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USACE / NAVFAC / AFCESA **UFGS-15181N (August 2003)**

Preparing Activity: NAVFAC **Superseding UFGS-15181N (September 1999)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags
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DIVISION 15 - MECHANICAL

SECTION 15181N

CHILLED, CONDENSER, OR DUAL SERVICE WATER PIPING

08/03

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SECTION 15181N

CHILLED, CONDENSER, OR DUAL SERVICE WATER PIPING
08/03

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NOTE: This guide specification covers the requirements for chilled water, condenser water, and hot and cold water (dual service) piping systems inside of buildings, or leading from equipment adjacent to buildings.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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NOTE: Project requirements may require addition of supplemental information to paragraphs contained herein.
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NOTE: Refrigerant piping is now covered by Section 15182 REFRIGERANT PIPING.
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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than

provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1	(1996; R 2002) Scheme for Identification of Piping Systems
ANSI B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ANSI B16.24	(1991; Errata 1991) Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500
ANSI B18.2.1	(1996; Errata 2003) Square and Hex Bolts and Screws Inch Series
ANSI Z53.1	(1979) Safety Color Code for Marking Physical Hazards

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2001) Water Pressure Reducing Valves
ASSE 1017	(2003) Temperature Actuated Mixing Valves for Hot Water Distribution Systems

AMERICAN WATER WORKS ASSOCIATION(AWWA)

AWWA C511	(1997) Reduced-Pressure Principle Backflow Prevention Assembly

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding
AWS Z49.1	(1999) Safety in Welding, Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME B1.1	(1989; R 2001) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(1983; R 2001) Pipe Threads, General Purpose, Inch
ASME B1.20.7	(1991: R 1998) Hose Coupling Screw Threads, Inch

ASME B15.1	(2000) Safety Standard for Mechanical Power Transmission Apparatus
ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.10	(2001; R 2003) Face to Face and End to End Dimensions of Valves
ASME B16.11	(2002) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(1992) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2002) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.3	(1998) Malleable Iron Threaded Fittings
ASME B16.34	(1996) Valves Flanged, Threaded, and Welding End
ASME B16.36	(1996) Orifice Flanges
ASME B16.39	(1998) Malleable Iron Threaded Pipe Unions
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(2001) Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.2	(1987; R 1999) Square and Hex Nuts
ASME B31.9	(1996) Building Services Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME BPVC SEC VIII D1	(2001) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 126	(1995; R 2001) Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 194/A 194M	(2003a) Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Both
ASTM A 307	(2002) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 53/A 53M	(2002) Pipe, Steel, Black and Hot-Dipped,

	Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2003) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(2002) Operating Salt Spray (Fog) Apparatus
ASTM B 32	(2003) Solder Metal
ASTM B 88	(2002) Seamless Copper Water Tube
ASTM B 88M	(1999) Seamless Copper Water Tube (Metric)
ASTM D 1654	(1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 2000	(2001) Rubber Products in Automotive Applications
ASTM F 1007	(1986; R 2002) Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F 1120	(1987; R 1998) Circular Metallic Bellows Type Expansion Joints for Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(1994; R 1995) Copper Tube Handbook

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2003)International Plumbing Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-58	(2002) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(2002) Butterfly Valves
MSS SP-69	(2002) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1998) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(1997) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(1999) Ball Valves with Flanged or

	Butt-Welding Ends for General Service
MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2001) Class 3000 Steel Pipe Unions, Socket-Welding and Threaded
MSS SP-85	(2002) Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures
NEMA MG 1	(2003) Motors and Generators

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA HVACTAB	(2002, 3rd Ed) HVAC Systems - Testing, Adjusting and Balancing

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-50541	(Basic; Notice 1) Valves, Tank Float, Angle and Globe Pattern
FS A-A-50560	(Basic) Pumps, Centrifugal, Water Circulating, Electric-Motor-Driven
FS A-A-50562	(Basic) Pump Units, Centrifugal, Water, Horizontal; General Service and Boiler-Feed: Electric-Motor- or Steam-Turbine-Driven
FS A-A-50568	(Basic) Gages, Liquid Level Measuring, Tank
FS WW-S-2739	(Basic) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1200	Hazard Communication
29 CFR 1910.144	Safety Color Code for Marking Physical Hazards

UNDERWRITERS LABORATORIES (UL)

UL 429 (1999; Rev thru Feb 2004) Electrically Operated Valves

1.2 GENERAL REQUIREMENTS

****
NOTE: The following information shall be shown on the project drawings:

1. Single line plan and necessary sections indicating location, sizes, and routing of associated piping.

2. Flow and generic control diagrams for system(s).

3. Appropriate schedules and details for equipment or components.

Designer should consider cathodic protection for buried piping. When necessary, include herein or in another section as required by the specific design to protect piping for desired life of system. Waterproof non-corrosive (non-metallic) conduit is a recommended alternative.
****

Section 15050N BASIC MECHANICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.2.1 Description of Work

****
NOTE: Edit as necessary.
****

Work shall include furnishing, installing, and testing of [chilled] [condenser] [hot and cold (dual service)] water piping system, as indicated, together with piping, tubing, flanges, bolting, gaskets, valves, fittings, pressure containing assemblies, flow measuring equipment, flow control equipment, circulating pumps, and associated appurtenances necessary for a complete and operable system. [Work also includes [modifications] [and] [connections] to existing [chilled] [condenser] [hot and cold (dual service)] water system(s).]

1.2.2 Associated Work

****
NOTE: Edit, specifying associated sections for specific project.
****

[Other work associated with this section including controls, insulation, exterior water distribution system(s), chillers, cooling towers, boilers, heat exchangers, water treatment chemicals and equipment, anti-freeze solutions and equipment, and painting is covered in other sections of this specification.]

