

Bidding and Contract Requirements
Addendum No. 1

Date: May 30, 2017

To: Plan Holders

Subject: Addendum No. 1 to the Bidding Documents for:

Brookens Pod 200
2 Multi-Zone RTU Replacement
Champaign County Administrative Services
1776 East Washington Street
Urbana, Illinois 61801

Addendum No. 1 becomes a part of the bidding and contract documents and modifies the original bidding documents, dated May 4, 2017. Acknowledge receipt of Addendum No. 1 in the space provided on Bid Form. **FAILURE TO DO SO MAY SUBJECT BIDDER TO DISQUALIFICATION.**

Specifications

1. Section 23 0500 - Common Work Results for HVAC
 - a. Delete in its entirety and replace with the attached.
2. Section 23 0510 - Heating, Ventilating and Air Conditioning
 - a. Delete in its entirety and replace with the attached.
3. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment
 - a. Add the attached Section 23 0529.
4. Section 23 0593 - Testing, Adjusting and Balancing for HVAC
 - a. Delete in its entirety and replace with the attached.
5. Section 23 0700 - HVAC Insulation
 - a. Add the attached Section 23 0700.
6. Section 23 7416.13 - Custom New Roof Mounted Air Conditioning Replacement
 - a. Page 23 7416.13-1, Paragraph Part 2 - Products-Approved Manufacturers: Add Paragraph 5. as follows:
 5. Air Zone International.

Drawings

1. Sheet MED-01 - Partial Plan - Pod 200 - Mech / Elec - Demo
 - a. Add the following General Notes
 6. The HVAC Contractor shall remove and reinstall existing lay-in ceilings in Room 215 at the access locations above Room 216 and in the Mail Room and Equipment Room in Area 209. Coordinate relocation and provide protection of all equipment in these spaces during demolition and new work.

7. The HVAC Contractor shall partially drain down existing hot / chilled water system to install new isolation and balance valves in the existing locations above the concrete ceiling of 216.



8. The HVAC Contractor shall protect roof during demolition and new work.



9. Provide Flooring protection and install dust partitions and barriers as required during demolition and new work to protect existing finishes and building occupants. Coordinate with Owner.

2. Sheet ME-01 - Partial Plan - Pod 200 - Mech / Elec - New Work

a. Add the following General Notes:

10. The new multi-zone rooftop manufacturer shall field verify exact duct and curb dimensions prior to submittals. The new unit shall match the existing zone layout and unit footprint.
11. Cut and patch wall between Room 216 and Room 209 as required for routing new hot water and chilled water lines to RMZ-3 and RMZ-4.

- b. Add note to the partial roof plan - "Provide condensate drains on the southwest side of RMZ-3 and RMZ-4. Route drain away from the roof hatch."

Bids are due Thursday, June 1, 2017 at 2:00 p.m. prevailing time at Lyle Shields Conference Room, Brookens Administrative Center, 1776 East Washington, Urbana, Illinois 61802.

Respectfully submitted,

GHR Engineers and Associates, Inc.

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JGM/smh

Addendum No. 1.wpd

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. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. 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-dieneterpolymer 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."

1.8 HAZARDOUS MATERIALS

- A. No asbestos-containing materials may be used anywhere on this project.

- B. No lead-based materials may be used anywhere on this project.

1.9 LOCATION OF EQUIPMENT

- A. The approximate location of all equipment and pipe is shown on the drawings.
- B. Architect / Engineer may change the location of any equipment or piping 5' in any direction without these changes being made the subject of an extra charge provided such changes are made before final installation.
- C. Where offsets in piping, additional fittings, necessary drains, minor valves, traps, devices, etc., are required to complete the installation, to clear obstructions or the work of other Contractors or for the proper operation of the system, these shall be deemed to be included in the Contract and shall be furnished and installed complete by the Contractor at no additional charge.

PART 2 - PRODUCTS

2.1 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.

2.2 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 maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- 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, BAg1, 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.

2.3 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- 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.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

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: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 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 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.
- E. 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.

1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.5 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.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch 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.

2.7 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 and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated and rough brass.
- 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.

2.8 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, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 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. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - 6. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - 7. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - 8. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls, 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 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 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.
 - b. Steel Sheet Sleeves: For pipes NPS 6 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 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.
- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches 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.
- Q. 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 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.
- R. 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 "Through-Penetration Firestop Systems" for materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- ### 3.2 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 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.

3.3 PIPING CONNECTIONS

- A. **Make connections according to the following, unless otherwise indicated:**
 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. **Wet Piping Systems:** Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 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.

3.5 SPACE PREFERENCE

- A. Coordinate the location and elevation of all work. Verify with all other Contractors to avoid conflicts.
- B. In case of conflicts, the following installation priorities shall prevail:
 - 1. Recessed electric fixtures
 - 2. Sanitary / vent and storm drainage
 - 3. Closed loop water piping
 - 4. Low pressure ductwork
 - 5. Domestic water lines
 - 6. Sprinkler lines
 - 7. Electric conduits
- C. No other work shall have preference over plumbing lines below fixtures.
- D. No other work shall have preference over bus duct or conduit above or below electric switchgear and panels.
- E. No piping conveying fluids shall be installed directly over electrical or elevator equipment.

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 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.

3.8 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

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING
Section 23 0510 – Heating, Ventilating and Air Conditioning

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. HVAC Contractor: Provide and install heating, ventilating and air conditioning systems as shown on the drawings and as specified herein. Work includes but is not limited to the following:

- a. Demolition
- b. Hot water piping
- c. Chilled water piping
- d. Vent piping
- e. Drain piping
- f. Water specialties
- g. Valves and fittings
- h. Flex connections
- i. Testing
- j. Cleaning

B. Work Not Included

1. Materials, equipment or final connections to items of equipment specified or noted on the drawings to be furnished or executed under another contract.

1.2 RELATED WORK

A. Specified elsewhere:

1. Sections: Architectural / Structural and General Work
2. Section 22 00 20 - Mechanical Insulation
3. Division 23 - Mechanical Systems

1.3 QUALITY ASSURANCE

- A. Use only new material and apparatus of the specified design and manufacturer. Furnish all materials in accordance with latest ANSI, AWWA, ASTM, NFPA, AGA, ASME, IBR, UL standards and other applicable standards or codes.

