SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.
B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
C. Section 23 21 23, HYDRONIC PUMPS: Pumps.
D. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION: Piping insulation.
E. Section 23 23 00, REFRIGERANT PIPING: Refrigerant piping and refrigerants.
F. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS: radiant ceiling panels.
G. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.

1.3 QUALITY ASSURANCE

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, 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.
C. For mechanical pressed sealed fittings, only tools of fitting manufacturer shall be used.
D. Mechanical pressed fittings shall be installed by factory trained workers.
E. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be the same manufacturer as the grooved components.
   1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Manufacturer's Literature and Data:

1. Pipe and equipment supports. Submit calculations for variable spring and constant support hangers.
2. Pipe and tubing, with specification, class or type, and schedule.
3. Pipe fittings, including miscellaneous adapters and special fittings.
4. Flanges, gaskets and bolting.
5. Grooved joint couplings and fittings.
6. Valves of all types.
7. Strainers.
8. Flexible connectors for water service.
9. Pipe alignment guides.
10. Expansion joints.
11. Expansion compensators.
12. All specified hydronic system components.
13. Water flow measuring devices.
14. Gages.
15. Thermometers and test wells.
16. Electric heat tracing systems.
17. Seismic bracing details for piping.

C. Submit the welder’s qualifications in the form of a current (less than one year old) and formal certificate.

D. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system 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 Autocad and pdf 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. American National Standards Institute, Inc.

B. American Society of Mechanical Engineers/American National Standards Institute, Inc. (ASME/ANSI):

B1.20.1-83(R2006).....Pipe Threads, General Purpose (Inch)

B16.4-06.....Gray Iron Threaded FittingsB16.18-01 Cast Copper Alloy Solder joint Pressure fittings

B16.23-02.....Cast Copper Alloy Solder joint Drainage fittings

B40.100-05.....Pressure Gauges and Gauge Attachments

C. American National Standards Institute, Inc./Fluid Controls Institute (ANSI/FCI):

70-2-2006.....Control Valve Seat Leakage

D. 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

B16.22-01.....Wrought Copper and Bronze 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

E. 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

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

A234/A234M-07 ..... Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and 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

A615/A615M-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

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

C177-04 ..... Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus

C478-09 ..... Precast Reinforced Concrete Manhole Sections

C533-07 ..... Calcium Silicate Block and Pipe Thermal Insulation

C552-07 ..... Cellular Glass Thermal Insulation

D3350-08 ..... Polyethylene Plastics Pipe and Fittings Materials

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

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

D1785-06 ..... Poly (Vinyl Chloride0 (PVC) Plastic Pipe, Schedules 40, 80 and 120

D2241-05 ..... Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)

F439-06 ..... Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

F441/F441M-02 ..... Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

F477-08 ..... Elastomeric Seals Gaskets) for Joining Plastic Pipe

F. 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

G. American Welding Society (AWS):

B2.1-02.....Standard Welding Procedure Specification

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

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

I. Expansion Joint Manufacturer’s Association, Inc. (EJMA):

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

J. 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

K. National Sanitation Foundation/American National Standards Institute, Inc. (NSF/ANSI):

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

50-2009a.....Equipment for Swimming Pools, Spas, Hot Tubs and other Recreational Water Facilities – Evaluation criteria for materials, components, products, equipment and systems for use at recreational water facilities

61-2008.....Drinking Water System Components – Health Effects

L. Tubular Exchanger Manufacturers Association: TEMA 9th Edition, 2007

1.6 SPARE PARTS

A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

PART 2 - PRODUCTS

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

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

2.2 PIPE AND TUBING

A. Chilled Water, Condenser Water, Heating Hot Water, and Glycol-Water (other than solar), and Vent Piping:

1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.
2. Copper water tube option: ASTM B88, Type K or L, hard drawn. Soft drawn tubing, 20 mm (3/4 inch) and larger, may be used for runouts routed under slab to floor mounted fan coil units.

B. Extension of Domestic Water Make-up and All Solar Hot Water Piping: ASTM B88, Type K or L, hard drawn copper tubing.

C. Cooling Coil Condensate Drain Piping:

1. From air handling units: Copper water tube, ASTM B88, Type M, or schedule 40 PVC plastic piping.
2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.

