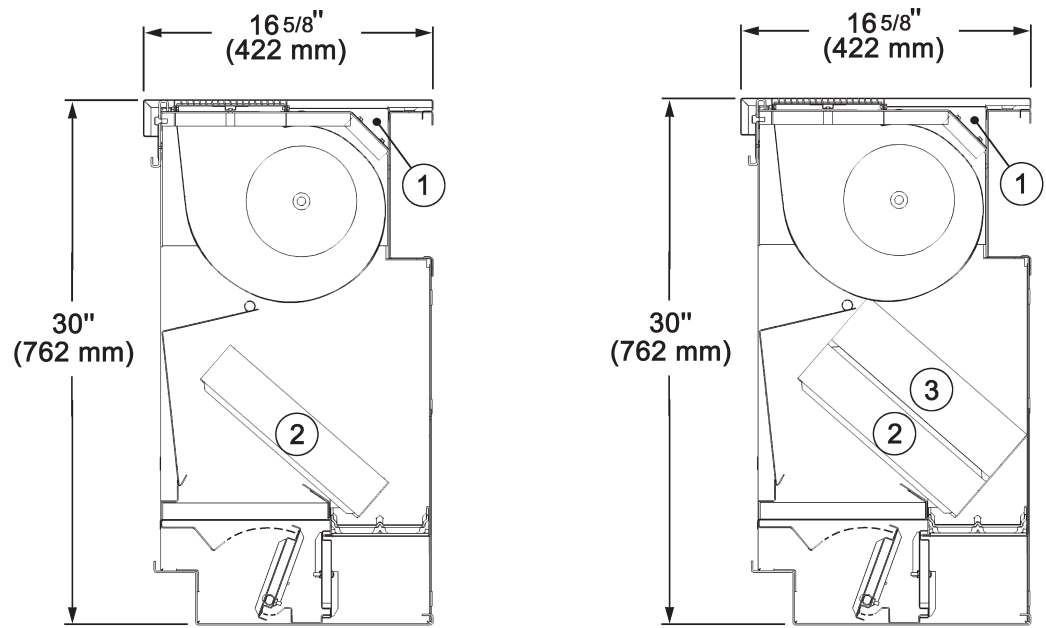
**Table 1: Physical Data**

			S07 / H07 / V07	S10 / H10 / V10	S13 / H13 / V13	S15 / H15 / V15
Nominal Airflow CFM (L/s)			750 (340)	1000 (472)	1250 (590)	1500 (708)
Fan Data	Number of Fans:		2	3	4	4
	Size	Diameter - in (mm)	8.12 (206mm)	8.12 (206mm)	8.12 (206mm)	8.12 (206mm)
		Width- in (mm)	8.25 (210mm)	8.25 (210mm)	8.25 (210mm)	8.25 (210mm)
Filter Data	Nominal Size	in	10 x 36-1/2 x 1	10 x 48-1/2 x 1	10 x 60-1/2 x 1	10 x 36-1/2 x 1
		(mm)	254 x 927 x 25	254 x 1232 x 25	254 x 1537 x 25	254 x 927 x 25
	Area - Ft <sup>2</sup> (m <sup>2</sup> )		2.54 (.24)	3.37 (.31)	4.2 (.39)	5.08 (.47)
Shipping Weight	Quantity:		1	1	1	2
	16-5/8" Deep Units		350 (168)	425 (193)	495 (225)	570 (259)
	21-7/8" Deep Units		370 (163)	445 (202)	525 (238)	600 (272)
Coil Water Volume Gallons (Liters)	1 Row Coil		0.25 (0.95)	0.31 (1.17)	0.38 (1.44)	0.44 (1.67)
	2 Row Coil		0.45 (1.70)	0.57 (2.16)	0.69 (2.61)	0.82 (3.10)
	3 Row Coil		0.64 (2.42)	0.82 (3.10)	1.01 (3.82)	1.19 (4.50)
	4 Row Coil		0.83 (3.14)	1.08 (4.09)	1.32 (5.00)	1.57 (5.94)
	5 Row Coil		1.03 (3.90)	1.34 (5.07)	1.64 (6.21)	1.95 (7.38)



Dimensional Data

AVS Unit Cross Sections  
Face & By-Pass Damper Control



Single Coil Units		Two Coil Units	
1 Raceway for factory wiring 2 Hot Water, Steam, Chilled Water, CW/HW (2-pipe)		<b>Direct Expansion Units (DX)</b>	<b>Chilled Water Units</b>
		1 Raceway for factory wiring 2 Hot Water 3 Direct Expansion	1 Raceway for factory wiring 2 Hot Water 3 Chilled Water
		2 Direct Expansion 3 Steam	2 Chilled Water 3 Electric Heat or Steam



# Certified Drawing

AVS-007J

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

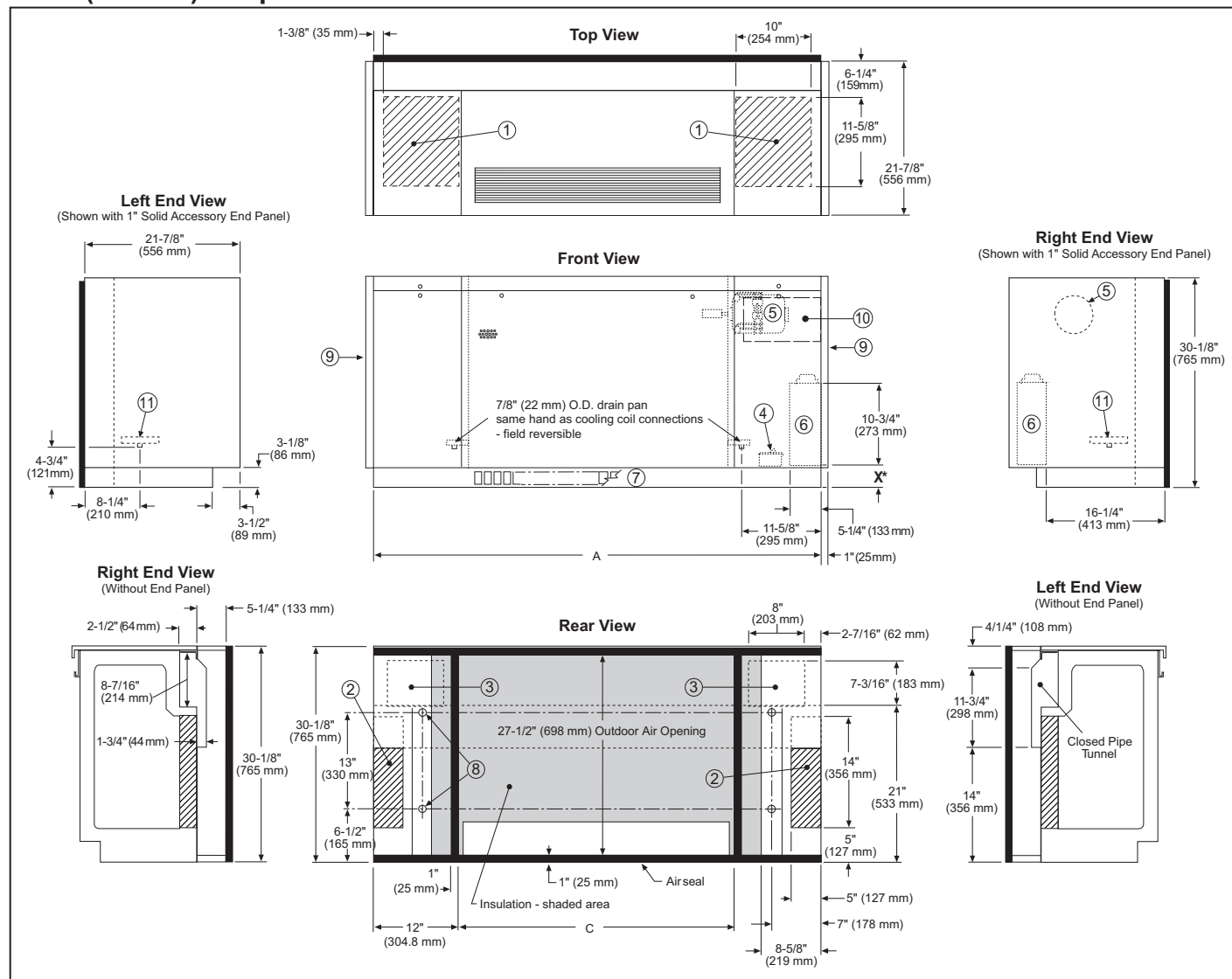
Group: **Unit Ventilator**

Type: **Inlet Air Arrange.**

Date: **May 2018**

## Daikin Classroom Floor Unit Ventilator Model AVS (J Vintage) Arrangement AN – Full Adapter Back, Closed Pipe Tunnel

### 21 7/8" (556mm) Deep Floor Unit – Dimensions



Unit Size	Dimensions in inches (mm)		Drawing Notes ( ①, *, etc.)
	A	C	
S07, H07, V07	62 (1575)	38 (965)	1 Bottom entry within 10" x 11-5/8" (254 mm x 295 mm) area 2 Rear entry area 14" x 5" (356 mm x 127 mm). 3 Opening between pipe tunnel & end compartment. 4 Disconnect Switch for main power wiring. 5 Fan motor. 6 Electrical connection box. 7 Slotted kickplate for return air arrangements; partially open kickplate for draftstop arrangements. 8 (4) - 7/8" (22 mm) diameter holes in back for anchoring unit to wall. 9 Accessory panels not included with unit, order separately as an accessory. 10 Controls location (MicroTech® units only). 11. Galvanized drain pan (optional stainless steel). X = 3.88" for units with MicroTech controls. X = 14.43" for all other control options.
S10, H10, V10	74 (1880)	50 (1270)	
S13, H13, V13	86 (2184)	62 (1575)	
S15, H15, V15	98 (2489)	74 (1880)	
S20, H20, V20	118 (3000)	86 (2184)	