1.4 SUBMITTALS

- A. See Architectural Sections for requirements.

PART 2 - PRODUCTS

2.1 PIPING DATA - HEATING

- A. Install all vents for all of the safety valves, pressure reducing valves and all equipment in this contract requiring such vents. Connect safety valves to vent lines with an open connection made by sliding a larger pipe over the stub from exhaust valve. Unless otherwise shown on the drawings, extend vents through roof and where possible pitch all vent piping to drain into a condensate receiver. Flash all vents through roof with a 12" high roof jack fabricated of 6 lb sheet lead and extend 12" from side of vent in all directions on roof. Provide counter-flashing rain skirt clamped around pipe over top of roof jack.

- B. Pipe and fittings for the various systems shall be as follows:
- C. Hot Water Piping
 - 1. All hot water piping shall be standard weight Schedule 40 black steel pipe with all joints 2½" and larger welded or flanged. Fittings shall be standard weight screwed cast iron or butt-type welding. Accomplish all reductions in horizontal supply pipe size with eccentric reducing fittings installed with top level.
 - 2. At HVAC Contractor's option, type L hard drawn copper tubing with wrought copper fittings may be used in sizes 2-1/2" and smaller. Solder all joints with 95-5 tin-antimony solder. Use dielectric unions at all connections to dissimilar materials.
- D. Chilled Water Piping
 - 1. All chilled water piping shall be standard weight Schedule 40 black steel pipe with all joints 2½" and larger welded or flanged. Fittings shall be standard weight screwed cast iron or butt-type welding. Accomplish all reductions in horizontal supply pipe size with eccentric reducing fittings installed with top level.
 - 2. At HVAC Contractor's option type L hard drawn copper tubing with wrought copper fittings may be used in sizes 2" and smaller. Solder all joints with 95-5 tin-antimony solder. Use dielectric unions at all connections to dissimilar materials.
- E. Vent Piping
 - 1. All vent piping shall be Schedule 40 black steel, with all joints welded. Fittings shall be standard weight butt-type welding of same material as piping.
- F. Drain Piping
 - 1. All above grade condensate drain piping shall be schedule 40 black steel or type DWV copper piping with copper drainage fittings. Minimum size shall be 1½". Provide cleanout plug at all points where piping changes direction.

2.2 HOT WATER SPECIALTIES

- A. Manual air vents in pipelines shall be constructed of short vertical sections of line size piping to form air chamber. See detail on drawings. Provide vents in all high points in piping and at the top of each pipe riser.
- B. Manual air vents at fin tube heating elements, cabinet unit heaters shall be brass needle valves, screwdriver operated (Dole No. 9).
- C. Automatic air vents shall be chrome-plated brass, float type, suitable for maximum system pressure.
- D. Acceptable Manufacturers
 - 1. Dunham-Bush
 - 2. Dole
 - 3. Sarco

2.3 PIPING SPECIALTIES

- A. Provide and install pressure/temperature measuring glands to allow pressure and temperature readings to be taken. Units shall be suitable for 500 psig with

temperatures ranging from 40 to 275°F. Units shall utilize nodel seals. (Minister and Associates, 314 New Salem Street, Park Forest, Illinois 60466 (708) 481-6090). Sisco P/T plugs: MESA Inc. (314) 644-6060. Test Plugs: H.O. Terice Co. TU: HCI 800-313-4822.

B. Provide at the following locations:

1. Chilled water coils
2. Hot water heating coils

2.4 VALVES - HEATING

A. Use valves for all piping systems as scheduled below and locate in main and branch lines and at equipment where shown on the drawings for operation and maintenance of the system.

B. All valves shall be line-sized (same size as line in which they are installed). Exceptions to this requirement may be made for:

1. Control valves.
2. Balancing valves.

C. Install a screwed or flanged union between each valve, within 6" of the valve and any equipment or apparatus which may require service or removal. Arrange piping and valves in such a manner that no piping need be disturbed, except branch to individual equipment or apparatus, when removing or servicing.

D. All valves shall be tight in operation and if any leaks are found, they shall be repacked with best grade of packing to suit service.

E. All risers shall be valved. Branch runouts shall be valved where indicated on the drawings.

F. All bypass valves shall be globe or butterfly type.

G. All shut-off valves 3" and larger shall be either gate valves or butterfly valves.

H. Gate Valves

1. General Shut-off Service - 2" and smaller up to 125 psig

- a. Gate Valves for use in general shut-off service of steam, condensate, water, and oil shall be 125 SWP, 300 WOG, bronze threaded end, rising stem, solid wedge, union bonnet and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	2714
Milwaukee	1151

2. General Shut-off Service - 2½" and larger up to 125 psig

- a. Gate Valves shall be 125 SWP, 200 WOG, cast iron, flanged end bronze trim, rising stem, OS & Y and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	1793
Milwaukee	F-2885-M

3. General Shut-off Service - 2" and smaller over 125 psig
 - a. Gate Valves shall be 200 SWP, 400 WOG, bronze threaded end, rising stem, solid wedge, union bonnet and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	2375
Milwaukee	1153
4. General Shut-off Service - 2" and smaller up to 150 psig
 - a. Gate Valves shall be 200 SWP, 400 WOG, bronze threaded end, rising stem, solid wedge, stainless or monel seat ring, union bonnet and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	2375
Milwaukee	1153
5. General Shut-off and Steam Service - 2½" and larger over 125 psig
 - a. Gate Valves shall be 250 SWP, 500 WOG, flanged end, cast iron, bronze trim, rising stem OS & Y and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	1797
Milwaukee	F-2894-M

I. Globe Valves

1. General Modulating Service - 2" and smaller up to 125 psig
 - a. Globe Valves for use in general modulating service and steam, condensate, water and oil shall be 150 SWP, 300 WOG, bronze threaded end, union bonnet and gland packed disc material shall be compatible to line media.

