

SECTION 23 21 13
HYDRONIC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Water piping to connect HVAC equipment, including the following:
 - 1. Chilled water, condenser water and drain piping.
 - 2. Extension of domestic water make-up piping.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS AND PRODUCT DATA.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 07 11, HVAC INSULATION: Piping insulation.
- E. Section 23 21 23, HYDRONIC PUMPS: Pumps.

1.3 QUALITY ASSURANCE

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS AND PRODUCT DATA.
- B. Manufacturer's Literature and Data:
 - 1. Pipe and equipment supports.
 - 2. Pipe with specification, class or type, and schedule.
 - 3. Pipe fittings, including miscellaneous adapters and special fittings.
 - 4. Flanges, gaskets and bolting.
 - 5. Valves of all types.
 - 6. Strainers.
 - 7. All specified hydronic system components.
 - 8. Water flow measuring devices.
 - 9. Differential pressure transducer
 - 10. Gages.
 - 11. Thermometers and test wells.
 - 12. Refrigerant R-134A monitor

- C. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11 COMMON WORK RESULTS FOR HVAC.
- D. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water and other piping systems and equipment.
 - 1. One wall-mounted stick file with complete set of prints. Mount stick file in the chiller plant or control room along with control diagram stick file.
 - 2. One complete set of reproducible drawings.
 - 3. One complete set of drawings in electronic format (Autocad, pdf, or other approved format).

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - B16.1-98.....Cast Iron Pipe Flanges and Flanged Fittings
 - B16.3-2006.....Malleable Iron Threaded Fittings: Class 150 and 300
 - B16.4-2006.....Gray Iron Threaded Fittings: (Class 125 and 250)
 - B16.5-2003.....Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard
 - B16.9-07.....Factory Made Wrought Butt Welding Fittings
 - B16.11-05.....Forged Fittings, Socket Welding and Threaded
 - B16.18-01.....Cast Copper Alloy Solder Joint Pressure Fittings
 - B16.24-06.....Cast Copper Alloy Pipe Flanges and Flanged Fittings
 - B16.39-06.....Malleable Iron Threaded Pipe Unions
 - B16.42-06.....Ductile Iron Pipe Flanges and Flanged Fittings
 - B31.1-08.....Power Piping
- D. American Society for Testing and Materials (ASTM):
 - A47/A47M-99 (2004).....Ferritic Malleable Iron Castings
 - A53/A53M-07.....Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A106/A106M-08.....Standard Specification for Seamless Carbon
Steel Pipe for High-Temperature Service

A126-04.....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe Fittings

A181/A181M-01.....Standard Specification for Carbon Steel
Forgings, for General-Purpose Piping

A183-03 Standard Specification for Carbon Steel Track
Bolts and Nuts

A216/A216M-08 Standard Specification for Steel Castings,
Carbon, Suitable for Fusion Welding, for High
Temperature Service

A307-07 Standard Specification for Carbon Steel Bolts
and Studs, 60,000 PSI Tensile Strength

A536-84 (2004).....Standard Specification for Ductile Iron
Castings

A 615/A 615M-08.....Deformed and Plain Carbon Steel Bars for
Concrete Reinforcement

A653/A 653M-08.....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-
Iron Alloy Coated (Galvannealed) By the Hot-Dip
Process

B32-08.....Standard Specification for Solder Metal

B61-02.....Standard Specification for Steam or Valve
Bronze Castings

B62-02.....Standard Specification for Composition Bronze
or Ounce Metal Castings

B88-03.....Standard Specification for Seamless Copper
Water Tube

B209 07.....Aluminum and Aluminum Alloy Sheet and Plate

C177 07Standard Test Method for Steady State Heat Flux
Measurements and Thermal Transmission
Properties by Means of the Guarded Hot Plate
Apparatus

C591-08.....Unfaced Preformed Rigid Cellular
Polyisocyanurate Thermal Insulation

D1784 08.....Rigid Poly (Vinyl Chloride) (PVC) Compounds and
Chlorinated Poly (Vinyl Chloride) (CPVC)
Compounds

E. American Water Works Association (AWWA):

C110/08.....Ductile Iron and Grey Iron Fittings for Water
C203 02.....Coal Tar Protective Coatings and Linings for
Steel Water Pipe Lines Enamel and Tape Hot
Applied

F. American Welding Society (AWS):

A5.8/A5.8M-04.....Specification for Filler Metals for Brazing and
Braze Welding
B2.1-02.....Standard Welding Procedure Specification