# Certified Drawing

AVS-V-R-B-6in-052

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

Group: **Unit Ventilator**

Type: **End Panel Dimen.**

Date: **May 2018**

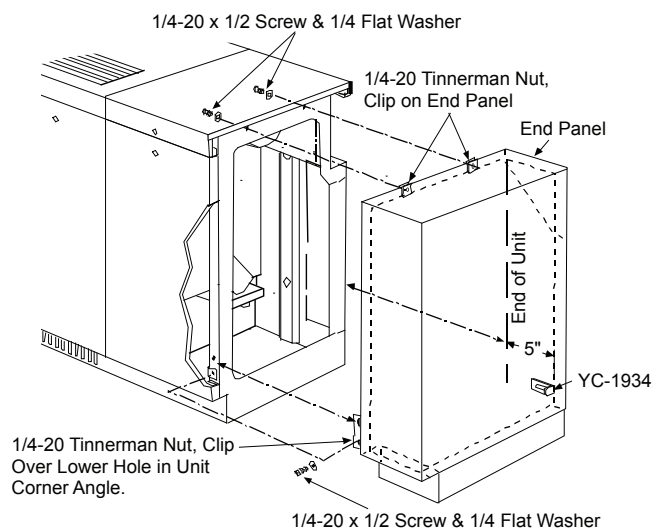
## Daikin Classroom Floor Unit Ventilator 6" End Panel & Enclosure Application Models AVS, AVV, AVR & AVB

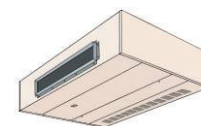
Available in: (Check one that applies)

- ☐ Antique Ivory      ☐ Putty Beige      ☐ Cupola White  
☐ Off White      ☐ Soft Gray

**Table 1: 6" (152 mm) End Panel Dimensions (Check one that applies)**

	16-5/8" (422mm) Deep End Panel	21-7/8" (556mm) Deep End Panel	28" (711mm) Deep End Panel
<b>Top View</b>			
<b>End View With No Cut-out</b>			





Job Information		Technical Data Sheet
Job Name	North Salem CSD MSHS	
Date	3/7/2022	
Submitted By	Scott Shufflebotham	
Software Version	07.90	
Unit Tag	UV-4 - Left - F-204	

Unit Overview			
Model Number	Model Type	Cooling Coil Type	Heating Coil Type
UAHF9H07	Face & Bypass	2-Pipe CW / HW	2-Pipe CW / HW
Arrangement	Control Type	Cooling Coil Hand	Heating Coil Hand
Horizontal, Ceiling Mounted, Bottom Grille Return Air, Top Duct Collar OA	Field Mounted Controls (By Others)	Left Hand Cooling	Left Hand Heating

Physical			
Unit Length	Unit Depth	Unit Height	Weight
36.00 in	64.00 in	16.62 in	385 lb

Electrical				
Voltage	Minimum Voltage	Maximum Voltage	Total Unit MCA	Maximum Fuse Size
115/60/1 V/Hz/Phase	104 v	126 v	6.3 A	15 A

Fan					
Performance					
Fan Motor	Speed	Air Volume CFM	External Static Pressure inH <sub>2</sub> O	Motor Power HP	Fan Full Load Current A
ECM, 3-Speed	Low	600	0.00	0.333	5.00

Chilled Water Coil					
Performance					
Capacity		Air Temperature			
Total Btu/hr	Sensible Btu/hr	Entering		Leaving	
		Dry Bulb °F	Wet Bulb °F	Dry Bulb °F	Wet Bulb °F
17247	11114	80.9	67.2	63.8	58.4
Number of Rows	Fluid				
	Temperature		Type	Flow Rate gpm	Pressure Drop ft H <sub>2</sub> O
	Entering °F	Leaving °F			
3	45.0	53.6	Water	4.00	2.58
Fluid Connections					
Supply		Return		Condensate	
7/8 inch		7/8 inch		7/8 inch	

## Hot Water Coil

Performance				
Total Capacity Btu/hr	Air Temperature Dry Bulb		Fluid Temperature	
	Entering °F	Leaving °F	Entering °F	Leaving °F
52060	40.0	120.0	180.0	127.9
Fluid				
Type	Flow Rate gpm		Pressure Drop ft H <sub>2</sub> O	
Water	2.00		0.64	

## Warranty

Type	
Extended:	None

## AHRI Certification



Certified in accordance with the AHRI Unit Ventilator Certification Program, which is based on AHRI Standard 840/841. Certified units may be found in the AHRI Directory at [www.ahridirectory.org](http://www.ahridirectory.org).

## Notes

## Accessories

Part Number	Description
GCA302048	Flanges for 36" Length Unit (w/Plenum) H07

Certified Drawing		AHF-36-102J
Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin		Group: <b>Unit Ventilator</b>
		Type: <b>Basic Unit Data</b>
		Date: <b>May 2018</b>

## Daikin Classroom Model AHF 36" Deep Ceiling Unit Ventilator – Arrangements AT & AH – Front Discharge, Series H07, H10, H13, H15, V07, V10, V13, V15

### Standard Features

- UL/cUL listed
- AHRI Certified chilled water performance. Unit ventilation rate certified and tested per Air Conditioning, Heating and Refrigeration (AHRI) standard 840.
- Institutional quality cabinet with durable, baked alkyd enamel paint finish on exterior panels and discharge grille. (Double deflection grilles have clear anodized aluminum finish).
- Welded chassis constructed from galvanized steel
- Three bottom panels, two of which are hinged, for ease of service access and handling. Single panel access to filter and controls.
- Removable bar discharge grille (AT - arrangement).
- All access panels have positive positioning threaded fasteners operated with 5/32" hex wrench
- Anti blow through room air damper.
- Rigid, double wall, insulated outdoor air damper made from welded galvanized steel, with mohair end and damper seals in turned over edges.
- Standard galvanized or optional stainless steel drain pan. Drain pan connections C/L located 4"(10mm) above unit bottom. Hand of connection and direction of slope is field selectable.
- Room air fan shaft has oilable sleeve bearings for quietness and long life.
- Low speed room air fan constructed of injection molded polypropylene for precise, smooth, quiet performance.
- Electrically Commutated Motor (ECM) available for applications with External Static Pressures (ESP) up to 0.45 (112 Pa).
- UL/cUL listed individual fusing of fan motor and controls.
- EC motor controlled for 3 speeds, high-medium-low and off. Optional variable speed motor available.
- MicroTech® controls (optional) state of the art "MicroTech" unit controller is a stand alone microprocessor based DDC control device that is pre-engineered, pre-programmed, pre-tested and factory installed. It provides correct sequence of operations and the advantage of one source responsibility.
- Steam coils equipped with vacuum breaker.
- Manual air vent and drain plug on water coils.
- Throwaway filter(s) factory installed in unit.
- Heating only units can be adapted for future air conditioning.

### Physical Data

Unit Series			H07 / V07	H10 / V10	H13 / V13	H15 / V15
Nominal Airflow - cfm (L/s)			750 (354)	1000 (472)	1250 (590)	1500 (708)
Fan Data	Number of Fans		2	3	4	4
	Size	Dia. in. (mm)	8.12 (206)	8.12 (206)	8.12 (206)	8.12 (206)
		Width - in. (mm)	8.25 (210)	8.25 (210)	8.25 (210)	8.25 (210)
Filter Data	(Qty) Size	in. (Nominal)	(1) 10 × 36½ × 1	(1) 10 × 48½ × 1	(1) 10 × 60½ × 1	(2) 10 × 36½ × 1
		(mm)	254 × 927 × 25	254 × 1232 × 25	254 × 1537 × 25	254 × 927 × 25
	Area	Ft. <sup>2</sup> (m <sup>2</sup> )	2.54 (.24)	3.37 (.31)	4.2 (.39)	5.08 (.47)
*Approx. Shipping Weight lb. (kg)	Discharge Air Arrangement	AT, AH	385 (179)	465 (211)	540 (245)	620 (281)
Coil Water Volume Gal. (Ltrs)	1-Row Coil		.25 (0.95)	.31 (1.17)	.38 (1.44)	.44 (1.67)
	2-Row Coil		.45 (1.70)	.57 (2.16)	.69 (2.61)	.82 (3.10)
	3-Row Coil		.64 (2.42)	.82 (3.10)	1.01 (3.82)	1.19 (4.50)
	4-Row Coil		.83 (3.14)	1.08 (4.09)	1.32 (5.00)	1.57 (5.94)
	5-Row Coil		1.03 (3.90)	1.34 (3.90)	1.64 (6.21)	1.95 (7.38)

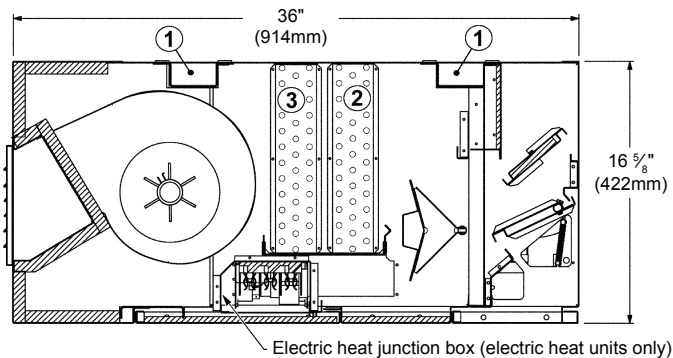
\* Approximate weights based on Face & Bypass damper controlled unit with 4-row cooling coil, 2-row hot water coil and MicroTech® Controls.