1.2.3 System Design Temperatures, Pressures, and Classes

System design pressures shall not be less than 1.5 times system maximum operating pressure at design temperature. Piping components shall be suitable for use under design pressures specified. Except as modified herein, pressure/temperature limitations shall be as specified in referenced standards and specifications. Pressures in this specification are pressures in kiloPascal (kPa) psi above atmospheric pressure, and temperatures are in degrees Centigrade (C) Fahrenheit (F). System design, component selection, and system installation, including pressure containing parts and materials, shall meet or exceed the following requirements:

[a. [Chilled] [and] [Condenser] water piping shall be designed for a minimum service pressure of 862 kPa at 66 degrees C 125 psi at 150 degrees F; minimum ANSI Class 125.]

[b. Hot and cold (dual service) water piping shall be designed for a minimum service pressure of 1034 kPa at 121 degrees C 150 psi at 250 degrees F; minimum ANSI Class 150.]

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control

approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Gaskets

Soldering [and brazing] metals

Pump motors

Instrumentation[; G][; G, [_____]]

Pumps

Motor starters

Tanks

For valves, submit valve manufacturer's published ratings and maximum operating pressure differential. For relief valves, also submit manufacturer's published discharge capacity ratings. For pumps, include pump speed and characteristic curves for performance of impeller selected for each pump. Curves shall indicate capacity versus head, efficiency, and brake horsepower for full range, from shutoff to free delivery.

SD-07 Certificates

Welding procedure

Performance qualification record

List of welders' names and symbols

Backflow preventer certificate

SD-08 Manufacturer's Instructions

Pumps

Tanks

SD-10 Operation and Maintenance Data

Pumps, Data Package 3[; G][; G, [_____]]

Flow measuring equipment, Data Package 2[; G][; G, [_____]]

Submit in accordance with Section 01781 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted operating instructions

1.4 QUALITY ASSURANCE

1.4.1 Defective Welds

Give welders making defective welds, after passing a qualification test, a requalification test. Welders failing requalification test shall not be permitted to work under this contract.

1.4.2 Previous Welder Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalifying subject to approval of the Contracting Officer and provided that conditions specified in ASME B31.9 are met before a procedure is used.

1.4.3 Welding Procedure

Before performing welding, the Contractor shall submit to the Contracting Officer three copies of welding procedure specification for each metal included in the work, together with proof of qualifications in accordance with ASME B31.9.

1.4.4 Performance Qualification Record

Before performing welding, the Contractor shall also submit to the Contracting Officer three copies of the Welder's Performance Qualification Record in conformance with ASME B31.9 showing that the welder or operator was tested under the approved procedure specification submitted by the Contractor. Certification dates shall be less than one (1) year old.

1.4.5 List of Welders' Names and Symbols

Submit the assigned number, letter, or symbol used to identify the work of the welder, and affix it immediately upon completion of the weld.

1.4.6 Backflow Preventer Certificate

Submit for each design, size, and make of backflow preventer being provided for the project. Certificate shall be from the Foundation for Cross-Connection Control Research, University of Southern California, and shall attest that this design, size and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval will not be acceptable in lieu of the above.

1.4.7 Posted Operating Instructions

Submit posted operating instructions for flow measuring equipment, piping system diagrams and codes.

1.5 SPECIMENS, CORROSION PREVENTION OF FERROUS METALS

Expose for 125 hours in a salt-spray fog test, except equipment located outdoors shall withstand 500 hours. Salt-spray fog test shall be in accordance with ASTM B 117 using a 5 parts by weight (plus or minus 1) of sodium chloride in 95 parts of distilled water or water containing not more than 200 parts per million of total solid sodium chloride solution. Immediately after completion of test, coating shall show no signs of blistering, wrinkling, or cracking, no loss of adhesion, and specimen shall

show no signs of rust creepage beyond 3 mm 1/8 inch on either side of scratch mark. Each specimen shall have a standard scratch as defined in ASTM D 1654. Film thickness of factory coating or paint system applied on equipment shall not be less than film thickness used as test specimen.

1.6 SAFETY PRECAUTIONS

1.6.1 Rotating Equipment Safety

Fully guard couplings, motor shafts, gears and other exposed rotating or rapidly moving parts in accordance with ASME B15.1. Guards shall be cast iron or expanded metal. Guard parts shall be rigid, secured, and readily removable without disassembling guarded unit.

1.6.2 Welding and Cutting Safety

AWS Z49.1.

PART 2 PRODUCTS

2.1 WATER PIPING, FITTINGS, AND ACCESSORIES

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NOTE: When service permits use of copper piping and an option exists, specify either Type "K" or "L" depending upon service and design pressure and temperature. Type "M" copper should only be specified for drain piping.

Designer should consider cathodic protection for buried piping. When necessary, include herein or in another section as required by the specific design to protect piping for desired life of system. Waterproof non-corrosive (non-metallic) conduit is a recommended alternative.

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Materials and dimensions shall conform to ASME B31.9.

2.1.1 Chilled Water Piping

Provide [butt welded] [electric-resistance welded] [seamless] Schedule 40 black steel pipe conforming to ASTM A 53/A 53M, Grade A and B. Piping 100 mm 4 inches and smaller may be hard drawn copper tubing; [Type K for underground piping] [and] [Type [_____] for other aboveground use] conforming to ASTM B 88M ASTM B 88.

2.1.2 Condenser Water Piping

Provide [butt welded] [electric-resistance welded] [seamless] Schedule 40 black steel pipe conforming to ASTM A 53/A 53M, Grade A and B, [or] [copper tubing conforming to ASTM B 88M ASTM B 88, Type K, hard drawn].

2.1.3 Hot and Cold Water (Dual Service) Piping

Provide [butt welded] [electric-resistance welded] [seamless] Schedule 40 black steel pipe conforming to ASTM A 53/A 53M Grade A and B, [or] [copper tubing conforming to ASTM B 88M ASTM B 88, Type _____, hard drawn].

2.1.4 Fittings and Flanges for Steel Piping

2.1.4.1 Sizes 3 to 50 Millimeters 1/8 to 2 Inches

Steel fittings, ASME B16.11, socket welding type, Class 3000, or threaded type Class 2000; malleable iron fittings, ASME B16.3, threaded type.