G. Copper Development Association, Inc. (CDA):

CDA A4015-06.....Copper Tube Handbook

H. Expansion Joint Manufacturer's Association, Inc. (EJMA):

EMJA-2003.....Expansion Joint Manufacturer's Association
Standards, Ninth Edition

I. Manufacturers Standardization Society (MSS) of the Valve and Fitting
Industry, Inc.:

SP-67-02a.....Butterfly Valves
SP-70-06.....Gray Iron Gate Valves, Flanged and Threaded
Ends
SP-71-05.....Gray Iron Swing Check Valves, Flanged and
Threaded Ends
SP-80-08.....Bronze Gate, Globe, Angle and Check Valves
SP-85-02.....Cast Iron Globe and Angle Valves, Flanged and
Threaded Ends
SP-110-96.....Ball Valves Threaded, Socket-Welding, Solder
Joint, Grooved and Flared Ends
SP-125-00.....Gray Iron and Ductile Iron In-line, Spring
Loaded, Center-Guided Check Valves

J. National Sanitation Foundation (NSF):

14 06.....Plastic Piping System Components and Related
Materials

K. Tubular Exchanger Manufacturers Association: TEMA 8th Edition, 2000

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR
HVAC.

2.2 PIPE AND TUBING

A. Chilled Water, Vent and Drain Piping:

1. Piping NSP 4 and large: Steel ASTM A53 Grade B, seamless or ERW, Schedule 40 with cast-iron threaded fittings ASME B16.4, Classes 125; cast-iron pipe flanges and flanged fittings ASME B16.1, Classes 125 and welded flanges joints.
2. Piping NSP 3 and smaller: Copper ASTM B88, Type L with wrought-copper fittings ASME B16.22 and brazed or flanged joints.
- B. Condenser Water:
 1. Piping NSP 4 and large: Steel ASTM A53 Grade B, seamless or ERW, Schedule 80 with cast-iron threaded fittings ASME B16.4, Classes 125; cast-iron pipe flanges and flanged fittings ASME B16.1, Classes 125 and welded flanges joints.
 2. Piping NSP 3 and smaller: Copper ASTM B88, Type L with wrought-copper fittings ASME B16.22 and brazed or flanged joints.
- C. Extension of Domestic Water Make-up Piping: ASTM B88, Type L copper tubing.
- D. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.3 FITTINGS FOR STEEL PIPE

- A. 4 inches and Larger: Welded or flanged joints.
 1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type.
 2. Welding flanges and bolting: ASME B16.5:
 - a. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- B. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets shall not be used for branch connections.

2.4 FITTINGS FOR COPPER TUBING

- A. 3 inches and Smaller: Brazed or Flanged Joints.
 1. Joints shall be made up in accordance with recommended practices of the materials applied.
- B. Bronze Flanges and Flanged Fittings: ASME B16.24.

2.5 DIELECTRIC FITTINGS

- A. Joints between different metallic piping materials, hydronic system components and accessories (valves, strainers, etc.) shall be made with approved dielectric fittings.
- B. 2 inches and Smaller: Threaded dielectric union, ASME B16.39.

C. 2 1/2 inches and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

D. Temperature Rating, 210 degrees F.

2.6 SCREWED JOINTS

A. Pipe Thread: ANSI B1.20.

B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.7 VALVES

A. Asbestos packing is not acceptable.

B. All valves of the same type shall be products of a single manufacturer. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

C. Provide chain operators for valves 4 inches and larger when the centerline is located 8 feet or more above the floor or operating platform.

D. Gate Valves:

1. 2 1/2 inches and larger: Flanged, outside screw and yoke.
 - a. MSS-SP 70, iron body, bronze mounted, 125 psig wedge disc.

E. Globe, Angle and Swing Check Valves:

1. 2 inches and smaller: MSS-SP 80, bronze, 150. Globe and angle valves shall be union bonnet with metal plug type disc.

F. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water piping. Check valves incorporating a balancing feature may be used.

1. Body: Cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged or wafer type.
2. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62.

Seats may be elastomer material.

G. Butterfly Valves: May be used in lieu of gate valves. Provide stem extension to allow 2 inches of pipe insulation without interfering with valve operation.

1. MSS-SP 67, flange lug type (for end of line service) rated 175 psig working pressure at 200 degrees F.
 - a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.