D. Chemical Feed Piping for Condenser Water Treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F441.

E. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded joints.

1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
2. Forged steel, socket welding or threaded: ASME B16.11.
3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: ASME B16.39.
5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.

B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Contractor’s option: Grooved mechanical couplings and fittings are optional.

1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
2. Welding flanges and bolting: ASME B16.5:
   a. Water service: Weld neck or slip-on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
      1) Contractor's option: Convoluted, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
   b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.

D. Grooved Mechanical Pipe Couplings and Fittings (Contractor’s Option): Grooved Mechanical Pipe Couplings and Fittings may be used, with cut or roll grooved pipe, in water service up to 110 degrees C (230 degrees F) in lieu of welded, screwed or flanged connections. All joints must be rigid type.

1. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A449 and A183.
2. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.
3. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

2.4 FITTINGS FOR COPPER TUBING

A. Joints:

1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
2. Contractor’s Option: Mechanical press sealed fittings, double pressed type, NSF 50/61 approved, with EPDM (ethylene propylene diene monomer) non-toxic synthetic rubber sealing elements for up 65 mm (2-1/2 inch) and below are optional for above ground water piping only.
3. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

2.5 FITTINGS FOR PLASTIC PIPING

A. Schedule 40, socket type for solvent welding.

B. Schedule 40 PVC drain piping: Drainage pattern.

C. Chemical feed piping for condenser water treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F439.

2.6 DIELECTRIC FITTINGS

A. Provide where copper tubing and ferrous metal pipe are joined.

B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

D. Temperature Rating, 99 degrees C (210 degrees F).

E. Contractor’s option: On pipe sizes 2” and smaller, screwed end brass ball valves or dielectric nipples may be used in lieu of dielectric unions.

2.7 SCREWED JOINTS

A. Pipe Thread: ANSI B1.20.

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

2.8 VALVES

A. Asbestos packing is not acceptable.

B. All valves of the same type shall be products of a single manufacturer.

C. Shut-Off Valves

1. Ball Valves (Pipe sizes 2” and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig), 4140 kPa (600 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.

2. Globe and Angle Valves

3. Globe Valves

a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.

b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

4. Angle Valves:

a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.

b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle.

D. Check Valves

1. Swing Check Valves:

a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.

b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

2. 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 and hot water piping. Check valves incorporating a balancing feature may be used.

a. Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.

b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

E. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.

1. Ball style valve.

2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.

3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.

F. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control.

Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:

1. Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
2. Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

2.9 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. Venturi Type: Bronze, steel, or cast iron with bronze throat, with valved pressure sensing taps upstream and at the throat.

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. Insertion Turbine Type Sensor: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

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 l/m (gpm).

G. Portable Water Flow Indicating Meters:
   1. Minimum 150 mm (6 inch) diameter dial, forged brass body, beryllium-copper bellows, designed for 1205 kPa (175 psig) working pressure at 121 degrees C (250 degrees F).
   2. Bleed and equalizing valves.
   3. Vent and drain hose and two 3000 mm (10 feet) lengths of hose with quick disconnect connections.
   4. Factory fabricated carrying case with hose compartment and a bound set of capacity curves showing flow rate versus pressure differential.
   5. Provide one portable meter for each range of differential pressure required for the installed flow devices.

H. Permanently Mounted Water Flow Indicating Meters: Minimum 150 mm (6 inch) diameter, or 450 mm (18 inch) long scale, for 120 percent of design flow rate, direct reading in lps (gpm), with three valve manifold and two shut-off valves.

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: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (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 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165psig) at 121 degrees C (250 degrees F).
      b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
   3. Provide ductile iron retaining rings and control units.

B. Mechanical Pipe Couplings:

See other fittings specified under Part 2, PRODUCTS.

2.12 EXPANSION JOINTS

A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.

B. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.

C. Bellows - Internally Pressurized Type:

1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
2. Internal stainless steel sleeve entire length of bellows.
3. External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
4. Welded ends.
5. Design shall conform to standards of EJMA and ASME B31.1.
6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
7. Integral external cover.