MANUFACTURER	VALVE NUMBER
Powell	150-A
Milwaukee	590
2. General Modulating Service - 2½" and larger up to 125 psig
 - a. Globe Valves shall be 125 SWP, 200 WOG, flanged end, cast iron, OS & Y, rising stem and bronze trim.

MANUFACTURER	VALVE NUMBER
Powell	241
Velan	0074 C Series
3. General Modulating Service - 2" and smaller over 125 psig
 - a. Globe Valves shall be 200 SWP, 400 WOG, bronze trim, threaded end, union bonnet, gland packed with hard faced stainless seat and disc.

MANUFACTURER	VALVE NUMBER
Powell	110
Milwaukee	592A
4. General Modulating Steam Service - 2" and smaller over 150 psig
 - a. Globe Valves shall be 200 SWP, 400 WOG, bronzed threaded end, rising stem, solid wedge, stainless or monel seat ring, union bonnet and gland packed.

MANUFACTURER	VALVE NUMBER
Powell	2608
Milwaukee	592A

5. General Modulating and Steam Service - 2½" and larger over 125 and 150 psig

- a. Globe Valves shall be 250 SWP, 500 WOG, flanged end, cast iron, rising steam, OS & Y, gland packed and bronze trim.

MANUFACTURER	VALVE NUMBER
Powell	256
Velan	1074C

J. Stop Check Globe Valves

1. Stop check valves for use on high pressure boiler steam outlets shall be as follows:

MANUFACTURER	VALVE NUMBER
Powell	3061
Velan	1034C

K. Butterfly Valves

1. Butterfly Valves for General Shut-Off Service - 2½" and larger up to 125 psig for use with chilled water and condenser water only.

- a. Butterfly Valves shall be of the double-tap, lug-style, cast iron body, with ductile iron discs, seats and seals, type 316, stainless steel shafts, secondary shaft seals and nonmetallic shaft bearings, shall be of EPDM for service to 250°F. Valves shall comply to API 609 and MSS-SP67 for use between ANSI class 125 iron and / or ANSI class 150 steel flange. Operator shafts shall be extended to allow clearance for insulation - 6" and smaller shall be lever operated - 8" and larger shall be gear and handwheel operated. All valves shall seal bubble-tight up to 125 psig.

- b. Install with shafts in horizontal position.

MANUFACTURER	VALVE NUMBER
Keystone	AR2
Grinnell	
Nibco	HPR with EPDM liner (LD-2000)
Watts	BF 03 with EPDM seat
DeZurik	Fig. 660 with EPDM liner
Milwaukee	M-Series

L. Balancing Valves

1. General Shut-off and Balancing Service for listed equipment - 1/2" - 2" up to 125 psig.

- a. The following valves shall be used in general shut-off and balancing service in all run-outs to convectors, unit heaters, radiation, fan coil units, unit ventilators, heaters, induction units, reheat coils, manual control convectors and injection nozzles. Valves shall be capable of a Bubble-Tight Shut Off.
- b. All return branches in hot and chilled water lines shall be furnished with balancing valve.
- c. Provide preformed insulation boots for all balancing valves. Boots shall be provided by valve manufacturer.
- d. These valves shall have infinite setting devices to prevent reopening past present balancing point when valves are used for shut-off

purposes. They shall be threaded end to match piping. Provide key operator and balancing stop.

- e. Valves shall have flow measurement ports to allow balancing. Make sure valves fit in intended space before ordering.

MANUFACTURER	VALVE NUMBER
Armstrong	CBV (with flow measurement ports)
Wheatley	GS (with flow measurement ports)
Tour and Anderson	TA (with flow measurement ports)

- 2. Pipeline shut-off and balancing service for air handling units, pumps and other listed equipment - 2-1/2" - 6" up to 125 psig.

- a. Use also for large piping, air handlers and larger flow.
- b. Double tap lug style bodies shall be used. These valves shall be capable of tight shut-off when in the closed position. Valves shall be complete with locking mechanism that can be set at a balance point so that the valves may be closed and opened, but not opened beyond the preset balance point. Valves shall be furnished with an indicator from 0 to 100% of valve opening. Valve connections shall conform to ANSI standards.

- c. Operator shafts shall be extended to allow insulation to cover the valves or valve manufacturer shall provide preformed insulation boots to match valves.

- d. Valves shall have flow measurement ports to allow balancing.

MANUFACTURER	VALVE NUMBER
Armstrong	CBV (with flow measurement ports)
Wheatley	GS (with flow measurement ports)
Tour and Anderson	TA (with flow measurement ports)

M. Ball Valves

- 1. Ball valves may be used in lieu of gate valves for hot water or chilled water. Ball valves with memory stop may not be used in lieu of balancing valves.
- 2. General Shut-off Service - 2" and smaller up to 125 psig

- a. Ball valves shall be 150 SWP, 400 WOG, full port, two piece bronze threaded or soldered end, blowout proof stem, stainless steel ball, TFE seat rings, and lever handle - fed. spec. MSS-SP-110. All ball valves shall have extended valve stems to allow full thickness insulation to be installed.

MANUFACTURER	VALVE NUMBER
Apollo	70-100-01
Crane	2180
Hammond	805
Watts Regulator	B6000
Jamesbury	351

- 3. General Shut-off Service - 2" and Smaller up to 150 psig

- a. Ball valves shall be 150 SWP, 400 WOG, full port, two or three piece bronze threaded or soldered end, blowout proof stem, stainless steel ball, TFE seat ring, full port lever handle - Fed. MSS-SP-110. All ball valves shall have extended valve stems to allow full thickness insulation to be installed.

MANUFACTURER	VALVE NUMBER
Apollo	77-140-01
Apollo (3pc)	82-140-01
Grinnell (2pc)	3700
Grinnell (3pc))	3810

Nibco (3pc)
Pittsburgh Brass
Worcester

590 or 595
SS-B
411T

2.5 EXPANSION JOINTS (Packless Type)

- A. Furnish and install Flexonics type Tube Turns telescopic expansion joints with 2-ply stainless steel bellows for all piping 2.50" and smaller where shown on drawings, or required for expansion of pipes and space does not permit use of fabricated expansion loops.
- B. Furnish and install Flexonics single or dual flexing, as shown on drawings, Tube Turns or ADSCO controlled flexing packless expansion joints with Type 304 stainless steel bellows for all piping 3" and larger where shown on drawings, or required for expansion of pipes and space does not permit use of fabricated expansion loops.