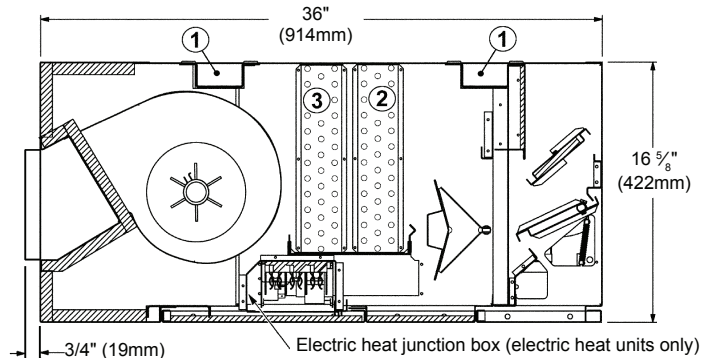
# Daikin Classroom Model AHF 36" Deep Ceiling Unit Ventilator – Arrangements AT & AH – Front Discharge, Series H07, H10, H13, H15, V07, V10, V13, V15

## Unit Cross Sections

### Arrangement AT - Double Deflection Grille



### Arrangement AH - Duct Collar



## Face & Bypass Damper Control

### Single Coil Unit

- ① Raceway for factory wiring (Single & two coil unit)
- ② Hot Water, Chilled Water or CW/HW (2-pipe), None
- ③ None, Steam

### Two Coil Units

- ② Hot water                      ② Chilled water
- ③ Chilled water                ③ Electric or Steam

- ② Hot water
- ③ Direct expansion

## Duct System Considerations

### Duct Design for Noise and Vibration Control

Proper acoustics is often a design requirement for schools. Most of the problems that are associated with HVAC generated sound can be avoided by properly selecting and locating the components of the system. There are some general do's and don'ts:

The following suggestions are required to reduce the amount of sound and noise due to vibration that reaches the occupied room:

- Use flexible duct connections.
- Make the discharge duct the same size as the unit discharge opening for the first five feet.
- Line the first 5 feet of the supply duct.
- Make two 90-degree turns in the supply and return ducts.
- Keep duct velocity low and follow good duct design procedures.
- Mount and support the ductwork independent of the unit.
- Line the first five feet of the return duct.
- Locate the return air intake away from the unit discharge.
- Provide multiple discharges.
- Restrict use of high pressure drop flexible ducting.
- Size the outdoor air and return air ducts to handle 100% of the total cfm to accommodate economizer or morning warm-up operation.

### NOTICE

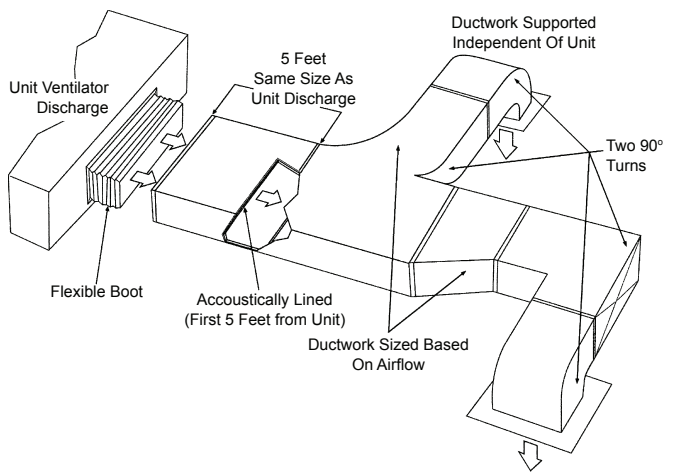
If a supply air duct with improper duct work is placed too close to the unit discharge, it will result in substantial noise. Avoid such forms of connections when designing ductwork where sound attenuation is critical. The following illustrations show suggested duct considerations per SMACNA and ASHRAE.

Sound control applies to the return side of the duct design as well as the supply side. The bottom-right illustration suggests installation of an intake/return-air duct. Note the return air opening, the sizing and changes in direction of the ductwork. The outdoor air intake and insulated duct work illustration on the next page suggests installation of outside air ducting.

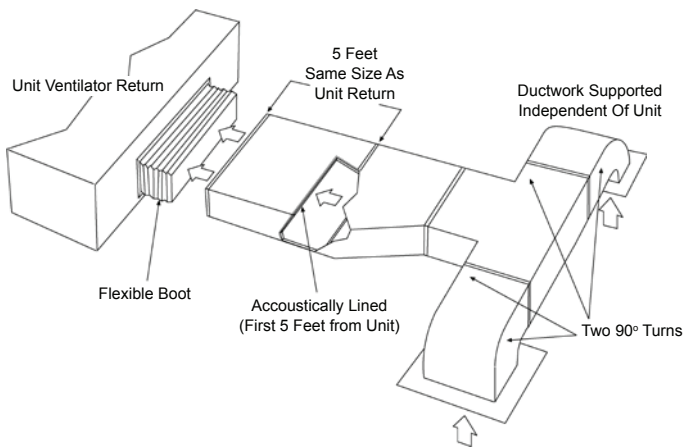
### NOTICE

These are general suggestions and offered only to stress their importance; however, there are additional important factors that must be considered. Assistance in the design of ductwork can be found in the ASHRAE Handbook and SMACNA publications, as well as other recognized authorities.

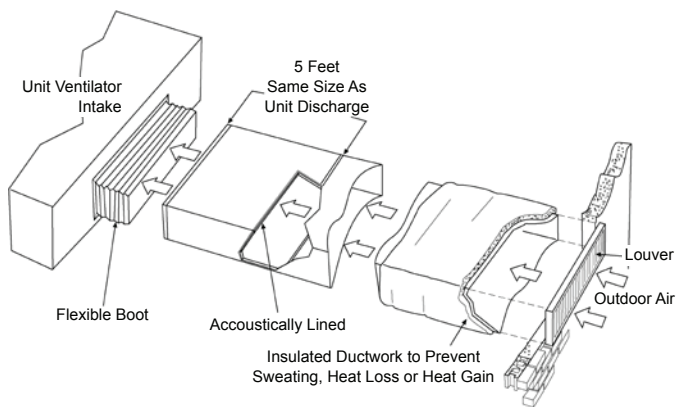
### Discharge Air Duct Work



### Intake/Return Air Duct Work



### Outdoor Air Intake and Insulated Duct Work



# Certified Drawing

AHF-AH36-108J

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

Group: Unit Ventilator

Type: Inlet Air Arrangement

Date: May 2018

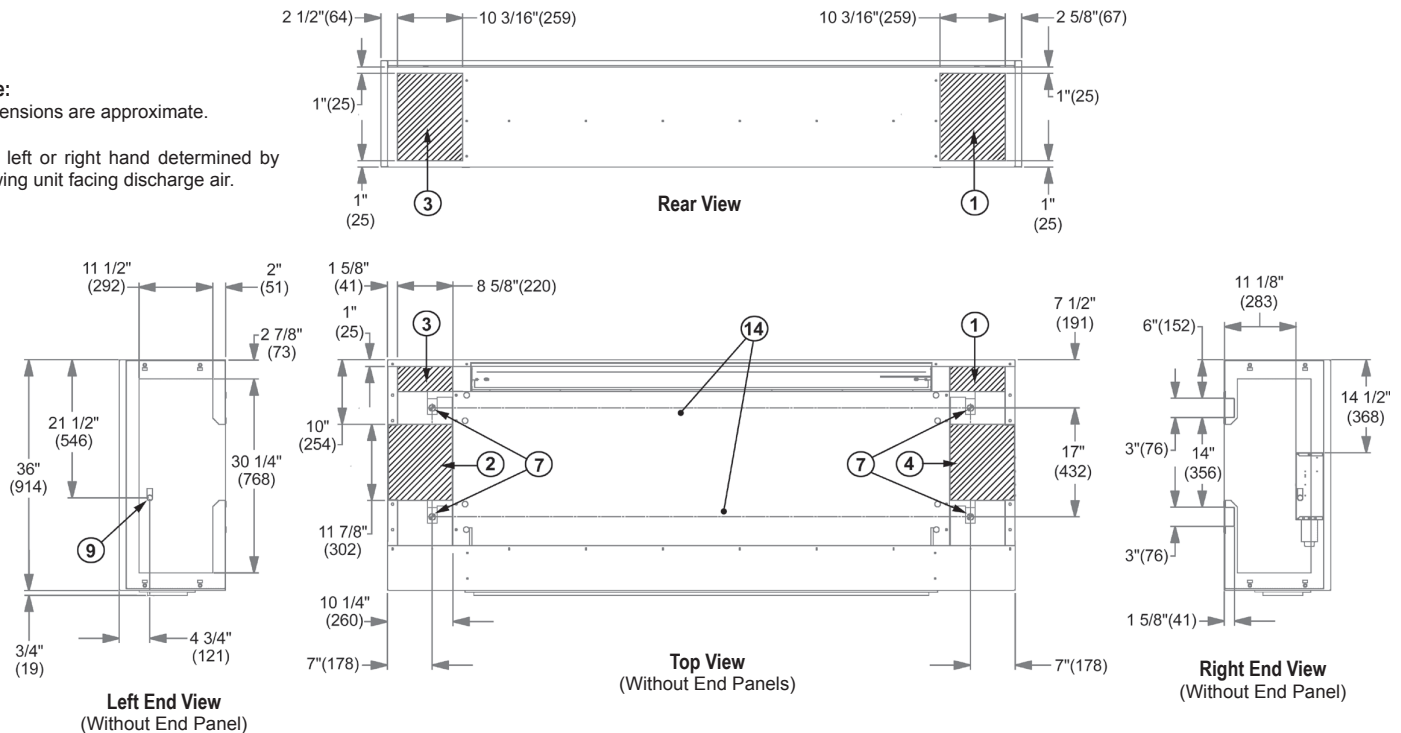
## Daikin Classroom Ceiling Unit Ventilator

### Model AHF – Air Arrangement AH – 36" Deep Unit Front Discharge With Duct Collar

#### Note:

Dimensions are approximate.