D. Bellows - Externally Pressurized Type:

1. Multiple corrugations of Type 304 stainless steel.
2. Internal and external guide integral with joint.
3. Design for external pressurization of bellows to eliminate squirm.
4. Welded ends.
5. Conform to the standards of EJMA and ASME B31.1.
6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
7. Integral external cover and internal sleeve.

E. Expansion Compensators:

1. Corrugated bellows, externally pressurized, stainless steel or bronze.
2. Internal guides and anti-torque devices.
3. Threaded ends.
4. External shroud.

5. Conform to standards of EJMA.

F. Expansion Joint (Contractor's Option): 2415 kPa (350 psig) maximum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, PTFE modified polyphenylene sulfide coated slide section, with grooved ends, suitable for axial end movement to 75 mm (3 inch).

G. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

H. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

I. Supports: Provide saddle supports and frame or hangers for heat exchanger. Mounting height shall be adjusted to facilitate gravity return of steam condensate. Construct supports from steel, weld joints.

2.13 HYDRONIC SYSTEM COMPONENTS

A. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 28 kPa (4 psig) above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 861 kPa (125 psig) working pressure at 107 degrees C (225 degrees F).

B. 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.

C. Automatic Air Vent Valves (where shown): Cast iron or semi-steel body, 1034 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

2.14 GAGES, PRESSURE AND COMPOUND

A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (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 100 kPa (30 inches Hg) to plus 700 kPa (100 psig).

2.15 PRESSURE/TEMPERATURE TEST PROVISIONS

A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

B. Provide one each of the following test items to the Resident Engineer:

1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, ––100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
3. 0 - 104 degrees C (220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.16 THERMOMETERS

A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (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 225 mm (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 Glycol-Water: 0-38 degrees C (32-100 degrees F).
2. Hot Water and Glycol-Water: -1 – 116 degrees C (30-240 degrees F).

2.17 FIRESTOPPING MATERIAL

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

2.18 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. Chilled water exposed to the weather.

C. Heat tracing shall be provided to the extent shown on the drawings (Floor plans and Elevations). Heat tracing shall extend below grade to below the defined frost line.

D. 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 2.2 degrees C (36 degrees F) minimum during winter outdoor design temperature, but not less than the following:
   a. 75 mm (3 inch) pipe and smaller with 25 mm (1 inch) thick insulation: 4 watts per foot of pipe.
   b. 100 mm (4 inch)pipe and larger 38 mm (1-1/2 inch) thick insulation: 8 watts per feet of pipe.

E. 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. 13 mm (1/2 inch) wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 300 mm (12 inch) intervals.
3. Pipe surface temperature control thermostat: Cast aluminum, NEMA 4 (watertight) enclosure, 13 mm (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 1.1 degrees C (34 degrees F).
4. Signs: Manufacturer's standard (NEC Code), stamped "ELECTRIC TRACED" located on the insulation jacket at 3000 mm (10 feet) intervals along the pipe on alternating sides.

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, fan-coils, coils, radiators, etc., 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. Install heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (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 25 mm (one inch) in 12 m (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 or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.

I. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
   1. Water treatment pot feeders and condenser water treatment systems.
   2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

J. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.

K. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC INSULATION.

L. Where copper piping is connected to steel piping, provide dielectric connections.

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 and STEAM GENERATION.

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. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.

D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

E. Solvent Welded Joints: As recommended by the manufacturer.

3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)

A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.

B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.

C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.

D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding.

3.4 SEISMIC BRACING ABOVEGROUND PIPING

Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.5 LEAK TESTING ABOVEGROUND PIPING

A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.

B. An operating test at design pressure, and for hot systems, design maximum temperature.

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 (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

3.6 FLUSHING AND CLEANING PIPING SYSTEMS

A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.

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 1.8 m/S (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 Resident Engineer.
2. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, 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 1.8 m/S (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.

3.7 WATER TREATMENT

A. Install water treatment equipment and provide water treatment system piping.

B. Close and fill system as soon as possible after final flushing to minimize corrosion.

C. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.

D. Utilize this activity, by arrangement with the Resident Engineer, for instructing VA operating personnel.

3.8 ELECTRIC HEAT TRACING

A. Install tracing as recommended by the manufacturer.

B. Coordinate electrical connections.

3.9 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Adjust red set hand on pressure gages to normal working pressure.

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