2.6 FLEXIBLE PIPE CONNECTORS

- A. Furnish and install molded "Teflon" flanged flexible couplings on suction and discharge connection of all piping deflections. Furnish connections complete with companion flanges, grommets limit bolts and monel reinforcing rings.
- B. Connectors shall be suitable for continuous operation at 220°F with pressures of 110 psig.
- C. Acceptable Manufacturers
 - 1. Belmont
 - 2. Garlock Inc.
 - 3. John Dore Co.
 - 4. Mercer
 - 5. Metraflex
 - 6. Resistoflex
 - 7. Flex Flo (Thermatech)
- D. Forward shop drawing submittals to the Architect / Engineer for review.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Pertinent Contractor shall remove all existing materials, system components, accessories and related items that will not be re-used.
- B. HVAC Contractor shall ensure that system is inactive before disabling the system. HVAC Contractor shall ensure that removal of system will not compromise the Owner's operations before removal occurs.
- C. Partial removals shall extend back to nearest active main. Provide and install caps or pipe plugs at main.
- D. No piping shall be left open as a result of demolition operations. Cap or plug all open piping. Crimping is not an acceptable means of capping piping.
- E. Refrigerant associated with demolished systems/equipment shall be reclaimed by HVAC Contractor in accord with applicable regulations. Such refrigerant becomes the property of the HVAC Contractor unless stated otherwise.

- F. All hangers and clamps shall be removed as part of demolition work if they are not re-used.
- G. All removed equipment and materials become the property of the pertinent removing Contractor unless otherwise noted.

3.2 DRAIN LINES

- A. HVAC Contractor shall provide and install a complete drain system from all coil drain pans in all air handling units, fan coils, evaporator coils and cooling coils. On double sloped pans and / or pans with two drain connections provide drains on both sides.
 - 1. Where multiple, stacked cooling coils are used each coil shall have its own drain pan. Provide internal drop tubes from each such pan down to the main drain pan.
- B. All drains shall be trapped. Traps shall be designed to withstand the maximum (positive or negative) pressures imposed on them by service without ponding or retaining water in the pans.
 - 1. Dimension from bottom of pan outlet to trap invert shall be equal to two times unit static pressure (in inches of water) plus unit velocity head (in inches of water).
 - 2. Dimension from bottom of trap to trap outlet shall be equal to two times unit static pressure (in inches of water).
- C. Drain lines shall be the same size as the pan outlet connections.
- D. All drain lines shall slope uniformly to termination point at slope of 1/8" per foot.
- E. Terminate drain lines at floor drains with indirect connection.

3.3 PIPE GUIDES AND ANCHORS

- A. Where expansion joints are used, pipes shall be guided two times on each side of the expansion joint. The guides shall be from 5'-0" and 25'-0" from the anchor unless otherwise noted on drawings. Guides shall be reviewed by the Architect / Engineer and shall be so designed as to prevent pipe movement in any direction except along the axis of the pipe run. Also provide guides on vertical pipes in shafts where indicated.
- B. Anchors shall be constructed of steel, shall be such as to prevent pipe movement in any direction, shall be welded to the pipe and shall be securely fastened to the building structure as reviewed by the Architect / Engineer and shall have sufficient strength to withstand the stress that it will be subjected to by the pipe movement.

3.4 WELDING

- A. If requested, furnish proof of the competency of each welding operator and, at the request of the Architect / Engineer, have all or any of the welding operators pass a standard qualification test such as ASME, AWS or Hartford Insurance Company procedure and tests. See Specification Section 22 00 10.

3.5 PRESSURE TESTS

- A. All testing equipment, labor and accessories shall be provided by the HVAC Contractor.

- B. HVAC Contractor shall disconnect or valve-off all equipment items that could be damaged by testing. All damage resulting from testing shall be the responsibility of the HVAC Contractor.
- C. All tests shall be performed before systems are concealed in building construction by insulation or otherwise made inaccessible.
- D. All leaks shall be repaired. Leaking systems shall be repaired and retested until systems are free of leaks. All damage resulting from leaks shall be the responsibility of the pertinent Contractor.
- E. Tests shall be witnessed by the Architect / Engineer or designated representative.
- F. Submit 3 copies of test reports to Architect / Engineer for record purposes. Tests shall be typewritten, shall be signed by the HVAC Contractor and shall list name(s) of witness(es).
- G. Tests shall be conducted using clear water as the testing media except for refrigeration and compressed air piping. See "Refrigeration piping" for testing of refrigeration piping. Use compressed air for testing of compressed air piping.
- H. All new piping shall be tested by pump pressure to a working pressure of not less than 100 psig. Where operating pressures exceed 50 psig, test pressure shall be two times the working pressure. Test duration shall be two hours for water tests, 8 hours for air tests.
- I. After tests are satisfactorily completed, the piping shall be drained, equipment reconnected and the system made ready for use.

3.6 CLEANING THE PIPING SYSTEMS

- A. At completion of installation and before final capacity tests are conducted, thoroughly clean all grease, oil and dirt from all parts of the new piping in a manner satisfactory to the Architect / Engineer.
- B. Flush entire new steam and condensate system with full steam pressure for a period of two hours.
 - 1. Remove trap interiors during cleaning and temporary piping shall be installed to vent steam to outside.
 - 2. After the steam and condensate systems have been flushed, put system back in normal operation with condensate going to drain for a period of one week.
 - 3. Thoroughly clean all new traps after the plant has been in continuous operation for a period of thirty (30) days. Clean trap interiors and remove all foreign matter.
 - 4. Examine and clean all of the new trap strainers and new strainers for all automatic valves.
- C. Cleaning of Chilled/Hot Water Systems
 - 1. Chilled water and hot water heating systems shall be chemically cleaned by one of the methods outlined below:
 - a. Trisodium Phosphate-Caustic
The system shall be filled with water and for every 100 gallons of system volume, 3 lbs. of trisodium phosphate and 3 lbs. of sodium hydroxide shall be added. This solution shall be circulated for 12 to 24 hours, at 120°F if possible. At end of circulation time begin flushing as outlined below in Section 2. CAUTION: This procedure

shall not be used if metals such as aluminum or galvanized are present in the system. The alternate methods "b" or "c" outlined below shall be used in these systems.