Unit left or right hand determined by viewing unit facing discharge air.



#### Component Description

- 1 Rear Entry Area – RH
- 2 Top Entry Area – LH
- 3 Rear Entry Area – LH
- 4 Top Entry Area – RH
- 5 Fan Motor
- 6 Electrical Connection Box
- 7 7/8" (22mm) Diameter Ceiling Mounting Holes
- 8 Duct Collar
- 9 Condensate Drain (Same end as cooling coil)
- 10 Return Air Grille (Optional)
- 11 End Panels
- 12 Bottom Hinged Access Panel (Filter & Controls)
- 13 Bottom Hinged Access Panel (Motor & End Bearing)
- 14 Wire Raceways
- 15 MicroTech Controller (UVC)

#### Note:

Electrical box location in right hand end will vary based on control and motor options selected.

#### Piping

- Piping Entry – Left Hand Coil 1 or 2  
Piping Entry – Right Hand Coil 3 or 4

#### Electrical – Main Power Wiring

- Wiring Entry 3 or 4  
Wiring Connection (Non-Electric Heat) - 6

#### Dimensions

Unit Size	Dim. "A"	MM	Dim. "C"	MM
H07 / V07	62	1575	36	914
H10 / V10	74	1880	48	1219
H13 / V13	86	2184	60	1524
H15 / V15	98	2489	72	1829





## Duct System Considerations

### Duct Design for Noise and Vibration Control

Proper acoustics is often a design requirement for schools. Most of the problems that are associated with HVAC generated sound can be avoided by properly selecting and locating the components of the system. There are some general do's and don'ts:

The following suggestions are required to reduce the amount of sound and noise due to vibration that reaches the occupied room:

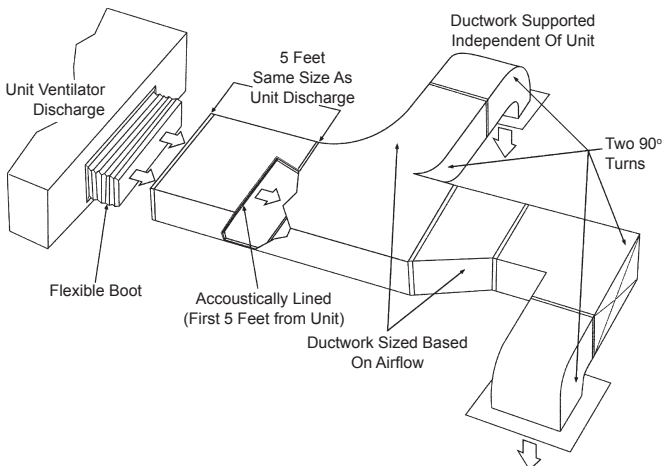
- Use flexible duct connections.
- Make the discharge duct the same size as the unit discharge opening for the first five feet.
- Line the first 5 feet of the supply duct.
- Make two 90-degree turns in the supply and return ducts.
- Keep duct velocity low and follow good duct design procedures.
- Mount and support the ductwork independent of the unit.
- Line the first five feet of the return duct.
- Locate the return air intake away from the unit discharge.
- Provide multiple discharges.
- Restrict use of high pressure drop flexible ducting.
- Size the outdoor air and return air ducts to handle 100% of the total cfm to accommodate economizer or morning warm-up operation.

### NOTICE

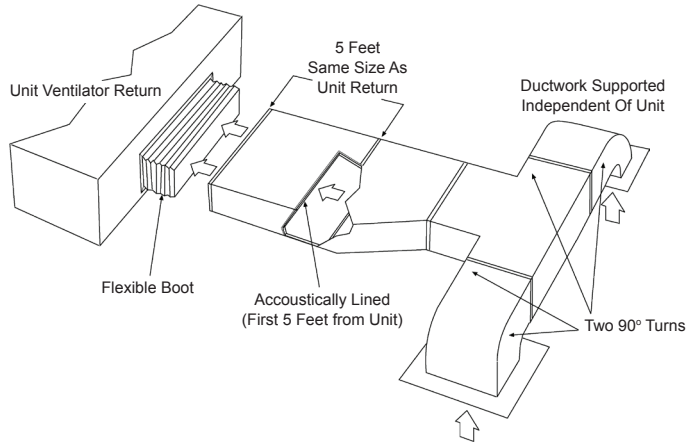
If a supply air duct with improper duct work is placed too close to the unit discharge, it will result in substantial noise. Avoid such forms of connections when designing ductwork where sound attenuation is critical. The following illustrations show suggested duct considerations per SMACNA and ASHRAE.

Sound control applies to the return side of the duct design as well as the supply side. The top-right illustration suggests installation of a intake/return-air duct. Note the return air opening, the sizing and changes in direction of the ductwork. The outdoor air intake and insulated duct work illustration at the lower-right suggests installation of outside air ducting.

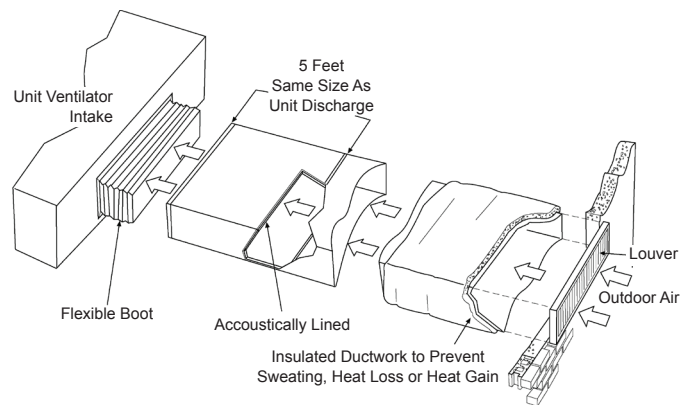
### Discharge Air Duct Work



### Intake/Return Air Duct Work



### Outdoor Air Intake and Insulated Duct Work



### NOTICE

These are general suggestions and offered only to stress their importance; however, there are additional important factors that must be considered. Assistance in the design of ductwork can be found in the ASHRAE Handbook and SMACNA publications, as well as other recognized authorities.





# Certified Drawing

AHF-H\_C-103J

Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

Group: **Unit Ventilator**

Type: **Basic Unit Data**

Date: **May 2018**

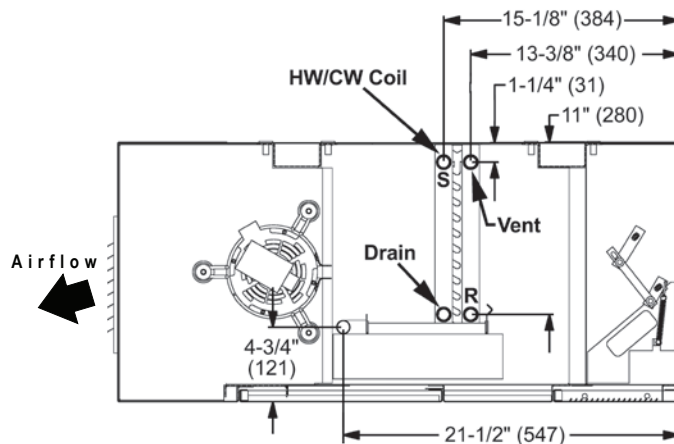
## Daikin Classroom Ceiling Unit Ventilator Model AHF Coil Connections - Heating and Cooling

### Chilled Water and Heating Coil Unit

#### Chilled/Hot Water 2-pipe Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.

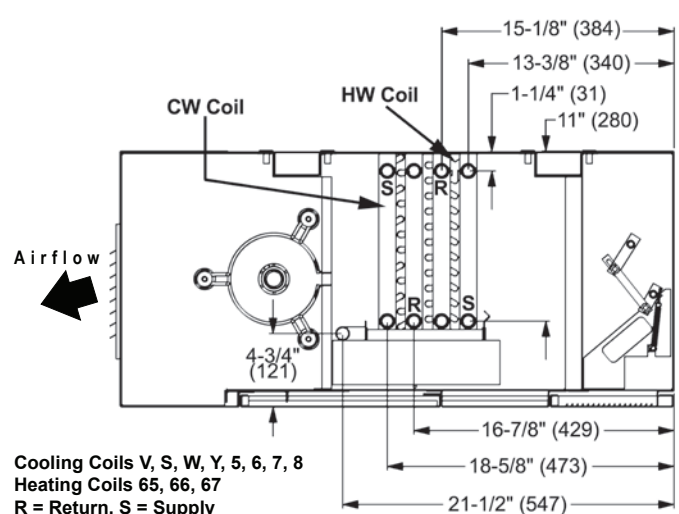


Coils U, D, E, F, 1, 2, 3, 4  
R = Return, S = Supply

#### Chilled Water and Hot Water Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.

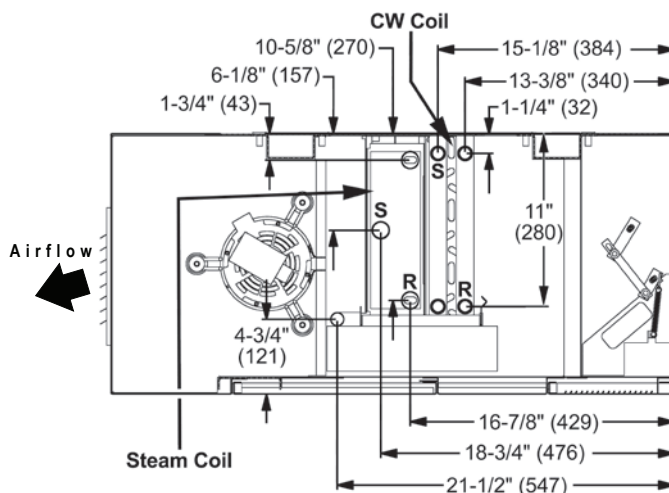


Cooling Coils V, S, W, Y, 5, 6, 7, 8  
Heating Coils 65, 66, 67  
R = Return, S = Supply