2.1.4.2 Sizes 65 Millimeters 2 1/2 Inches and Above

Steel fittings, ASME B16.9, butt-welding type, or ASME B16.5, flanged type, or convoluted steel flanges conforming to ASME BPVC SEC VIII D1; cast iron fittings, ASME B16.1, flanged type; bronze fittings up to 200 mm 8 inch size, ANSI B16.24, flanged type.

2.1.5 Fittings for Copper Tubing

Fittings for copper tubing shall be cast copper alloy solder-joint type conforming to ANSI B16.18 or wrought copper solder-joint type conforming to ASME B16.22.

2.1.6 Unions

2.1.6.1 Unions (Threaded) for Steel Pipe

ASME B16.39, or MSS SP-83.

2.1.6.2 Unions for Copper Tubing

ASME B16.22; solder-joint end type.

2.1.6.3 Dielectric Union

Provide insulated union of galvanized steel and female threaded on end. Solder joints conforming to ASME B16.39, Class 1 dimensional strength and pressure requirements. Union shall have water impervious insulation barrier capable of limiting galvanic current to one percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test.

2.1.7 End Connections

2.1.7.1 Steel Piping

50 mm2 inches and smaller shall be threaded or socket welded; 65 mm 2 1/2 inches and larger shall be flanged or butt welded.

a. Threaded joints: Thread in accordance with ASME B1.20.1.

b. Flanged joints:

(1) Bolting of flanges: Material used for bolts and studs shall conform to ASTM A 307, Grade B, and material for nuts shall conform to ASTM A 194/A 194M, Grade 2. Dimensions of bolts, studs, and nuts shall conform to ANSI B18.2.1and ASME B18.2.2 with threads conforming to ASME B1.1 coarse type with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or studs shall extend through nuts and may have reduced shanks of a diameter not less than diameter at root of threads. Carbon steel bolts shall have American Standard regular square or heavy hexagon heads and

shall have American Standard heavy, semifinished hexagonal nuts.

(2) Gaskets: ASTM D 2000, fluorinated elastomers, suitable for pressure and temperature ranges encountered, and compatible with grooves in flange faces. Dimensions for nonmetallic gaskets shall conform to ASME B16.21.

c. Butt weld joints: ASME B31.9. Use of backing rings shall conform to ASME B31.9. Ferrous rings shall be of good weldable quality and not exceed 0.05 percent sulfur; for alloy pipe, backing rings shall be of material compatible with chemical composition of parts to be welded and preferably of same composition. Backing rings shall be of continuous machined or split-band type. Provide backing rings for joints 65 mm 2 1/2 inches and larger.

d. Socket weld joints: ASME B31.9.

2.1.7.2 Joints for Copper Tubing

a. Soldering [and brazing] metals: Solder, ASTM B 32, Grade Sb5, tin-antimony alloy for service pressures up to 1034 kPa 150 psi; brazing filler metal, AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

b. Provide mechanically formed joints only for making tees in existing system "K" or "L" type tubing. Adjoining tubing shall be brazed. Joints shall meet system design and test requirements specified herein, be approved by the manufacturer for the specific service, and be installed in strict accordance with the manufacturer's procedures and instructions.

2.1.8 Valves and Related Equipment

End connections shall conform to paragraph entitled "End Connections." Valves shall have rising stems and shall open when turned counterclockwise.

2.1.8.1 Gate, Valves

a. Bronze gate valves, 50 mm 2 inches and smaller: MSS SP-80, wedge disc, rising stem, inside threaded type. Provide solder-joint ends when used with copper tubing.

b. Steel gate valves: ASME B16.34, outside screw-and-yoke type with solid wedge or flexible wedge disc, with trim of heat and corrosion-resistant steel as recommended by the manufacturer for service indicated.

c. Cast iron gate valves, 65 mm 2 1/2 inches and larger: MSS SP-70, outside screw-and-yoke type with bronze trim.

2.1.8.2 Globe and Angle Valves

a. Bronze, 50 mm 2 inches and smaller: MSS SP-80, with renewable seats and discs except internal slats for solder-end valves.

b. Steel: ASME B16.34, with heat and corrosion-resistant trim as recommended by the manufacturer for service indicated, and provided with tapped drains and brass plugs.

c. Cast Iron, 65 mm 2 1/2 inches and larger: MSS SP-85, with bronze trim, tapped drains, and brass plugs.

2.1.8.3 Check Valves

a. Bronze, 50 mm 2 inches and smaller: MSS SP-80, regrinding-swing-check type.

b. Steel, 65 mm 2 1/2 inches and above: ASME B16.34, with heat and corrosion-resistant trim as recommended by the manufacturer for conditions indicated.

c. Swing check valves: Provide with bolted caps.

d. Lift check valves, 50 mm 2 inches and smaller: Provide with bolted caps.

e. Cast iron check valves, 65 mm 2 1/2 inches and larger: MSS SP-71, with bronze trim.

2.1.8.4 Water Temperature Mixing Valves

ASSE 1017.

2.1.8.5 Water Pressure-Reducing Valves

ASSE 1003.

2.1.8.6 Plug Valves

MSS SP-78, cast iron or steel, Size 50 mm 2 inches and larger, [Flanged] [Threaded] End Connection. Replaceable valve seat is not required.

2.1.8.7 Ball Valves

MSS SP-110; copper alloy; valve design which permits inspection and repair of seats and seals without removing valve body from line; End Connection [threaded.] [soldered.] [welding ends.] [Flanged ball valve shall conform to MSS SP-72, [bronze] [steel].]

2.1.8.8 Drain Valves

Gate valves conforming to MSS SP-80, manually operated 20 mm 3/4 inch pipe size and above, with threaded ends. Provide hose nipple adapters for connecting a hose to lead to a convenient floor drain. [Provide frost-free valves for installations exposed to weather.]