b. Acrysol QR-1086 and Dequest 2010

The system shall be filled with water and for every 100 gallons of system volume, 2 gallons of cleaning concentrate shall be added. The cleaning concentrate shall be prepared as follows. In 100 gallons of water, add the following quantities of chemicals in the following order and mix thoroughly until dissolved. Use a polyethylene drum:

(1)	Acrysol QR-1086 (Rohm & Haas)	41.5 lbs
(2)	Dequest 2010 (Monsanto)	41.5 lbs
(3)	Potassium or Sodium Hydroxide	12.5 lbs

The cleaning solution shall be circulated in the system for 24 to 48 hours, preferably under light heat (120°F). If heat cannot be applied then circulate for 48 hours under ambient conditions. At completion of circulation time begin flushing of system as outlined below in Section 2.

c. Drewspense 4945 / Drewspense 4395

These are preblended proprietary cleaning chemicals. Drewspense 4945 is a combination of polymers, chelate, and a gluconic acid derivative designed to remove iron and copper oxides from the system. Drewspense 4395 is a nonionic surfactant which effectively removes silt, mud, clay, oil and other suspended matter from the system allowing them to be carried out of the system by flushing. To clean a system with this procedure, add 1 gallon of Drewspense 4945 and 1 gallon of Drewspense 4395 per 100 gallons of system volume. If foaming problems develop, the use of an antifoam such as Dow Corning Antifoam A should overcome the foaming tendency of Drewspense 4395. Circulate cleaning solution for 48 hours, at a temperature of 120°F if possible. If heat cannot be applied increase cleaner circulation time to 72 hours. After circulation time begin high velocity flushing as outlined below.

2. A temporary connection to city water with backflow prevention shall be provided to enable high velocity flushing of system. At completion of required cleaner circulation time begin continuous flushing of system while maintaining system full at all times to prevent the introduction of air into the system. Following cleaning, submit samples of system water to independent testing lab to determine if system has been cleaned properly. When cleaning system, ensure that all automatic valves are open to coils so the entire system will circulate and be cleaned. Also remove and clean system strainers following cleaning.

- a. Pertinent Contractor shall be responsible for providing the necessary pumping action to obtain a minimum velocity of 3 ft / sec in the piping being cleaned. Contractor shall be responsible for providing all bypasses and temporary piping necessary to clean the entire system(s).

3. After final cleaning, add 0.5 oz of Nalco 8325 (or approved equal) per gallon of system volume, to provide a nitrite level of 500 to 750 parts per million. This is a glycol compatible blend of corrosion inhibitors and will passivate the cleaned metal surfaces and protect them from corrosion. If filling the system with ethylene glycol, drain only the volume from the system

necessary to allow the introduction of glycol into the system. If glycol is not to be added, this blend of inhibitors must be left in the system.

- a. It may require 5 to 10 times the system volume to adequately flush the system. In order to properly clean a system, a minimum velocity of 3 ft per second must be attained in the system piping. If this velocity cannot be developed then manual cleaning methods will have to be used in those areas where this velocity is not achieved.
4. In systems which require the use of ethylene glycol based antifreeze solutions to prevent possible freezing and bursting of system piping, the glycol used to fill the system shall be as specified elsewhere.
5. Samples submitted to the independent testing laboratory shall meet the following test limits before acceptance of the system.

Chloroform extractables	5 PPM (mg/l) or less
Particulate matter	25 PPM (mg/l) or less on 1.2 micron media
Corrosion inhibitors	500-1000 as Nitrite
Glycol	To percentage as per project specification.

3.7 CIRCULATION (WATER SYSTEM)

- A. Insure a perfect and noiseless circulation of water and air throughout entire new water system, without pounding or air binding, in any part of the system when operating at gauge pressures varying from 1/4 to 75 lbs.
- B. Arrange all piping to drain by gravity. Provide drain valves with hose connections at all low points in the system, in all isolated sections of piping, at the base of all risers and downstream of all isolation valves.
- C. Properly vent all high points in hot water heating and chilled water piping systems.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.

- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
 1. AAA Technology & Specialties Co., Inc.
 2. Bergen-Power Pipe Supports.
 3. B-Line Systems, Inc.; a division of Cooper Industries.
 4. Carpenter & Paterson, Inc.
 5. Empire Industries, Inc.
 6. ERICO/Michigan Hanger Co.
 7. Globe Pipe Hanger Products, Inc.
 8. Grinnell Corp.
 9. GS Metals Corp.
 10. National Pipe Hanger Corporation.
 11. PHD Manufacturing, Inc.
 12. PHS Industries, Inc.
 13. Piping Technology & Products, Inc.
 14. Tolco Inc.
- B. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

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

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.
- 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 beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

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

1. Manufacturers:

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

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

1. Manufacturers:

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

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS ½ to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS ¾ to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS ½ to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS ½ to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS ¾ to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS ½ to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS ½ to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS ½ to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS ¾ to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS ¾ to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS ½ to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS ¾ to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS ¾ to NPS 20, if longer ends are required for riser clamps.

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 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.
- J. 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.
- K. 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.

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 absorb 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 absorb 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 absorb 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.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. 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.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
 - 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 according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING
Section 23 0593 – Piping and Air Systems Testing, Adjusting and Balancing

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Test and Balance Contractor: Test, adjust and balance air and piping systems. Work includes but is not limited to the following.
2. Test and Balance
 - a. Hydronic systems
 - b. Air systems
 - c. Control system tests
 - d. Reports

1.2 RELATED WORK

A. Specified elsewhere:

1. Sections: Architectural / Structural and General Work:
2. Division 23 - Mechanical
3. Division 26 - Electrical

1.3 JOB CONDITIONS

- A. Heating, ventilating, and air conditioning equipment shall be completely installed and in continuous operation to accomplish the testing, adjusting and balancing work specified. Complete air balancing prior to hydronic balancing.
- B. Perform testing, adjusting and balancing when outside conditions approximate design conditions for heating and cooling functions or when the system is operating at design capacity.
- C. The Architect / Engineer may be present during testing and balancing to verify that specified procedures are followed.