#### Chilled Water and Steam Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.

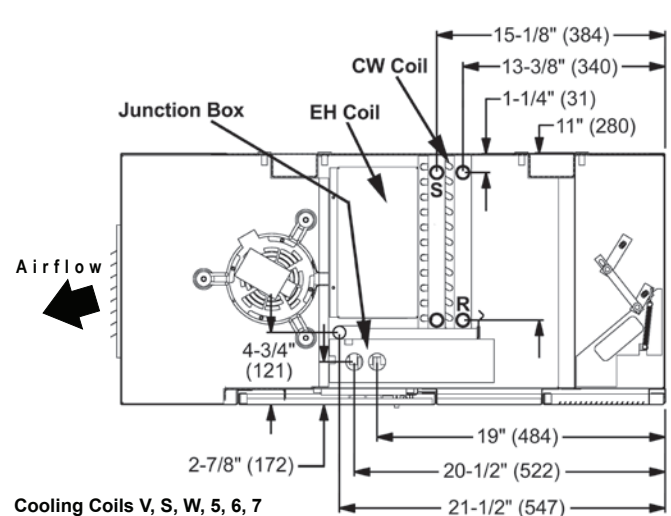


Cooling Coils V, S, 5, 6  
Heating Coils 68, 69  
R = Return, S = Supply

#### Chilled Water (1st Position) and Electric Heating Unit (Right-hand)

(Dimensions are the same for Left-hand unit)

Note: Connection hand is determined by facing discharge air grille.



Cooling Coils V, S, W, 5, 6, 7  
Heating Coil 12, 13  
R = Return, S = Supply  
EH = Electric Heat

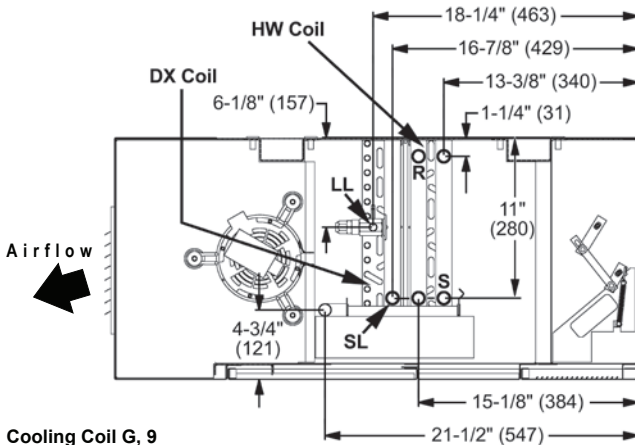
Note: Electric heating coil power connections are right end only. Junction box has 1" (25mm) and 2" (51mm) (trade size) knockouts, 10 1/2" (267mm) from right end of the unit.



## Direct Expansion (DX) and Heating Coil

### Direct Expansion with Hot Water Unit (Right-hand) (Dimensions are the same for Left-hand unit)

**Note:** Connection hand is determined by facing discharge air grille.



Cooling Coil G, 9  
Heating Coils 65, 66, 67  
R = Return, S = Supply  
LL = Liquid Line, SL = Suction Line

**Note:** Direct Expansion (DX) coils have female sweat connections.  
Interconnecting tubing is by others. See table below for correct tubing sizes.

### Heat/Cool Coil Position/Combinations In Air Stream

First Position in Air Stream	Second Position in Air Stream
U, D, E, F, 1, 2, 3, 4	00
65, 66, 67	V, S, G, 5, 6, 9
65, 66	W, 7
65	Y, 8
G, 9, 68, 69	G, 9, 68, 69
V, S, W, 5, 6, 7	12, 13
V, S, 5, 6, 65, 66, 67	G, 9, 68, 69

#### Heating Coils

65 = 1-Row Hot Water Coil  
66 = 2-Row Hot Water Coil  
67 = 3-Row Hot Water Coil  
68 = Low Capacity Steam Coil  
69 = High Capacity Steam Coil  
12 = Low Electric Heat Coil  
13 = High Electric Heat Coil  
00 = None

#### Cooling Coils

U or 1 = 2-Row CW/HW 2-pipe Coil  
D or 2 = 3-Row CW/HW 2-pipe Coil  
E or 3 = 4-Row CW/HW 2-pipe Coil  
F or 4 = 5-Row CW/HW 2-pipe Coil  
V or 5 = 2-Row CW Coil  
S or 6 = 3-Row CW Coil  
W or 7 = 4-Row CW Coil  
Y or 8 = 5-Row CW Coil  
G or 9 = Direct Expansion Coil

### Coil Water Capacities (Gallons/Liters)

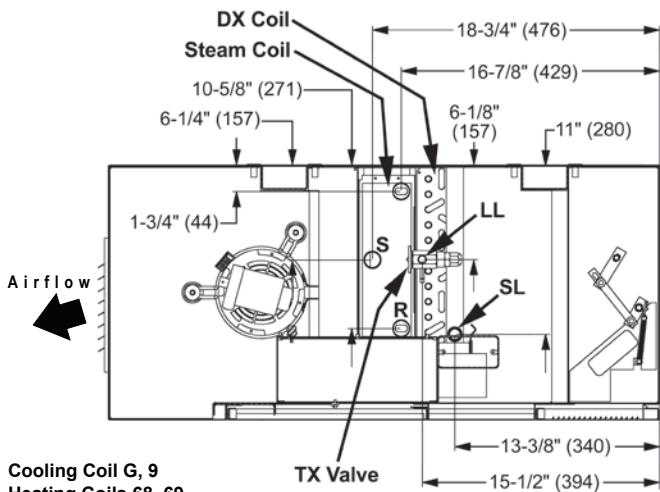
Coil Rows	Unit Series				
	H07 / V07	H10 / V10	H13 / V13	H15 / V15	H20 / V20
	Gallons (Liters)				
1 Row	0.25 (0.95)	0.31 (1.17)	0.38 (1.44)	0.44 (1.67)	0.44 (1.67)
2 Row	0.45 (1.70)	0.57 (2.16)	0.69 (2.61)	0.82 (3.10)	0.82 (3.10)
3 Row	0.64 (2.42)	0.82 (3.10)	1.01 (3.82)	1.19 (4.50)	1.19 (4.50)
4 Row	0.83 (3.14)	1.08 (4.09)	1.32 (5.00)	1.57 (5.94)	1.57 (5.94)
5 Row	1.03 (3.90)	1.34 (5.07)	1.64 (6.21)	1.95 (7.38)	1.95 (7.38)

#### Notes:

- All coils have the same end supply and return connections.
- All water connections are  $\frac{7}{8}$ " I.D. (female) sweat and all steam coils are  $1\frac{1}{8}$ " (female) sweat connections. All coil connections terminate 9" (229mm) from the end of the unit.
- Steam coils have a factory installed pressure equalizing valve and a 24" (610mm) long pressure equalizing line which terminates in a  $\frac{1}{2}$ " M.P.T. fitting.
- Steam/hot water connections may be same end as cooling coil connections, but they are recommended to be opposite end to facilitate piping. (Must be opposite end when using MicroTech® controls.)
- Condensate connection is same end as cooling coil connections, but is field reversible. Drain can be sloped in field.
- All dimensions are approximated.

### Direct Expansion and Steam Unit (Right-hand) (Dimensions are the same for Left-hand unit)

**Note:** Connection hand is determined by facing discharge air grille.



Cooling Coil G, 9  
Heating Coils 68, 69  
R = Return, S = Supply  
LL = Liquid Line, SL = Suction Line

**Note:** Direct Expansion (DX) coils have female sweat connections.  
Interconnecting tubing is by others. See table below for correct tubing sizes.

### Suction Line and Liquid Line Dimensions

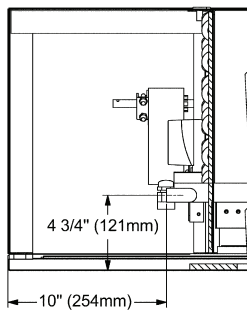
Unit Series	H07 / V07	H10 / V10	H13 / V13	H15 / V15	H20 / V20
	Dimensions are O.D. in inches (mm)				
Suction Line	3/4 (19)	3/4 (19)	7/8 (22)	7/8 (22)	7/8 (22)
Liquid Line	1/4 (6)	1/4 (6)	3/8 (10)	3/8 (10)	3/8 (10)



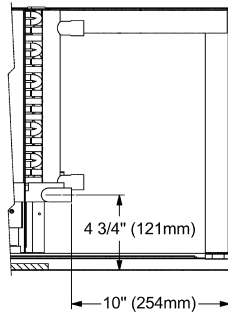
## Condensate Drain – All Units

Dimensions Exclude 1"(25mm) End Panel

Condensate Drain – 7/8" (22mm) I.D. x 1/8" (3mm) Wall, Flexible PVC Tubing



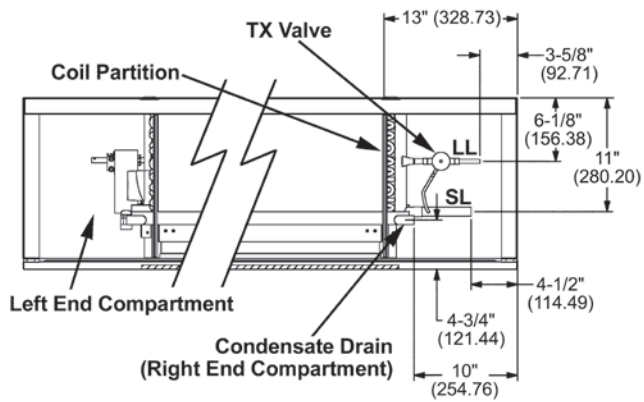
**Front View**  
**Left End Compartment**