2.1.8.9 Air Vent Valves

[Manually-Operated General Service Type] [and] [Automatic Type. Automatic-type air vent valves (Water Traps) shall be of ball-float type. Provide valves with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat of hardened, corrosion-resistant steel.] Air vent valves on water coils shall have not less than 3 mm 1/8 inch threaded end connections. Provide 20 mm 3/4 inch pipe size for water mains and 15 mm 1/2 inch minimum pipe size for other applications.

2.1.8.10 Automatic Flow Control Valves

Individually selected and factory calibrated by the manufacturer for service specified. Valves shall automatically limit rate of flow of system to required design capacity regardless of system fluctuations. Valves shall regulate flow within 5 percent of their tag rating over an operating pressure differential of at least 10 times the minimum required for control. Provide tamperproof valves with body tappings suitable for connecting instruments for verifying flow control performance. Provide self-cleaning, cartridge-piston type with stainless steel, variable area orifices and stainless steel or nickel-plated pistons. Valves shall have bronze bodies with threaded, soldered, or flanged connections as required for pipe fittings. Furnish each automatic flow control valve with a valve kit located outside of insulation, and hose fittings suitable for use with measuring instruments as indicated.

a. When meeting component requirements herein, composite valves consisting of integral ball valve(s), automatic flow control valve, thermo wells, gage cocks, strainer, and fittings, or a combination thereof, are acceptable where certified by the manufacturer for specific service and installed in strict accordance with the manufacturer's recommendations.

2.1.8.11 Butterfly Valves

MSS SP-67, Type I tight shutoff valve, and valve ends shall be [flanged] [single flange (lug type)] [flangeless (wafer type)]. Valve body material shall be [cast iron] [steel] [bronze] and bubble tight for shutoff at design pressure. Flanged and flangeless valves shall have 300 series corrosion-resistant steel stems and discs or bronze discs with molded elastomer disc seals. Flow conditions shall be for regulation from maximum flow to complete shutoff by the throttling effect. Valves smaller than 200 mm 8 inches shall have throttling handles. Valves 200 mm 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and indicators. Valves shall have a minimum of seven locking positions.

a. Butterfly valves 50 mm 2 inches and smaller: One-piece and three-piece design with male or female [threaded] [soldered] end connections and shall be bubble tight for shutoff at rated operating pressure of valve. Provide 300 series corrosion resistant steel stem and disc assembly. Disc seal shall be suitable for liquid used in system in which valve is to be installed. Provide valves designed for throttling service use with valve lever and indicator adjustment.

2.1.8.12 Solenoid Valves

Provide direct acting or pilot operating type for use with liquid service. Valves shall conform to UL 429, and be designed for pressure drop required. Valves shall have seal-capped manual opening stems and be constructed for servicing without removing from line. Each valve shall include a coil housing, stem-and-plunger assembly nonmagnetic to the plug, stainless steel enclosing tube, seat-and-plunger, and proper inlet and outlet connections for installing into piping system. Direction of flow shall be indicated on body. Provide solenoid valves designed, manufactured, and tested specifically for the service in all respects, including material. Coil housing shall include a moistureproof coil in a metal housing with electrical wires extending through a female-pipe-tap-conduit connection.

Coil shall be wired for electrical current used and be capable of withstanding temperature of liquid encountered plus heat from coil. Provide bodies, stems, and pistons of a material that will not corrode or pit when used in water systems. Valve with threaded connections shall conform to ASME B1.20.1.

a. Type of valves: Direct operated valve shall be of the type that operates plunger by direct action of coil. Pilot operated valves shall be floating piston or direct-connected-plunger type. Pilot operated valve with floating piston shall be used on 15 mm 1/2 inches or larger port size valves and capable of handling liquid temperature up to design temperature. Valves shall have flanged connections in sizes 40 mm 1 1/2 inches and larger with companion flanges for either welding or soldering to piping. Sizes 32 mm 1 1/4 inches and smaller may either have female thread connections or may be nonferrous with soldering connections.

2.1.8.13 Automatic Water Regulating Valves

For water cooled, halocarbon condenser service and controlled and operated by refrigerant pressure in condenser acting on a spring-balanced diaphragm or bellows, or condenser pressure controlled and operated by an electric or pneumatic operator. Control diaphragm shall be suitable for refrigerant in all respects including materials. Provide three way globe, straight through, or angle type [as indicated]. Valves shall have single seat with renewable composition discs with V-port skirts, tapered plugs or other means for providing the best control for the service. Valves up to and including 25 mm one inch in size shall be brass or bronze, with [threaded,] [union] [flared] end connections. Valves 32 and 40 mm 1 1/4 and 1 1/2 inches may be as specified for smaller sizes or of iron as specified for larger sizes. Valves 50 mm 2 inches and larger shall be flanged iron bodies with brass or bronze trim. Provide corrosion-resistant material for valve and operating motor to preclude corrosion of working parts due to leakage of water from stem packing. Valves shall have direction of flow clearly and permanently indicated. Two-position valves not intended for modulating service shall have quick-opening plugs. Solenoid valves used in connection with water regulating valves shall be suitable for operation on control voltage used in system. Threaded pipe connections shall conform to ASME B1.20.1.

2.1.8.14 Float Valves

FS A-A-50541, [Style A - angle pattern] [and] [or] [Style B - globe pattern]. Where float rods are extended for tank applications, extension shall be properly supported and guided to avoid bending of float rod or stressing of valve pilot linkage.

2.1.8.15 Safety Relief Valves

Provide cast iron bodies conforming to ASTM A 126, Grade B with corrosion resistant internal working parts.

2.1.8.16 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves shall be suitable for 862 kPa (gage) 125 psig at 87.8 degrees C 190 degrees F hot water. Valve shall function as a service valve when in fully closed position. Valve body shall have factory-installed tappings for

differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections shall have positive check valves or shutoff valves. Each valve shall have metal tag showing the liters per second gallons per minute flow for each differential pressure reading.

2.1.9 Miscellaneous Components for Piping System

2.1.9.1 Strainers

FS WW-S-2739, Type I (single screen) for IPS sizes below 50 mm 2 inches and Type II (single perforated basket) for sizes 50 mm 2 inches and above. Provide Type 304 stainless steel element with 1.20 mm 0.047 inch minimum diameter perforations, or Type 304 stainless steel screen. Select perforation diameter or screen mesh number suitable to protect the particular component indicated. Manual and automatic cleaners are not required.