1.4 QUALITY ASSURANCE

- A. Testing and balancing shall be performed by independent firms specializing in such work.
 1. The Test and Balance Contractor shall not be related to the Plumbing or HVAC Contractor in any business enterprise.
- B. Only qualified personnel shall perform testing and balancing work.
- C. Submit evidence that the personnel who will perform the testing and balancing of the project systems are qualified personnel for review by the Architect / Engineer prior to performing the work.
- D. Submit a list of completed projects successfully tested and balanced by the submitted qualified personnel for review by the Architect / Engineer, prior to performing the work.
- E. Perform all corrective measures caused by faulty installation. Retest, readjust and rebalance systems until satisfactory results are achieved.

1.5 DEFINITION

A. Qualified personnel are:

1. Personnel who have been certified by one of the following test and balance organizations.
 - a. AABC - Associated Air Balance Council.
 - b. Certified TBAB - Certified Testing, Balancing and Adjusting Bureau.
 - c. NEBB - National Environmental Balancing Bureau, Illinois Chapter.
 - d. SMARTA - Sheet Metal, Air Conditioning & Roofing Contractors Trade Association of Illinois.
 - e. TABIC - Test & Balancing Institute for Certification.

1.6 SUBMITTALS

- A. Submit data sheets on each item of testing equipment for Architect / Engineer review. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors.
- B. Submit a report containing all test data and other related information recorded during testing and balancing, placed on appropriate forms for Architect / Engineer review. Reports shall certify that the methods used and results achieved are as specified.

1.7 REVERIFICATION

- A. During Substantial Completion Inspection, a percentage (not more than 5%) of the recorded data will be subject to reverification by the Architect / Engineer. Take instrument readings as directed. Test points will be in normally accessible locations and randomly selected by Architect / Engineer.

PART 2 - PRODUCTS

2.1 WATER BALANCING INSTRUMENTS

- A. 30" Mercury U-Tube Manometer, 200 psig wwp, with three valve bypass assembly and return wells or mercury check valves.
- B. Inspector's Gauge Testing Set.
- C. Water Differential Pressure Gauge, 4.50" dial.
- D. Pressure gauge measurements points, quick-connect couplings, 1/4" ips.

2.2 AIR BALANCE INSTRUMENTS

- A. Velometer with probes and Pitot tube.
- B. Rotating vane anemometer.
- C. ASHRAE standard Pitot tubes stainless steel 5/16 outside diameter, lengths 18" and 36".
- D. Magnehelic differential air pressure gauges, 0 to 0.5", 0 to 1.0" and 0 to 5.0" water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube.
- E. Combination inclined-vertical portable manometer, range 0 to 5.0" water.

- F. Portable-type hook gauge, range 0 to 12" water.
- G. Portable flexible U-tube manometer, magnetic mounting clips, range 0 to 18" water.
- H. Conical or pyramidal shaped hood.

2.3 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

- A. Insertion thermometers, with graduations at 0.1°F or contact pyrometer.
- B. Sling psychrometer.
- C. Tachometer, centrifugal type.
- D. Revolution counter.
- E. Clamp-on volt-ammeter.
- F. Recorders, portable type for temperature and humidity.

PART 3 - EXECUTION

3.1 DRIVES

- A. All systems shall be provided with new, appropriately sized drives such that the full range of the pertinent VFD's is available for control of duct static pressure.

3.2 AIR SYSTEMS

- A. Test, adjust and balance systems in accord with the following:
 - 1. Preliminary:
 - a. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals. Inspect all system components for proper installation and operation.
 - b. Use manufacturers' ratings for all equipment to make calculations except where field test shows ratings to be impractical.
 - c. Verify that all instruments are accurately calibrated and maintained.
 - d. Install clean filters.
 - 2. Central System:
 - a. Test, adjust and record supply, return fan RPM to design requirements within the limits of mechanical equipment provided.
 - b. Test and record motor voltage and running amperes including motor nameplate data and starter heater ratings.
 - c. Make pitot tube traverse of main supply, exhaust and return ducts, determine and record cfm at fans and adjust fans to design cfm.
 - d. Test and record system static pressure, suction and discharge.
 - e. Test and adjust system for design minimum outside air, cfm.
 - f. Test and adjust systems for design return air, cfm.
 - g. Test and record heating apparatus entering air temperatures, dry bulb.
 - h. Test and record cooling apparatus entering air temperatures, dry bulb and wet bulb.
 - i. Test and record heating apparatus leaving air temperatures, dry bulb.

- j. Test and record cooling apparatus leaving air temperatures, dry bulb and wet bulb.
- 3. Distribution: Adjust zones or branch ducts to proper design cfm, supply and return.
- 4. Air Terminals:
 - a. Identify each air terminal from reports as to location and determine required flow reading.
 - b. Test and adjust each air terminal to within 10% of design requirement.
 - c. Test procedure on air terminals shall include comparison of specified fpm velocity and observed velocity, adjustment of terminal and comparison of specified cfm and observed cfm after adjustment.
 - d. Adjust flow patterns from air terminal units to minimize drafts to extent design and equipment permits.
- 5. Verification:
 - a. Prepare summation of readings of observed cfm for each system, compare with specified cfm and verify that duct losses are within specified allowable range. Determine coil and filter static pressure drops.
 - b. Verify design cfm at fans as described above.