**Front View**  
**Right End Compartment**

## Condensate Drain and DX Connection

Dimensions Exclude 1"(25mm) End Panel



Daikin Applied certifies that it will furnish equipment in accordance with this drawing and specifications, and subject to its published warranty. Purchaser's approval to this drawing signifies that the equipment is acceptable under the provisions of the job specifications. Any change made hereon by any person whomsoever is subject to acceptance by Daikin

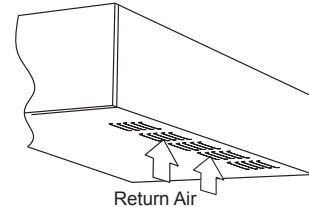
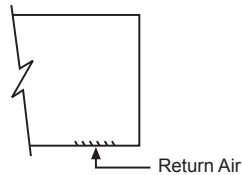
Group: **Unit Ventilator**

Type: **Basic Unit Data**

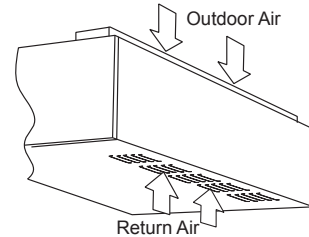
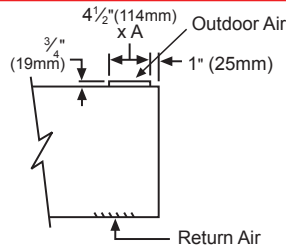
Date: **July 2018**

## Daikin Classroom Ceiling Unit Ventilator Model AHF, AHV, AHR and AHB Inlet Air Arrangements (Check Arrangement That Applies)

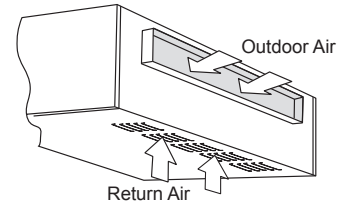
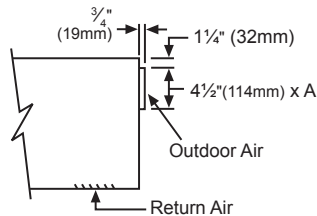
- ☐ **Arrangement 25**  
Recirculating Room Air  
(No Room Air/Outside Air Dampers)



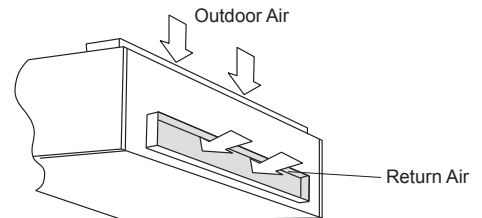
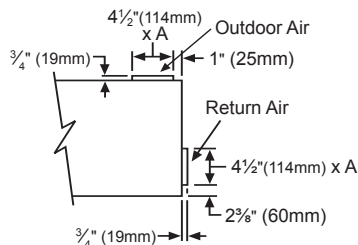
- ☐ **Arrangement 26**  
Return Air Bottom Grille/Outdoor Air  
Top Duct Collar



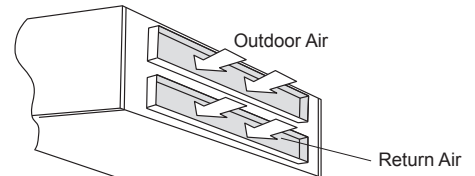
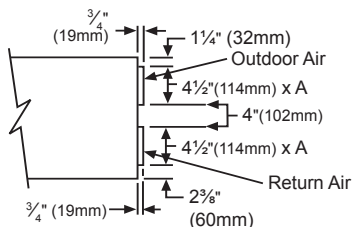
- ☐ **Arrangement 27**  
Return Air Bottom Grille/Outdoor Air  
Rear Duct Collar



- ☐ **Arrangement 28**  
Return Air Rear Duct Collar/Outdoor Air  
Top Duct Collar



- ☐ **Arrangement 29**  
Return Air Rear Duct Collar/Outdoor Air  
Rear Duct Collar



### Dimensions

Unit Series		07	10	13	15	20
A	inches	36	48	60	72	72
	mm	914	1219	1524	1829	1829

### Notes:

- For all recessed applications (full or partial) it is necessary to carefully examine both the inlet air and the discharge air physical locations. This must be done for each location individually and in combination with each other to ensure they are compatible with the specific installation.
- Duct collars shipped loose for field installation not by Daikin Applied.
- It is important also to verify there is sufficient clearance to open and remove the bottom access panels and end panels for routine maintenance.
- All dimensions approximated.



## Duct System Considerations

### Duct Design for Noise and Vibration Control

Proper acoustics is often a design requirement for schools. Most of the problems that are associated with HVAC generated sound can be avoided by properly selecting and locating the components of the system. There are some general do's and don'ts:

The following suggestions are required to reduce the amount of sound and noise due to vibration that reaches the occupied room:

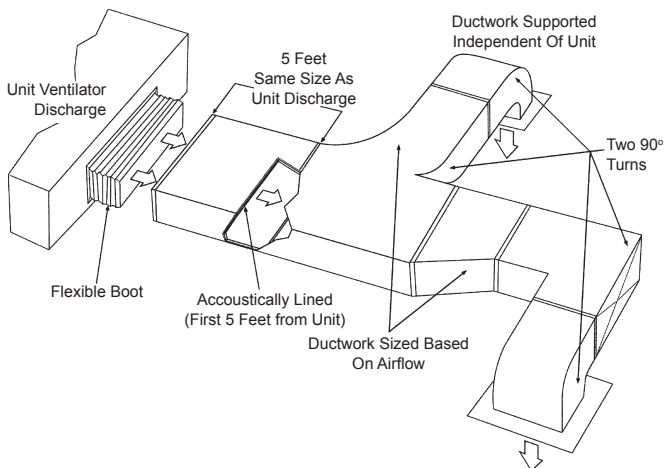
- Use flexible duct connections.
- Make the discharge duct the same size as the unit discharge opening for the first five feet.
- Line the first 5 feet of the supply duct.
- Make two 90-degree turns in the supply and return ducts.
- Keep duct velocity low and follow good duct design procedures.
- Mount and support the ductwork independent of the unit.
- Line the first five feet of the return duct.
- Locate the return air intake away from the unit discharge.
- Provide multiple discharges.
- Restrict use of high pressure drop flexible ducting.
- Size the outdoor air and return air ducts to handle 100% of the total cfm to accommodate economizer or morning warm-up operation.

### NOTICE

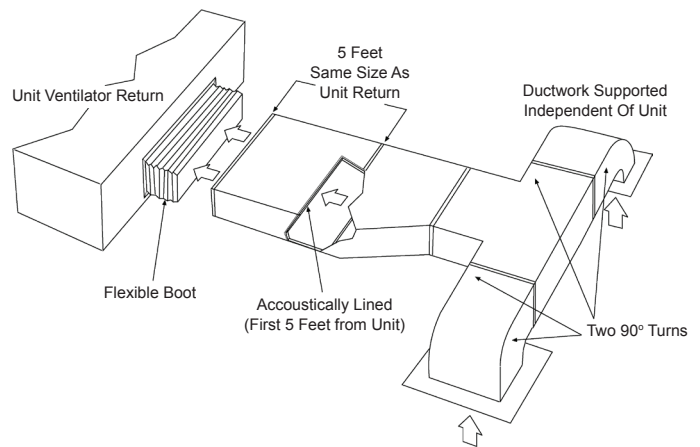
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Sound control applies to the return side of the duct design as well as the supply side. The top-right illustration suggests installation of an intake/return-air duct. Note the return air opening, the sizing and changes in direction of the ductwork. The outdoor air intake and insulated duct work illustration at the lower-right suggests installation of outside air ducting.

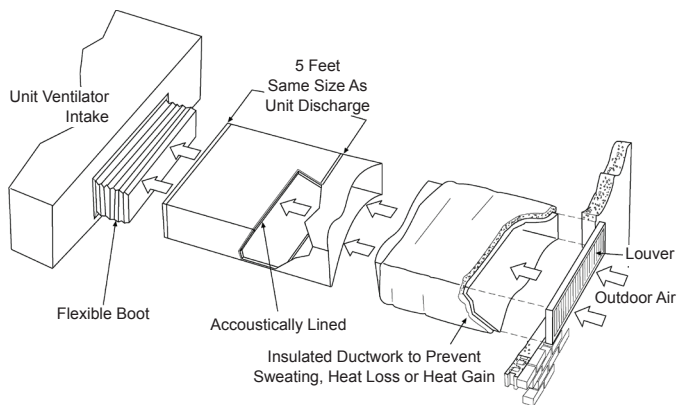
### Discharge Air Duct Work



### Intake/Return Air Duct Work



### Outdoor Air Intake and Insulated Duct Work



### NOTICE

These are general suggestions and offered only to stress their importance; however, there are additional important factors that must be considered. Assistance in the design of ductwork can be found in the ASHRAE Handbook and SMACNA publications, as well as other recognized authorities.