2.1.9.2 Flexible Hose

Provide water service type of seamless rubber tubing with molded nonferrous wire braid, or stainless steel bellows with stainless steel braid. Provide materials recommended by the manufacturer for use with [condenser cooling] [and] [chilled water.] Threaded couplings shall conform to American Standard NPT in accordance with ASME B1.20.7.

2.1.9.3 Flow Measuring Equipment

Orifice or venturi type. Flow metering equipment including pitot tubes, venturis, orifice plates, flanges, and indicating meters shall be the product of one and the same manufacturer. Provide flowmeters of [permanent type] [or] [portable type] [type indicated]. Flowmeters shall be suitable for service in which they are to be installed. Primary elements of flowmeters shall conform to ASME recommendations for flowmeters. Provide bronze, monel, or stainless steel materials for wetted parts of flow meters.

a. Orifices: Square-edge type, made of corrosion and erosion resistant metal and mounted between pipe flanges having factory-made pressure taps provided with shutoff valves. Orifice flanges shall conform to ASME B16.36.

b. Tubular flowmeters: Flow measuring elements consisting of venturi tubes or pitot tubes where indicated. Locations and arrangement of piping, both upstream and downstream of flow measuring elements shall conform to the manufacturer's published literature. Provide each flow measuring element with an integral tab, or a metal tag on a corrosion-resistant steel wire, extending outside pipe covering, and stamped or printed in a visible position with manufacturer's name and address; serial number of meter to which it is to be connected; name, number, or location of equipment served; specified rate of flow; and multiplier to be applied to meter reading. Provide taps with shutoff valves and quick connecting hose fittings for portable meters or double ferrule compression fittings for connection to tubing for permanently located meters or recorders. Tubes shall be calibrated in accordance with ASME recommendations.

(1) Venturi tubes: Certified by the manufacturer for the actual piping configuration and any necessary piping changes required for

certification without additional cost to the Government. Throat diameter for each venturi tube shall be designed so that at specified rate of flow the scale reading will fall between 50 percent and 80 percent of full scale value. Select venturi tube sizes from the manufacturer's latest published tables of flow versus differential pressure. Unrecovered head loss at maximum flow shall not exceed 10 percent. Provide bronze or cast iron tubes with bronze-lined throats, with flanged, threaded, or welded ends to suit piping system. Provide bodies of fabricated steel and fittings of the same class as piping in which installed. Two integral meter taps shall be provided in each venturi tube. Connections for attachment to portable flow meter hoses shall be readily accessible and not over 1.83 meters six feet above a floor or permanent platform.

(2) Pitot tube assemblies: Provide corrosion-resistant materials. Tubes shall be capable of measuring liquid flow through tube elements providing an averaged, interpolated flow measurement from a single, fixed position. Provide self cleaning elements and impact tube designed to rotate when turned by the operator to protect pressure-sensing elements of tube when not in use. Location and total amount of pitot tubes required for system flow measurement shall be as recommended by the manufacturer and as indicated.

c. Meters: Designed for a full scale pressure differential of 12.5 kPa 50 inches water gage for tubular type or 25 kPa (gage) 100 inches water gage for orifice type. Dials shall have square root or linear scales with developed length of not less than 305 mm 12 inches. Provide flush mounted panel meters that read directly in cubic meter per second gallons per minute. Dials of portable meters shall have square root scales reading from 0 to 6 liter per second 0 to 100 gpm for use with multiplier stamped on orifice or tubular type. Provide meters designed for not less than 1379 kPa 200 psi and protected against pressure surges. Meter bodies shall have taps for venting and draining.

(1) Permanently mounted meters: Each meter shall be connected completely [as indicated] [and] [as specified] and provided with the following: three valve manifold equalizer lines, two block valves, two vent and drain valves, and an integral pulsation damper. Overall accuracy of meters shall be plus or minus 2 percent of full scale flow over a range from 20 to 100 percent of full scale flow.

(2) Portable meters: Provide meter with a factory-fabricated carrying case with carrying handle. Provide case fitted to hold meter securely and to accommodate the following accessories:

(a) Two 4.50 meters 15 foot lengths of connecting hose with suitable female connectors for connecting from meter to [venturi tube] [orifice flange] [pitot tube] pressure-tap nipples. Provide hose designed for a minimum service pressure of 862 kPa 125 psi or 150 percent of maximum system service pressure, whichever is greater.

(b) A completely assembled three-valve manifold with two block valves and vent and drain valves, piped and mounted on a base designed for use laying flat on a stationary surface.

(c) A bound set of descriptive bulletins, installation and operating instructions, parts list, and a set of curves showing flow versus pressure differential for each orifice, venturi tube, or pitot tube with which meter is to be used.

(d) A metal instruction plate, secured inside cover, illustrating use of meter.

(e) Provide meters with overall accuracy of plus or minus 5 percent of full scale flow over a range from 20 to 100 percent of full scale flow.

2.1.9.4 Pipe Hangers and Supports

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NOTE: When the project specification does not have a section for insulation of mechanical systems, include requirements of Section 15080 for metal protection shields and inserts for insulated piping in this section.
****

Design and fabrication of pipe hangers, supports, and welding attachments shall conform to MSS SP-58. Hanger types and supports for bare and covered pipes shall conform to MSS SP-69 for system temperature range. Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58. Provide metal protection shields and inserts for insulated piping in accordance with Section 15080N MECHANCIAL INSULATION. [Sway bracing shall conform with ASME B31.9.]

2.1.9.5 Pipe Guides

Provide [spider type] [cylindrical type] [or] [hold-down slide type] utilizing factory-bonded graphite, teflon, or oil-impregnated metal matched surfaces.