3.3 TESTING, BALANCING AND ADJUSTING

- A. At the completion of the installation of the air distribution systems, the following tests shall be made.
- B. All instruments for testing are to be furnished by this Contractor and must be reviewed by the Architect / Engineer before use on job. All readings shall be recorded on approved forms. All instruments used shall be recently calibrated and same set of instruments shall be used throughout the balancing procedures.
- C. The air distribution systems shall be balanced with the volume dampers, splitter dampers and adjustable air extractors in the duct systems as follows:
 - 1. All air handling equipment in building shall be operating during the balancing procedures. Supply systems with return fans shall be balanced in the 100% outside air position. System shall then be set in minimum outside air position and manual volume damper after automatic return air dampers adjusted to maintain constant supply air volume. Supply systems without return fans shall be adjusted to the minimum outside air position. All filters shall be new and clean. All volume dampers and extractors shall be set at 2/3 open position.
 - 2. Fans shall be adjusted to specified air quantities by using rotating vane anemometer traverse over entering air face of cooling coils in built-up air handling systems, with pitot tube and inclined manometer or a velometer having proper duct jet attachment for traverse at fan inlet.
 - 3. Individual outlets shall be adjusted to specified air quantities using either the "proportional method" starting at last outlet and working towards main or the "trial and error" method, with a velometer having proper attachment or a rotating vane anemometer.
 - 4. Branch ducts (having more than one outlet) shall be adjusted to specified air quantities by using a pitot tube and inclined anemometer or a velometer having proper duct jet attachment for traverse as near to takeoff as practical.

5. Above procedures shall essentially be followed for all systems and shall be repeated until proper balance is achieved throughout systems from -0% to +10% of specified air quantities.
- D. After balance is completed, lock nuts or stop screws shall be installed at all volume dampers and extractors to permit them to be shut-off but prevent opening beyond the set balance position.
- E. For more detailed step-by-step procedures the Balancing and Adjustment Manual for Air Distribution Systems published by Sheet Metal and Air Conditioning Contractors National Association shall be used.
- F. All readings taken throughout the balancing procedure shall be recorded on approved forms and upon completion of balancing and testing shall be "certified" as being correct and submitted for review.
- G. Upon receipt of "certified" balancing forms and letter of certification that all balancing, testing and adjusting is completed in accordance with plans and specifications and that all systems are operating properly, the Architect / Engineer or his designated representative will conduct a balance inspection. Furnish personnel, instruments and equipment as required to assist the Architect / Engineer during this "balance inspection".
- H. If during the above balance inspection any portion of any system is found in improper balance, that entire system shall be rebalanced and a new report submitted. The rebalance shall be checked and if again found in improper balance, this Contractor shall again rebalance and submit report. This procedure shall be repeated until the systems are properly balanced to the satisfaction of the Architect / Engineer.

3.4 HYDRONIC HEATING SYSTEMS

- A. Test, adjust and balance system in accordance with the following requirements:
 1. Preliminary:
 - a. List all mechanical specifications of tested equipment and verify against contract documents. Inspect all system components for proper installation and operation. Clean all screens.
 - b. Open all line valves to full open position. Close coil bypass stop valves, then set mixing control valve to full coil flow.
 - c. For each pump, verify rotation, test, and record pump shut-off head, and test and record pump wide-open head.
 - d. Verify proper water level in expansion tanks and in the system. Verify that system is entirely full of fluid. Vent all air vents.
 - e. Verify that air vents in high points of water systems are installed and operating freely.
 - f. Verify that all instruments are accurately calibrated and maintained.
 2. Central Equipment:
 - a. Set chilled water and hot water pumps to proper flow quantity.
 - b. Adjust flow of chilled water through chiller to design value.
 - c. Adjust flow of hot water through heat exchangers to design quantity.
 - d. Adjust steam pressure at PRV and record at each steam heat exchanger.
 - e. Observe leaving water temperatures and return water temperatures at chiller and heat exchangers. Reset to correct design temperatures.

- f. Record pump operating suction and discharge pressures.
Determine final dynamic head.
- 3. Distribution:
 - a. Balance flow to each chilled water coil and hot water coil.
 - b. Record steam pressure at each steam coil.
- 4. Terminal Units
 - a. Upon completion of flow readings and adjustments at coils, mark all settings and record following data:
 - (1) Inlet water temperatures.
 - (2) Leaving water temperatures.
 - b. Observe fluid pressure drop through coil at set flow rate on call for full cooling and for full heating.
 - c. Set valve in bypass to match coil flow pressure drop on full bypass.
- 5. Verification:
 - a. Record rated and actual running amperage for each pump motor.
Measure and record gpm of all pumps.
 - b. Record total dynamic head for each pump.

3.5 AUTOMATIC CONTROL SYSTEM

- A. The Temperature Control Contractor shall set and adjust automatically operated devices to achieve specified sequence of operation.
- B. Testing organization shall verify all controls for proper calibration and list those controls requiring adjustment by temperature control system installer.

3.6 SYSTEM PERFORMANCE REPORT

- A. After the conclusion of balancing operations, make temporary installation of portable recorders and simultaneously record temperatures and humidity during summer and winter conditions at representative locations in each system.
- B. Architect / Engineer will direct all test locations.
- C. Make recordings during summer and winter for a seven-day period, continuous over a weekend, and including at least one period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition and within 10°F dry bulb temperature of minimum winter design condition.
- D. Report of test results shall include original recording and two reproductions.

3.7 SUBMISSION OF REPORTS

- A. Fill in test results on approved forms.
- B. Submit three certified copies of required test reports to the Architect / Engineer for review.
- C. Include in report a list of instruments used and test date of calibration.

- D. Submittals shall be legibly signed by the individual(s) responsible for the accuracy of the work.

END OF SECTION

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. Provide and install complete insulation systems as shown on the drawings and as specified herein. Work includes, but is not limited to, the following:
 - a. HVAC Contractor: Insulating of:
 - (1) Hot water heating piping
 - (2) Chilled water piping

1.2 RELATED WORK

A. Specified elsewhere:

1. Division 23 - Mechanical Systems

1.3 QUALITY ASSURANCE

- A. Installations shall be by qualified personnel thoroughly trained and experienced in the skills required and completely familiar with the manufacturer's current recommended methods of installation as well as the requirements of the work.
- B. All insulation shall be applied in accordance with MICA "Commercial and Industrial Insulation Standards".