# Specification for Unit Ventilator AVAH ALL

## PART 1: GENERAL

### 1.01 WORK INCLUDED

- A. The contractor shall furnish and install packaged unit ventilator systems, of the capacities, performance, and configuration, as indicated in the unit schedule. Each unit shall be complete with factory furnished components and accessories as shown in the plans and as specified herein.
- B. Electrical work required as an integral part of the temperature control work is indicated on the mechanical drawings, and is the responsibility of the HVAC contractor to hire the services of a temperature control contractor and/or system integrator contractor to provide a complete system to perform the sequence of operation shown, or as described in this specification. The full sequence of operation must be provided and installed by this contractor for all trades.

### 1.02 SUBMITTALS

- A. Submit schedule for all types, sizes and accessories. Schedule shall include certified performance data, room locations and all operating data.
- B. Submit shop drawings for all units including all dimensional information, construction details, installation details, required opening sizes, roughing locations for piping and electrical work and accessory equipment. Equipment must meet specifications. Where deviations from the specifications exist, they must be identified.
- C. Provide field wiring diagrams for all electrical power and temperature control field-wiring connections.
- D. Submittals shall also include complete operating and maintenance instruction manuals and unit specific replacement parts lists.

### 1.03 QUALITY ASSURANCE

- A. Unit ventilators shall be listed by Underwriters Laboratories Inc. (U.L.) for the United States and Canada.
- B. Motors shall conform to the latest applicable requirements of NEMA, IEEE, ANSI, and NEC standards.
- C. Unit ventilation rate to be certified and tested per Air Conditioning and Refrigeration Institute (ARI) standard 840.
- D. Unit to be certified and labeled compliant with the seismic design provisions of the International Building Code (IBC) Chapter 16 and independent test agency requirements of Chapter 17.

## PART 2: PRODUCTS - Unit Ventilators

### 2.01 Cabinet and Chassis:

- A. Unit frames shall be of unitized, welded construction, with structural elements aligned in an assembly jig prior to welding, to insure proper dimensions, rigidity, and squareness. Frames assembled with mechanical fasteners shall not be acceptable.
- B. Internal sheet metal parts shall be constructed of galvanized steel to inhibit corrosion.
- C. Exterior cabinet panels shall be fabricated from furniture grade steel of not less than 16 gauge steel with no sharp edges and no unsightly screw heads and shall receive an electro-statically applied powder paint, and be oven baked with environmentally friendly thermosetting urethane powder finish to provide a high quality appearance. Finish color shall be as selected by Architect from manufacturer's standard colors.
- D. Exterior cabinet panels shall be fabricated from furniture grade steel of not less than 18 gauge steel with no sharp edges and shall receive an electrostatically applied powder paint, and be oven baked with environmentally friendly thermosetting urethane powder finish to provide a high quality appearance. Finish color shall be off- white.
- E. The interior areas of the unit ventilator shall be insulated for sound attenuation and to provide protection against condensation of moisture on or within the unit. The unit shall be provided with an ultra-quiet sound package consisting of acoustically matched low speed fans to fan housing, sound barrier insulation material (non-fiberglass) adhered to the bottom underside of the unit top panel, sides of the fan section and sound absorbing insulation (non-fiberglass) material applied to the unit front panel.



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- F. Units shall be constructed so that testing and troubleshooting can be accomplished in the end pockets of operating units, without affecting the normal air flow patterns through the unit.
- G. Each unit shall be provided with a non-fused power interrupt switch that disconnects the main power to the unit for servicing or when the unit is to be shut down for an extended period of time. The fan motor and controls shall have the hot line(s) protected by factory installed cartridge type fuse(s).
- H. The manufacturer shall have published cataloged sound data available for the engineer's review. Sound data shall have been conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32. Sound test data shall be based on standard cfm at standard air (fixed density of air at 70F) in accordance with ARI procedures based upon ARI 350. The engineer shall have the right to reject equipment not conforming to the specified manufacturer's sound data, as a minimum.
- I. The manufacturer shall have published cataloged sound data available for the engineer's review. Sound data shall have been conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32. Sound test data shall be based on standard cfm at standard air (fixed density of air at 70F) in accordance with ARI procedures based upon ARI 350. The engineer shall have the right to reject equipment not conforming to the specified manufacturer's sound data, as a minimum.

### 2.02 Floor Units:

- A. Floor mounted units shall have an integral pipe tunnel for convenient crossover of piping and a built-in metal wire raceway from right end compartment to left end compartment to contain any line voltage electrical wiring separate from the air stream. Line voltage wiring shall not be touchable in the air stream of the unit during normal maintenance procedures of oiling bearings or motors. Unit shall come standard with a factory installed and wired disconnect switch.
- B. Unit top surface shall be supplied with a charcoal bronze textured finish, to resist scuffing, reduce glare and help hide fingerprints. Unit top shall have two access doors, one at each end (for access to motor and bearings for easy servicing). The front and ends shall be available in a selection of architecturally pleasing colors by the manufacturer, for selection by the Architect.
- C. Unit discharge grille shall be constructed of continuous rounded edge steel bars to provide 10 degree vertical deflection. A 1/4" painted, galvanized mesh screen shall be provided beneath the discharge grille to protect against objects being dropped through the discharge grille.
- D. The unit top and grille shall be of a modular construction so that it is removable for service and maintenance.
- E. The unit front surface shall be comprised of three separate removable panels. The controls and piping shall be accessible without removing the entire front panel. Panels shall be secured to the unit with recessed, tamper resistant, Allen head fasteners. Slots for flat head screwdrivers shall not be acceptable as tamper resistant.
- F. An extended cabinet depth unit, 21 7/8" deep, shall incorporate a full adapter back with closed pipe tunnel with the same features of the standard cabinet depth units with the additional capability of bringing in fresh air from 1" to 28" from the floor. The unit top, back and vertical adapter back partitions shall be insulated and sealed to form a thermal barrier. The vertical and horizontal insulated metal extensions shall have a 1" wide compressible gasket to form an airtight seal between the wall and the unit. A field removable horizontal support plate between the unit bottom and top to achieve the 1" to 28" fresh air access shall not be acceptable.

### 2.03 Ceiling Units (Ceiling units shall be similar in construction to floor units, with the following additional features):

- A. ---NO TEXT---
- B. Three bottom panels, two of which are hinged, shall be provided for ease of service access and handling. Retainer chains shall be provided to prevent sudden release of the hinged bottom panels. End panels shall be secured to the unit with recessed, tamper resistant, Allen head fasteners. Slots for flat head screwdrivers shall not be acceptable as tamper resistant.
- C. Ceiling mounted units shall have a built-in metal wire raceway from right end compartment to left end compartment to contain any line voltage electrical wiring separate from the air stream. Line voltage wiring shall not be touchable in the air stream of the unit during normal maintenance procedures of oiling bearings or motors.

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- D. The discharge opening of the unit shall be fitted with a duct collar.
- E. A ceiling trim flange shall be provided for recessed units. The trim flange shall be 3-sided or 4-sided as required.
- F. The centerline of the cooling condensate drain shall be a minimum of 4" above the bottom of the unit to allow for appropriate trapping of the condensate disposal line.

### 2.04 Coils:

- A. Coil assembly shall be of a modular construction so that it is removable from the bottom of the unit.
- B. Coil assembly shall be of a modular construction so that it is removeable from the front of the unit.
- C. All coils shall be installed in a draw through position to assure uniform air distribution over the full-face area of the coil, and an even unit discharge temperature.
- D. All heating and cooling coils shall be constructed with copper tubes and mechanically bonded aluminum corrugated plate type fins. All coils shall have aluminum individual unshared fin surfaces. An air break shall exist between coils.
- E. Water heating and cooling coils shall be furnished with a threaded drain plug at the lowest point and a manual air vent at the high point of the coil. A factory installed low temperature freeze-stat shall be provided on the leaving edge of the water heating coil in a wave-like configuration to sense multiple locations and shall react to possible freezing conditions. The unit-mounted controls shall incorporate this device.

### 2.05 Drain Pan

- A. All units (either heating only, heat/cool, cool only or reheat) shall come furnished with an insulated drain pan constructed of stainless steel. A drain outlet shall be provided on both ends of the drain pan with one outlet capped. The drain hand of connection shall be easily field-reversed by relocating the cap to the opposite end without disassembly of the unit or movement of the unit drain pan.
- B. The drain pan shall be able to be sloped in either direction for proper condensate removal.
- C. Drain shall be provided with a secondary, overflow drain connection on both ends of the pan.

### 2.06 Fans and Motor:

- A. The fan and motor assembly shall be of a low speed design to assure maximum quietness and efficiency.
- B. Fans shall be double-inlet, forward-curved, centrifugal type with offset aerodynamic blades. Fans and shaft shall be statically and dynamically balanced as an assembly in the unit before shipment.
- C. Fan housings shall be constructed of galvanized steel incorporating logarithmic expansion for quiet operation. Fan and motor assembly shall be of the direct drive type. Belt drive fans shall not be allowed.
- D. Motors shall be 115 volt, single phase, 60Hz, ECM with auto reset internal thermal overload device designed specifically for unit ventilator operation. Motors shall be located out of the conditioned air stream.
- E. High Static units with external static pressures (ESP) up to 0.45 shall utilize an Electrically Commutated Motor (ECM).
- F. All components of the fan/motor assembly shall be removable from the bottom of ceiling mounted units.
- G. All components of the fan/motor assembly shall be removable from the top of floor-mounted units.
- H. Units shall have sleeve type motor and fan shaft bearings, and shall not require oiling more than annually. All bearings shall be located out of the airstream. Bearings in the air stream are not acceptable.
- I. ECM Motor speed shall be factory programmed for three (3) speeds, HIGH-MEDIUM-LOW-OFF (not accessible from the exterior of the unit). Fan motor shall have hot leg protected by a factory installed cartridge fuse.