2.1.9.6 Pipe Sleeves

Pipe sleeves penetrating outside walls, floors, and roof slabs shall be zinc-coated steel pipe conforming to ASTM A 53/A 53M. Sleeves penetrating inside partitions shall be zinc-coated sheet steel not less than 0.51 mm 0.02 inches thick, conforming to ASTM A 653/A 653M.

2.1.9.7 Condensate Drains

ASTM B 88MASTM B 88, Type M or Type L, hard drawn with ASME B16.22 fittings.

2.1.9.8 Cooling Coil Drain Pans

[Steel, Series 300 corrosion-resistant] [Galvanized steel], [double] [single] pan(s).

2.1.10 Pumps

****
NOTE: Base pump selection upon the particular service and system requirements. Horizontal (axially) split-case double suction type pumps operating at not over 1800 RPM, or pumps as

specified below, are acceptable. The following is provided as a guide only.

Discharge Pipe Connections (Nominal Pipe Size)	Meter	Pump Type	Total Dynamic Head	Max. Pump Speed RPM
200 mm and smaller	38 (Max.)	Vertical (radially) split		1800
100 mm and smaller	30 - 60	Vertical (radially) split		3600
80 mm and smaller	18 (Max.)	(a) Vertical (radially) split, single-suction		1800
		(b) Close couple		1800
80 mm and smaller	Above 18	(a) Vertical (radially) split, single-suction		1800
		(b) Close couple		1800

Discharge Pipe Connections (Nominal Pipe Size)	Meter	Pump Type	Total Dynamic Head	Max. Pump Speed RPM
8" and smaller	125 (Max.)	Vertical (radially) split		1800
4" and smaller	100 - 200	Vertical (radially) split		3600
3" and smaller	60 (Max.)	(a) Vertical (radially) split, single-suction		1800
		(b) Close couple		1800
3" and smaller	Above 60	(a) Vertical (radially) split, single-suction		1800
		(b) Close couple		1800

****

Horizontal centrifugal water pumps for [dual service] [chilled water], [and] [condenser] water systems shall conform to FS A-A-50562, Type I-General Service, [Style 1-Horizontally (Axially) Split Case] [Style 2-End Suction (On Base Plate)] [Style 3-End Suction Closed Couple] [Class 1-Single Stage] [Class 2-Multi-stage], and shall have replaceable mechanical seals of material and style recommended by the manufacture for the particular service. End suction pump shall have vertical (radially) split casing. Pumps shall have [single] [double] suction with [volute] [or] [diffuser] water passage. Impellers shall have [radial] [or] [mixed] flow. Select pumps so that the operating point on selected impeller-curve will lie at or to left of shutoff side of, and not more than 5 percent below, point of maximum efficiency for impeller. [Vertical or horizontal, inline circulator pumps for forced hot water heating systems shall conform to FS A-A-50560.]

2.1.10.1 Pump Motors

Motors shall conform to NEMA MG 1 and be suitable for electrical characteristics as indicated. Provide [open] [splash proof] [totally enclosed] type.

2.1.10.2 Motor Starters

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NOTE: Motor control requirements should be coordinated with Electrical Section and will depend on field conditions. The following types of motor starters should be used as a guide only. When electrical power circuits to which air conditioning units are connected are heavily loaded, full voltage-across line starting may result in excessive voltage drop on circuit.

Motor kW	**Voltage**	**Type Starter**
Up to 5.50	**208-230**	**Across line magnetic**
5.50 to 11	**208-230**	**Across line magnetic, part wind or wye delta**

Motor H.P.	**Voltage**	**Type Starter**
Up to 7 1/2	**208-230**	**Across line magnetic**
7 1/2 to 15	**208-230**	**Across line magnetic, part wind or wye delta**

****

NEMA ICS 2 [manual] [across the line] [reduced-voltage-start] [part-wind] [wye-delta] type with NEMA ICS 6 [general purpose] [weather-resistant] [watertight] enclosure.

2.1.11 Tanks

2.1.11.1 Expansion Tank

Provide welded steel tank constructed and tested hydrostatically in accordance with ASME BPVC SEC VIII D1. Minimum design pressure of tank shall be as specified. Tank shall be zinc-coated inside and out after fabrication by ASTM A 123/A 123M hot-dip process. Tank shall have drain, fill, air charging and system connections.

2.1.11.2 External Air Separation Tank

Provide steel tank, designed and constructed in accordance with ASME BPVC SEC VIII D1, factory-tested and ASME-labeled for design pressure specified. Capacity of separator shall not be less than indicated. Tank shall have tangential connections, flanged for sizes 65 mm 2 1/2 inches and larger and threaded connections for 50 mm 2 inches and smaller inlets and outlets. Each unit shall have an internal design suitable for creating required vortex and subsequent air separation, for air release to [system expansion tank] [atmosphere] [vent] and shall also have a galvanized steel strainer. Provide a blow-down connection with a gate valve piped to nearest floor drain.

2.1.12 Instrumentation

Provide scale range based upon location, application, and design pressure as indicated or specified.

2.1.12.1 Pressure and Vacuum Gages

Dial Type, elastic element, ASME B40.1 with integrally mounted restrictor, dial size 114 or 150 mm 4 1/2 or 6 inches; positive, vacuum, compound, or differential pressure type as indicated.

2.1.12.2 Tank Gages

FS A-A-50568.

2.1.12.3 Indicating Thermometers

Thermometers shall be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) shall have a nominal scale diameter of 125 mm 5 inches. Construction shall be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem shall be straight, length as required to fit well. Bimetal thermometers shall have a scale diameter of 90 mm3 1/2 inches. Case shall be hermetic. Case and stem shall be constructed of stainless steel. Bimetal stem shall be straight and of a length as required to fit the well.

2.1.12.4 Remote Reading Thermometers

Separable well type with insertion length and sensing portion length of well and socket suitable for piping and service intended.