1.4 SUBMITTALS

- A. See Architectural Sections.
- B. Provide submittals for:
 1. Pipe insulation
 2. Equipment insulation
 3. Plastic insulation jacket

PART 2 - PRODUCTS

2.1 INSULATION

- A. Materials of insulation shall be manufactured by Johns-Manville, Schuller, Owens Corning, Knauf, Rubatex, Armstrong, Certain-Teed (acceptable manufacturers will vary depending upon material being specified herein after).
- B. Insulation shall be rigid glass fiber with fire retardant vapor barrier jacket. Insulation of fittings shall be in accordance with manufacturer's recommendations using glass fiber wrapping and formed jacket.
- C. Insulating materials and APT jackets shall conform to latest NFPA and IECC standards with flame-spread rating not to exceed 25 and smoke developed rating not to exceed 50. Vapor barrier jackets shall have a water vapor permeability rating not to exceed .02 perms when tested in accordance with ASTM Standard E-96.

- D. Flexible fire retardant elastomeric thermal insulation for use on refrigerant piping and equipment in cold piping systems (strainers, pumps, special valves) shall be manufactured by Armstrong, Schuller or Rubatek. Insulation shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less. Seal all joints with appropriate adhesive. On equipment, such as strainers, the insulation shall be installed so that those portions of the equipment which require servicing will have removable sections for access.

1. Do not use elastomeric insulation on surfaces that exceed 120°F.
2. Pertinent Contractors shall be responsible for ensuring that use of this material in return air plenums is in full compliance with all codes and is acceptable to the authority having jurisdiction. This matter shall be resolved before shop drawings are submitted.
3. Elastomeric insulation shall not be used on two-pipe heating / cooling.

E. Specialties

1. All hot piping fittings and cold fittings and flanges shall be wrapped with low density glass fiber blanket insulation built up to same thickness as adjacent insulation and wired in place with 20 gauge copper clad annealed wire. Cover with plastic pre-fab jacket and seal joint and end overlaps with white nylon tape.
2. All cold water valves, control valves, unions and other fittings requiring access shall be insulated with elastomeric foam or fiberglass of the same thickness and type as the rest of the system.
3. Covering on all pipe fittings shall be notched on the interior of fittings and shall pass unbroken through hangers and pipe sleeves.
4. Valves, unions, relief valves and strainers shall be insulated.
5. Valves, unions, strainers and flanges in heating hot water piping need not be covered. Insulation shall be tapered back, neatly cemented and covered same as fittings to permit access to the joint, valve and strainer without disturbing covering.
6. Insulation and vapor barrier on cold piping systems shall be continuous and shall prevent condensation and water problems.
7. All piping carrying cold fluid shall be insulated with elastomeric insulation coated with two coats of paintable coating where exposed to UV light indoors. Cover elastomeric insulation with PVC jacket outdoors and where exposed to abrasions in light traffic areas indoors and outdoors.

F. Piping

1. Covering on all piping shall pass unbroken through hangers and pipe sleeves with insulation protection saddles. Molded fiberglass saddles shall be directly adhered to insulation jacket using an appropriate glue.

a. Acceptable Manufacturers:

- (1) Buckaroos, Inc.
- (2) Pipeshield, Inc.
- (3) B-Line Systems, Inc.
- (4) Centerline

2. Where section of water pipe 2-1/2" and larger passes through hangers, provide fiberglass plug inserts to prevent crushing of insulation. Size of pipe shall indicate number of plug to insert, i.e., 2" = 2 plugs, 4" = 4 plugs, etc. Provide 7¼ lbs. density insulation on pipe 2" and smaller extending 6" beyond ends of metal jacket. Insulation shall be of same thickness as specified material. Vapor barrier shall not be damaged.

a. Acceptable Manufacturers:

- (1) Buckaroos, Inc.
- (2) Pipeshield, Inc.
- (3) B-Line Systems, Inc.
- (4) Centerline

- 3. All laps in jacket shall be on top of horizontal pipes and toward the wall in vertical pipes and shall be sealed with staples and flame retardant adhesive. Laps shall be a minimum of 3" at end joints and 1-1/2" on longitudinal joints.
- 4. Insulate the following piping as described below, or as noted on drawings:
- 5. Apply 3-1/2 lb minimum density, 0.27 maximum k factor / inch fiberglass pipe insulation on piping systems.
- 6. Apply 3-1/2 lb minimum density, 0.27 maximum k factor / inch fiberglass pipe insulation on piping systems in accordance with the following:

HWSH - Hot Water Supply Heating
 HWRH - Hot Water Return Heating
 HWRRH - Hot Water Reverse Return Heating

PIPE SIZE	INSULATION THICKNESS
1-1/2" and less	1-1/2"
2" and greater	2"

CHWS - Chilled Water Supply
 CHWR - Chilled Water Return
 CHWRR - Chilled Water Reverse Return

PIPE SIZE	INSULATION THICKNESS
All Sizes	1-1/2"

- 7. Apply elastomeric foam pipe insulation on piping systems in accordance with the following maximum k factor 0.27 / inch:

Cold control valves

PIPE SIZE	INSULATION THICKNESS
All	1-1/2"

- 8. Apply elastomeric foam pipe insulation on piping system in accord with the following maximum k factor 0.27 / inch (can be used in lieu of fiberglass if allowed by Code):

CHWS, CHWR

PIPE SIZE	INSULATION THICKNESS
All Sizes	1-1/2"

- 9. Seal ends of insulation and inside surface of insulation to pipe every 21' on straight runs, at each side of fittings and valves and at all equipment.
- 10. Insulation on piping in concealed locations may use permanently treated (not salt treatment) flame-retardant jacket. Jackets on hot lines in concealed locations may be stapled without use of adhesive as specified above.

PART 3 - EXECUTION

3.1 INSULATING PIPING

- A. Provide all pipe covering, thermal insulation, protective jacketing, saddles, shields and plugs for the systems in their contracts as specified. Work shall be

performed by skilled mechanics regularly engaged in the application of pipe insulation.

- B. No insulation shall be applied until all pressure tests have been successfully completed.

3.2 PIPING OUTDOORS

- A. Pipe insulation installed outdoors shall be protected by:
 - 1. Weathertight aluminum jacketing
- B. Foam pipe insulation installed outdoors shall be protected by aluminum jacketing.

END OF SECTION