- b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
- c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
 - 1) Valves 6 inches and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
 - 2) Valves 8 inches and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.
- H. Ball Valves: Brass or bronze body with chrome-plated ball with full port and Teflon seat at 400 psig working pressure rating. Screwed or solder connections. Provide stem extension to allow operation without interfering with pipe insulation.
- I. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size and be one of the following types.
 - 1. Butterfly valve as specified herein with memory stop.
 - 2. Eccentric plug valve: Iron body, bronze or nickel-plated iron plug, bronze bearings, adjustable memory stop, operating lever, rated 125 psig and 250 degrees F.

2.8 WATER FLOW MEASURING DEVICES

- A. Minimum overall accuracy plus or minus three percent over a range of 70 to 110 percent of design flow. Select devices for not less than 110 percent of design flow rate.
- B. Magnetic Flow Meter by Cadillac Manufacturer or approved equal. Flow Meter shall have 304 stainless steel body, integral grounding rings.

The flow meter shall be bi-directional or single direction with the following features:

 - 1. Accuracy: +/-0.25% of rate or reading with 1.5 pipe diameter up or downstream of meter centerline.
 - 2. Turndown: 300 to 1 at above stated accuracy.
 - 3. Longevity: Mean time between failure (MTBF) of 40 years.
 - 4. Power supply: 100 to 240 VAC, 50/60 Hz.

5. Outputs: 4-20 MADC and Pulse with digital I/O (4 points)
 6. Digital inputs (2).
 7. HART Protocol communications.
- C. Wafer Type Circuit Sensor: Cast iron wafer-type flow meter equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral check valve designed to minimize system fluid loss during the monitoring process.
- D. Self-Averaging Annular Sensor Type: Brass or stainless steel metering tube, shutoff valves and quick-coupling pressure connections. Metering tube shall be rotatable so all sensing ports may be pointed down-stream when unit is not in use.
- E. Flow Measurement/Balance Valves: A system comprised of two valves of bronze and stainless steel metallurgy designed for 175 psig pressure at 250 degrees F, with thermal insulation sleeve.
1. Measurement and shut-off valve: An on/off ball valve with integral high regain venturi and dual quick connect valves with integral check valves and color coded safety caps for pressure/temperature readout.
 2. A butterfly balancing valve as specified herein, with memory stop and quick connect valve for pressure/temperature readout.
- F. Flow Measuring Device Identification:
1. Metal tag attached by chain to the device.
 2. Include meter or equipment number, manufacturer's name, meter model, flow rate factor and design flow rate in gpm.
- G. Permanently Mounted Water Flow Indicating Meters: Minimum 6 inch diameter, or 18 inch long scale, for 120 percent of design flow rate, direct reading in (gpm), with three valve manifold and two shut-off valves.

2.9 DIFFERENTIAL PRESSURE TRANSDUCER

- A. Wet/Wet differential pressure transducer with dual diffused piezoresistive sensing elements with stainless steel metal isolation - model 231-MS2 by Setra manufacturer or approved equal.

Fixtures:

1. Excitation: 24 VDC @50 MA
2. Output: 4 to 20 MA
3. Accuracy: $\pm 1.0\%$ FS
4. Operating temperature: 0 to 185°F

5. Compensated temperature: 30 to 149°F
6. Thermal effects:
 - Zero: $\pm 0.02\%$ FS/°F
 - Span: $\pm 0.02\%$ FS/°F
7. Maximum line pressure: 100 PSIG
8. Response time: 1-5 sec
9. Wetted parts: 316 Stainless Steel

2.10 STRAINERS

A. Basket or Y Type.

1. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 0.045 inch diameter perforations.
2. 4 inches and larger: 0.125 inch diameter perforations.

2.11 FLEXIBLE CONNECTORS FOR WATER SERVICE

A. Flanged Spool Connector:

1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
2. Working pressures and temperatures shall be as follows:
 - a. Connector sizes 2 inches to 4 inches, 165 psig at 250 degrees F.
 - b. Connector sizes 5 inches to 12 inches, 140 psig at 250 degrees F.
3. Provide ductile iron retaining rings and control units.

2.11 HYDRONIC SYSTEM COMPONENTS

A. Plate and Frame Heat Exchanger:

1. Fixed frame with bolted removable corrugated channel plate assembly, ASME code stamped for 150 psig working pressure.
2. Corrugated channel plates shall be type 316 or 304 stainless steel.
3. Channel plate ports to be double gasketed to prevent mixing or cross-contamination of hot side and cold side fluids. Gaskets shall be of glue free design and suitable for system fluids, EPDM.
4. Channel plate carrying bars to be carbon steel with zinc yellow chromate finish.