### 2.07 Face & Bypass Damper:

- A. Each unit shall be provided with a factory-installed face and by-pass damper, constructed of aluminum. The long sealing edges of the damper shall have silicone rubber impregnated cloth seals for long life and positive sealing. Face and bypass dampers without sealing edges to prevent air bypass shall not be acceptable. The damper ends shall have blended mohair seals along the ends glued to the damper end for a positive seal. Plastic clip-on brush end seals shall not be acceptable as an end seal. The unit design shall incorporate the face and bypass damper to prevent coil



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surface wiping and be before the fan in a draw-thru configuration. The face and by-pass damper shall be arranged to have a dead air space to minimize heat pick-up in the by-pass position.

B. Each unit shall be provided with a factory-installed face and by-pass damper, constructed of aluminum. The long sealing surfaces of the damper shall seal positively against stops fitted with extruded EPDM rubber seals. Face and bypass dampers without sealing edges to prevent air bypass shall not be acceptable. The damper ends shall have blended mohair seals along the ends glued to the damper end for a positive seal. Plastic clip-on brush end seals shall not be acceptable as an end seal. The unit design shall incorporate the face and bypass damper to prevent coil surface wiping and be before the fan in a draw-thru configuration. The face and by-pass damper shall be arranged to have a dead air space to minimize heat pick-up in the by-pass position.

### 2.08 Outdoor & Room Dampers:

A. Each unit shall be provided with separate room air and outdoor air dampers.

B. The room air damper shall be two-piece, double-wall construction fabricated from aluminum, and be counterbalanced against backpressure to close by gusts of wind pressure, thereby preventing outdoor air from blowing directly into the room.

C. The outdoor air damper shall be two piece, double wall construction fabricated from galvanized steel, with ½" thick, 1½ lb. density glassfiber insulation encapsulated between the welded blade halves for rigidity and to inhibit corrosion. The outdoor air damper shall have additional foam insulation on the exterior surface damper blade and on the ends of the outdoor air chamber. A single blade damper, which can be twisted and will leak air, will not be considered.

D. Dampers shall be fitted with blended mohair seals along all sealing edges. Pressure adhesive sponge neoprene or plastic clip-on brush type sealers for damper seals are not acceptable. Rubber type gasket using pressure adhesive for fastening to metal and exposed to the outside air is not acceptable.

E. Dampers shall use the turned-metal principle on long closing ends with no metal-to-metal contact for proper sealing.

F. The damper shaft shall be mechanically fastened to the blade, and shall operate in bearings made of nylon or other material which does not require lubrication.

### 2.09 Filter:

A. Each unit ventilator shall be equipped with a one-piece filter located to provide filtration of the return air/outdoor air mixture, in lieu of separate filters for each air stream. The entire filter surface must be useable for filtration of 100% room air or 100% of outdoor air. The filter shall be easily accessible from the bottom, and removable in one piece without removal of the unit return air damper stop. The unit shall ship with a factory installed 1" thick fiberglass, single-use type.

B. Each unit ventilator shall be equipped with a one-piece filter located to provide filtration of the return air/outdoor air mixture, in lieu of separate filters for each air stream. The entire filter surface must be useable for filtration of 100% room air or 100% of outdoor air. The filter shall be easily accessible from the front, and removable in one piece without removal of the unit return air damper stop. The unit shall ship with a factory installed 1" thick fiberglass, single-use type.

C. Spare filters shall be (SELECT):

1. 1" thick fiberglass, single-use type.
2. 1" thick permanent wire mesh washable.
3. 1" thick permanent metal frames with replaceable media.

### 2.010 Control Components:

A. The hot water or steam heating coil shall use a factory selectable, field installed, end of cycle control valve to control the heating medium during the heating cycle. Upon a power failure, the heating valve shall spring return to the normally open position for flow of water. Valves without spring return to the normal position upon a power

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failure shall not be acceptable. The valves shall be of the 2-way or 3-way configuration as specified in the valve specifications.

B. Each unit ventilator shall be furnished capable of accepting direct coupled damper actuators and, if a hot water coil is furnished, with a factory installed low temperature freeze-stat provided on the leaving edge of the water heating coil in a wave-like configuration to sense multiple locations and shall react to possible freezing conditions. The temperature control contractor shall be responsible for the proper operation of controls to prevent damage of any unit ventilator components while ensuring comfort.

### 2.011 Control Functions:

A. The Unit Ventilator Digital Controller (here after referred to as UVC) shall support ASHRAE Cycle II operation. The control cycle shall be used to maintain the required minimum amount of ventilation whenever possible, which can be increased during normal operation for economizer cooling, but can also be reduced to prevent excessively cold discharge air temperatures.

B. Cool Mode:

### 2.012 Unit Ventilator Options / Accessories:

#### A. Draft/Stop Window-Down Draft Protection

1. Where indicated, the floor mounted unit ventilators shall be designed for use with, and provided with Draft/Stop window down draft protection system, installed continuously under the sill. Unit ventilators shall be designed to accommodate either Draft/Stop wall enclosures or Draft/Stop accessory cabinets.
2. Where indicated, the unit ventilator supplier shall provide wall hung enclosure fronts for under sill mounting, flush with the top of the unit ventilator. Each enclosure shall have (SELECT one) [extruded aluminum inlet grilles] [stamped inlet grilles] located in the enclosure top, and adjustable dampers below the grille for final airflow adjustment. Enclosure front and bottom panels shall be solid, and finished to match the unit ventilator finish. All sleeves, wall mounting plates, and end caps shall be provided to complete the installation.
3. Where accessory cabinets are indicated, the window down draft protection system shall be an integral part of the storage cabinets.

#### B. Ventimatic Shutter (Room Exhaust)

1. Where indicated, the unit manufacturer shall provide a passive (non-powered) "in-room" air pressure relief Ventimatic shutter, mounted on a separate wall louver to prevent excessive static pressure. The Ventimatic shutter shall use gravity for preventing outside air from blowing into the room and shall be made of a temperature resistant glass fabric impregnated with silicone rubber for flexibility. The fabric shall retain its original properties down to -50F.

#### C. Classroom Matching Accessories

1. Furnish and install in accordance with manufacturer's printed instructions, matching accessories; shelf cabinets, sink and bubbler cabinets, and filler sections, where indicated on the plans. Colors to match the unit ventilator. All accessory section to be with draft-stop system where the unit ventilator is so indicated. Shelving lengths to be scaled from drawings. Top of shelving to be made of Formica. Sinks to be stainless steel. All sections to have adjustable kick plates, and leveling legs and slots for spline attachment to the unit ventilator matching edges.

#### D. Outdoor Air Intake Louver: Outdoor air intake louver shall be provided by unit ventilator manufacturer except as otherwise noted on the drawings. (SELECT one:)

1. Masonry wall intake louver shall be constructed with horizontal chevron type blades. Provide weep holes in the louver frame and diamond pattern expanded aluminum bird screen on the interior side. Louver shall be fabricated of extruded aluminum 6063-T5. The intake assembly and frame shall be 16 ga. horizontal chevron type aluminum blades in a 12 ga. frame, with (SELECT) [1. unfinished capable of field painting], OR [2. manufacturer's oven baked powder paint finish and color for selection by the Architect], OR [3. clear anodized finish].
2. Panel wall or masonry wall intake louver shall be constructed with vertical blade double brake type blades. Provide weep holes along face of bottom frame and diamond pattern expanded aluminum bird screen on the interior side. Louver shall be fabricated of extruded aluminum 6063-T5. The intake assembly and frame shall be

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16 ga. vertical blade double brake type aluminum blades in a 14 ga. frame, with (SELECT) [1. unfinished capable of field painting], OR [2. manufacturer's oven baked powder paint finish and color for selection by the Architect] OR, [3. clear anodized finish].

3. (optional) Where indicated, each intake louver assembly shall be furnished with a matching four sided flange around the perimeter of the opening of same material and finish as louver.

4. (optional) Where indicated, each intake louver assembly shall be furnished with a decorative aluminum intake grille with square holes to match the louver opening, maximizing the air opening. The grille shall come with holes for mounting to building exteriors. The grille shall be of same material and finish as the louver.

E. SD Card: An optional SD card shall be available as a factory installed option, to be used to collect trend data.

### 2.013 Basis of Design:

A. By Daikin.

B. Acceptable Alternates:

1. With prior approval only. Submit detailed listing of all variations in form, fit, or function, in addition to specified submittal data for approval before bidding. Equipment or manufacturers not listed in this specification shall not be acceptable or approved for installation. Provide required information as specified in Section 01350.

## PART 3: EXECUTION

### 3.01 INSTALLATION

A. Install all equipment in strict accordance with manufacturer's instructions and so as to be compatible with the intent of the respective system performance requirement.

B. The System Integrator/Controls contractor shall be responsible for the integration of all factory provided unit mounted controls and unit communications as required/specified for unit integration into the Building Automation System and proper unit operation.

C. Contractor shall clean each unit and accessory section of construction dust and debris, prior to turning systems over to the owner.

D. Contractor shall install clean filters in each unit at time of system commissioning, and shall deliver to the owner one complete set of spare filters, and one spare motor of each type used in the project.

E. System Integrator/Controls contractor shall be responsible for the integration of all factory provided unit mounted controls and unit communications as required/specified for unit integration into the Building Automation System and proper unit operation.

F. Installer shall engage the services of manufacturer's factory trained service technician to provide check, test, and start-up of each unit ventilator system.

G. Contractor shall provide one-year warranty for furnishing parts and labor for replacing any part of the unit ventilator or accessory sections, which becomes defective in operation. Unit ventilator manufacturer's representative shall maintain a local stock of replacement parts to support the systems specified herein.

H. Contractor shall submit a completed "Check Test and Start Sheet" for each Unit Ventilator installed for verification of proper installation and start up.