2.1.12.5 Pressure/Temperature Test Ports

Pressure/Temperature Test ports shall have brass body and EPDM and/or Neoprene valve seals. Ports shall be rated for service between 2 and 135 degrees C 35 and 275 degrees F and up to 3447 kPa (gage) 500 psig. Ports shall be provided in lengths appropriate for the insulation thickness specified in Section 15080N MECHANICAL INSULATION and installed to allow a minimum of 305 mm 12 inches of access for probe insertion. Provide with screw-on cap attached with a strap or chain to prevent loss when removed. Ports shall be 8 mm DN 1/4 inch NPT and accept 3 mm 1/8 inch diameter probes.

2.1.13 Expansion Joints

2.1.13.1 Guided Slip Tube Expansion Joints

ASTM F 1007, internally-externally guided, injected semiplastic packing, with service outlets, and ASME B16.5 flanged end connections. Provide single or double slip tube type as indicated.

2.1.13.2 Flexible Ball Expansion Joints

Carbon steel with polished steel balls capable of 360 degrees rotation plus 15 degrees angular flex movement, ASME B16.5 flanged end connections. Provide pressure-molded composition gaskets suitable for continuous

operation at twice design temperature.

2.1.13.3 Bellows Expansion Joints

ASTM F 1120, Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, external protective covers, and ASME B16.5 flanged end connections. Joints shall be designed to withstand 10,000 cycles over a period of 20 years.

2.1.14 Backflow Preventers

Reduced pressure principle type conforming to applicable requirements of AWWA C511.

PART 3 EXECUTION

3.1 INSTALLATION

Install piping and piping components to ensure proper and efficient operation of equipment, and controls and in accordance with manufacturer's printed instructions. Provide proper supports for mounting of vibration isolators, stands, guides, anchors, clamps and brackets. Arrange piping connections to equipment so that removal of equipment or components of equipment including tube withdrawal from chillers, pump casing, shaft seals and similar work can be accomplished with the least amount of disassembly or removal of piping system. Provide piping connected to equipment with vibration isolators with flexible connections which shall conform to vibration and sound isolation requirements for system. Electric isolation shall be provided between dissimilar metals to reduce rate of galvanic corrosion.

3.1.1 Water Piping

ASME B31.9.

3.2 PIPING SYSTEMS

Cut to measurements established at site and work into place without springing or forcing. Install piping with line flexibility included to absorb expansion and contraction due to temperature changes of piping systems. Piping line flexibility shall be achieved by use of [pipe bends or loops] [or] [bellows-type expansion joints] [and] [or] [slip-type expansion joints] [flexible ball-type expansion joints].

[a. Bellows-type expansion joints: Provide limit stops to limit total movement in both directions. Cold set joints to compensate for temperature at time of installation. Provide [single] [or] [double] bellows expansion joint [as indicated]. Provide first pipe alignment guide no more than 4 pipe diameters from expansion joint; provide second pipe alignment guide no more than 14 pipe diameters from first guide.]

3.2.1 Flanged Joints

Faced true, square, tight and provided [as indicated] [and] where necessary for normal maintenance. Mate with valves and various equipment connections. Remove raised faces when used with flanges having a flat face.

3.2.2 Threaded Joints

Clean threads and apply suitable amount of teflon tape or teflon pipe dope prior to making joint.

3.2.3 Pipe Bends

Acceptable in lieu of pipe fittings where space permits. Pipe bends shall have a uniform radius of at least five times the nominal pipe diameter. Pipe bends shall be free of any flattening, wrinkling, or thinning of pipe walls other than minor external surface distortions. In occupied space pipe bend radii shall not exceed five times the nominal pipe diameter.

3.2.3.1 Copper Tubing

Pipe bends for annealed copper tubing in lieu of fittings may be provided where space permits. Bends for annealed copper tubing shall conform to CDA A4015. Tubing bends shall be free of any appreciable flattening, wrinkling, or thinning of tubing walls.

3.2.4 Reducing Fittings

Provide to connect changes of sizes in piping lines. Make branch connections with tees [except that factory-made-forged-steel welding branch outlets or nozzles having integral reinforcements and conforming to ASME B31.9 may be provided when the nominal diameter of piping system branch does not exceed one nominal pipe size less than nominal size of piping segment containing fitting].

3.2.5 Insulation

Piping insulation [shall be in accordance with Section 15080N MECHANICAL INSULATION] [and] [shall be as indicated] [and] with enough clearance allowed between pipes to permit application of insulation.

3.2.6 Brazing and Soldering

Preparation and procedures for soldering and brazing of joints shall conform to ASME B31.9 and shall be in accordance with the procedure as outlined in CDA A4015.

3.2.7 Dielectric Unions or Flanges

Provide between ferrous and nonferrous piping, equipment, and fittings; except that bronze valves and fittings may be provided without dielectric couplings for ferrous-to-ferrous or nonferrous-to- nonferrous connections. Flanges and unions shall conform to requirements of ASME B16.10.

3.2.8 Pipe Hangers and Supports

Installation including spacing shall conform to ASME B31.9.

3.2.9 Pipe Guides

Protect and clean teflon or oil-impregnated matched surfaces prior to start-up.

3.2.10 Flexible Connections

Install flexible pipe connectors on piping connected to equipment. Flexible section shall consist of rubber, tetrafluoroethylene resin, corrosion-resistant steel, bronze, monel, or galvanized steel. Material provided and configuration shall be suitable for [pressure,] [vacuum,] [temperature,] and circulating medium. Flexible section shall have [threaded,] [welding,] [soldering,] [flanged] [or] [socket-weld] ends and shall be suitable for service intended. Flexible section may be reinforced with metal retaining rings, with built-in braided wire reinforcement and restriction bolts or with wire braid cover suitable for service intended.