5. Fixed frame plates and moveable pressure plates to be corrosion resistant epoxy painted carbon steel.
 6. Piping connections 2" and smaller to be carbon steel NPT tappings. Piping connections 4" and larger to be studed port design to accept ANSI flange connections. Connection ports to be integral to the frame or pressure plate.
 7. Finished units to be provided with OSHA required, formed aluminum splash guards to enclose exterior channel plate and gasket surfaces.
 8. Provide two sets of replacement gaskets and provide one set of wrenches for disassembly of plate type heat exchangers.
 9. Performance: As scheduled on drawings.
- B. Automatic Air Vent Valves: Cast iron or semi-steel body, 150 psig working pressure, stainless steel float, valve, valve seat and mechanism, minimum 1/2 inch water connection and 1/4 inch air outlet. Air outlet shall be piped to the nearest floor drain.
- C. Air Purger: Cast iron or fabricated steel, 125 psig water working pressure, for in-line installation.
- D. Air Separator: ASME Pressure Vessel Code construction for 125 psig working pressure, flanged inlet and outlet connection and strainer. The removable strainer shall be of stainless steel with 3/16 inches diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. The contractor shall remove and clean strainer after 24 hours operation and after 30 days operation. Unit shall have separate top fittings for connection for connection to system expansion tank and for air vent. There shall be a bottom connection for blow down cleaning. The air separator shall be constructed with the ASME boiler and pressure vessel code and stamped 125 psig design pressure.
- E. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 4 psig above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 125 psig working pressure at 225 degrees F.
- F. Pressure Relief Valve: Bronze or iron body and bronze or stainless steel trim, with testing lever. Comply with ASME Code for Pressure Vessels, Section 8, and bear ASME stamp.

2.12 GAGES, PRESSURE AND COMPOUND

- A. ASME B40.100, Accuracy Grade 1A, (pressure or compound for water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or

phenolic case, 4-1/2 inches in diameter, 1/4 inch NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.

- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.
- C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.
 - 1. For condenser water suction (compound): Minus 30 inches Hg to plus 100 psig.

2.13 PRESSURE/TEMPERATURE TEST PROVISIONS

- A. Pete's Plug: 1/4 inch MPT by 3 inches long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed.
- B. Provide one each of the following test items to the Contracting Officer's Representative (COR):
 - 1. 1/4 inch FPT by 1/8 inch diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
 - 2. 3-1/2 inch diameter, one percent accuracy, compound gage 30 inches Hg to 100 psig range.
 - 3. 32 to 220 degrees F pocket thermometer one-half degree accuracy, one inch dial, 5 inch long stainless steel stem, plastic case.

2.14 THERMOMETERS

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 6 inch brass stem, straight, fixed or adjustable angle as required for each in reading.
- B. Case: Chrome plated brass or aluminum with enamel finish.
- C. Scale: Not less than 9 inches, range as described below, two degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges:
 - 1. Chilled Water and condenser water: 32-100 degrees F.

2.15 FIRESTOPPING MATERIAL

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

2.16 ELECTRICAL HEAT TRACING SYSTEMS

- A. Systems shall meet requirements of the National Electrical Code (NEC), Section 427.
- B. Provide tracing for outdoor piping subject to freezing temperatures (Below 38 degrees F) as follows:
 - 1. Condenser water piping for cooling towers
 - 2. Make-up water
 - 3. Chilled water piping in all areas exposed to the weather.
- C. Heating Cable: Flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself.
 - 1. Provide end seals at ends of circuits. Wire at the ends of the circuits is not to be tied together.
 - 2. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 36 degrees F minimum during winter outdoor design temperature, but not less than the following:
 - a. 3 inch pipe and smaller with 1 inch thick insulation: 4 watts per foot of pipe.
 - b. 4 inch pipe and larger 1-1/2 inch thick insulation: 8 watts per feet of pipe.
- D. Electrical Heating Tracing Accessories:
 - 1. Power supply connection fitting and stainless steel mounting brackets. Provide stainless steel worm gear clamp to fasten bracket to pipe.
 - 2. 1/2 inch wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 12 inch intervals.
 - 3. Pipe surface temperature control thermostat: Cast aluminum, NEMA 4 (watertight) enclosure, 1/2 inch NPT conduit hub, SPST switch rated 20 amps at 480 volts AC, with capillary and copper bulb sensor. Set thermostat to maintain pipe surface temperature at not less than 34 degrees F.
 - 4. Signs: Manufacturer's standard (NEC Code), stamped "ELECTRIC TRACED" located on the insulation jacket at 10 feet intervals along the pipe on alternating sides.

2.17 REFRIGERANT R-134A MONITOR

A. Available manufacturers' but not limited to:

1. OI Analytical Corporation
2. MSA
3. Bacharach, Inc

B. Refrigerant Alarm Panel

1. The system shall be of traditional life safety standalone configuration, hardwired to safety devices and capable of detecting the presence of refrigerant gas down below the 10 parts per million (ppm) level with an accuracy of ± 1 ppm from 10 ppm to 100 ppm and $\pm 2\%$ from 100 ppm to 1,000 ppm. Response time shall be 20 seconds or less to 90% of step change.
2. The system shall be compound specific and should not alarm when other common gases are present. Oxygen deficiency monitoring is not acceptable in lieu of allowable exposure level (AEL), permissible exposure level (PEL), or threshold limit value-time weighted average (TLV-TWA) monitoring for human exposure safety or flame or explosion precaution.
3. The system shall provide separate low, mid, and high alarm relay closures with resistive load contact ratings of 240 VAC at five amps. These relays shall normally be open or closed selectable with single pole operation. The system shall provide for a relay board option that will supply an additional three sets of relays (total of 12) and will allow for up to four separate alarm zones.
4. The system shall provide three independently selectable alarm levels for each port and output through the low, mid, and high alarm relays.
5. The system shall be designed to accept a field-installable expansion device that will provide extra ports for future expansion.
6. The system shall provide a malfunction relay closure that is normally closed. This relay closure will correspond with a display that identifies a temperature control, sample flow loss, and infrared energy loss malfunction in digital text form on the front panel.
7. Outputs from the system will include a 4-20 mA output for all ports, an RS-485 output, or an optional RS-232 output.

8. Sample flow rate of the system shall be 2-2.5 L/min with a sample flow malfunction set for 1 L/min.

C. Installation and Startup

1. Sample Tubing Material—Install ¼" O.D. stainless steel or aluminum tubing, seamless type (hard or annealed), complying with ASTM-B 280 or in accord with ASTM-B88. Soldered or brazed connections are not acceptable due to foreign gases and contaminants. Polyethylene or polypropylene ¼" O.D. tubing, similar to Parker Hannifin, may be used if preapproved, installed, or bundled in ½" or ¾" EMT conduit, or larger, 80% free area. Poly tubing and other gas absorbing/leaching types are not acceptable due to sample corruption.
2. Location and Termination—Tubing shall be field assembled with compression fittings, terminated 6"-12" from the floor with 0.1 micron particulate/coalescent filters furnished by the monitor manufacturer. Locate the sensing terminations in areas not subject to damage and downwind in the direction of the device's convection airflow for monitoring and where shown on the drawings. Identify each sample tube, both ends, with stamped, nonferrous metal tags labeling zone/chiller monitored.
3. Control wiring—Usually installed by control contractor. The analog/signal wiring shall be shielded.
4. Power wiring—Usually installed by electrical contractor. Provide a 120 VAC isolated and dedicated power circuit.
5. Conduct the complete installation and startup in accord with the manufacturer's recommendations. Become familiar with the manufacturer's complete instruction book. Provide a minimum of one hour of instruction to the owner's authorized operating personnel in the proper operation/maintenance of the system. If the monitor requires keystrokes or programming to query information in normal daily operation, provide additional programming instruction to the Government's satisfaction at no additional cost to the Government.

PART 3 - EXECUTION

3.1 GENERAL

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment and to coordinate with other trades. Provide

all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide one inch minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than one inch in 40 feet. Provide eccentric reducers to keep bottom of sloped piping flat.
- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Provide manual air vent at all piping system high points and drain valves at all low points.
- I. Connect piping to equipment as shown on the drawings. Install components such as:
 - 1. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

- J. Thermometer Wells: In pipes 2-1/2 inches and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- K. Joints between different metallic piping materials, hydronic system components and accessories (valves, strainers, etc.) shall be made with approved dielectric fittings.

3.2 PIPE JOINTS

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.
- D. Solvent Welded Joints: As recommended by the manufacturer.

3.3 LEAK TESTING ABOVEGROUND PIPING

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the COR. Tests may be either of those below, or a combination, as approved by the COR.
- B. An operating test at design pressure.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

3.4 FLUSHING AND CLEANING PIPING SYSTEMS

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals.
 - 1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents

and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet per second, if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the COR.

2. Cleaning: Using products supplied circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

3.5 ELECTRIC HEAT TRACING

- A. Install tracing as recommended by the manufacturer.
- B. Coordinate electrical connections.

3.6 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Adjust red set hand on pressure gages to normal working pressure.

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