3.2.11 Pipe Sleeves

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NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.
****

Provide pipe sleeves for pipes and tubing which penetrate building structure. Securely retain sleeves in position and location before and during construction. Space between pipe and sleeves, or between insulation of pipe and sleeves, shall be not less than 6 mm 1/4 inch between outside of pipe or insulation, and inside wall of sleeves. Pack annular space with hemp or fiberglass, and seal with elastic cement. Sleeves for uninsulated pipes shall have ends flush with finished wall surfaces and pipe or tubing with outside perimeter of pipe calked to sleeve. Sleeves for insulated pipes shall extend 15 mm 1/2 inch from concrete or masonry ceiling or wall faces and outside perimeter of insulation shall be caulked to sleeve on both sides of faces. Seal terminal ends of pipe insulation with mastic. Sleeves for lines passing through floors shall extend 75 mm 3 inches above finished floor slab, and be calked to the slab. Equip lines passing through exterior walls and roof areas with flashing and counter flashing [as indicated] [or] [as approved] to form a watertight roof seal [and shall conform to [_____]].

3.3 WATER PIPING

[Chilled Water,] [Condenser Water,] [and] [Hot and Cold Water (Dual Service)] Piping:

3.3.1 Fabrication and Assembly of Piping and Components

Welding, heating, and soldering shall conform to ASME B31.9 and as specified herein. [Horizontal runs of piping shall pitch toward water chiller at not less than 25 mm in 6 meters one inch in 20 feet.] Provide sufficient pitch to assure adequate drainage and venting. Drain valves at low points of piping system, and automatic air vent valves at high points where air pockets would occur. Piping shall follow general arrangement shown, cut accurately to measurements established for the work by the Contractor, and worked into place without springing or forcing, except where cold-springing is indicated. Piping and equipment within buildings shall be entirely out of the way of electrical conduit, lighting fixtures, equipment and doors, windows, and other openings. Run overhead piping in buildings in the most inconspicuous positions. Provide adequate clearance from walls, ceilings, and floors to permit welding of joints; at least 152 mm 6 inches for pipe sizes 100 mm 4 inches and less, 254 mm 10 inches for pipe sizes over 100 mm 4 inches, and in corners provide sufficient clearance to permit the welder to work between pipe and one wall. Provide

for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate piping until inspected, tested, and approved. Protect materials and equipment from weather. Run pipe to be insulated as shown and as required with sufficient clearance to permit application of insulation. Do not miter pipe to form elbows, or notch straight runs to form full-sized tees, or utilize any similar construction. Except where shown otherwise, run vertical piping plumb and straight and parallel to walls. Thoroughly clean each section of pipe, fittings, and valves to be free of foreign matter before erection. Prior to erection, hold each piece of pipe in an inclined position and thoroughly tap to loosen sand, mill scale, and foreign matter. Before final connections are made to apparatus, wash interior of piping thoroughly with water. Blow out piping with high pressure steam or compressed air to remove rust scale, oil, and debris. Plug or cap open ends of mains during shutdown periods. Do not leave lines open at any place where foreign matter might accidentally enter.

3.3.1.1 Insulation of Copper Tubing

Insulate copper tubing placed in cinder fill or run through cinder block foundation from cinder material to prevent sulphur corrosion by wrapping complete continuous tubing surface with protective tape.

3.3.1.2 Strainers

Provide strainers in [chilled water] [and] [condenser water] lines to protect orifices, automatic valves, pump and compressor from foreign materials. Locate strainers close to equipment to be protected. Install strainers with screen drum and in direction of flow, as marked on strainer body. Strainers shall have isolating service valves to permit servicing strainer with minimum loss of fluid. Provide clearance for removal and replacing of strainer screens. Strainers shall have screens of ample net free area and be composed of materials which shall be compatible with fluid being used. Provide reducer fittings for changes in pipeline sizes and strainer connection sizes. Provide a pressure gage with valved connection to inlet and outlet sides of strainer for determining pressure drop through strainer, for indicating need for cleaning strainer screen.

3.3.1.3 Shell and Tube Vessels and Clearance

Provide shutoff valves in water lines to vessels to permit servicing without draining system. Locate valves so as not to interfere with head removal. Where water boxes are provided, water piping connections may be made directly to covers. Provide piping with mechanical piping connections adjacent to covers, and water shutoff valves located so as not to interfere with tube cleaning or pulling operations after pipe sections have been removed. Maintain working space for removal of heads, and on one end of vessel provide a clear space at least equal to overall length, breadth, and depth of the tube bundle for tube removal. A door opening, window, or wall opening, may be utilized for this purpose.

3.3.1.4 Piping, Chilled Water Coils

Provide chilled water coils with a counterflow piping arrangement. Connect supply piping at bottom of coil and connect return piping at top of coil. Provide supply piping to coil connection with gate valve, strainer, thermometer-bypass tee for valve bypass when three way valve is provided, tee with nipple, globe valve with hose connection, and union in that order. In lieu of orifice with manometer connections and [plug valve] or [ball

valve] a calibrated balancing valve may be provided for balancing the water flow. Provide return piping from coil connection with a union, tee with nipple, globe valve with hose connection, air chamber and vent at high point, thermometer, automatic control valve and bypass, when required, orifice with manometer connections, [plug valve] [or] [ball valve] for balancing, and gate valve, in that order. Provide lengths of straight, uninterrupted pipe before and after orifice flanges, as required by the orifice manufacturer. Provide [plug valve] [or] [ball valve] for balancing in three-way valve by-pass piping when included as part of system. Provide unions and flanges as necessary to permit removal of coil and automatic control valves. Piping and fittings shall not interfere with access to equipment. For multi-coil arrangement, provide each supply and return line to and from coil with a union, thermometer well, and [plug valve] [or] [ball valve] for balancing.

3.3.1.5 Pumps

Support, anchor, and guide so that no strains are imposed on pump by weight or thermal movement of piping. Provide air vent valve on pump casing. Pipe drain outlets on pump bases to nearest floor or other acceptable drains, with necessary clean-out tees. Provide pig tails or pet cocks for pressure gages on suction and discharge for water balancing measurements.

3.3.1.6 Valves

Install at equipment to allow maintenance or isolation, and to establish proper and sequential operation of complete system. Shell and tube liquid coolers shall have fluid valves installed so that tubes are accessible for cleaning or replacing. Provide globe valves or plug cocks where required to regulate flow to obtain equal distribution of gas or fluid handled. Remove valve bonnets, where valve construction permits removal, when connecting valves by brazing to copper tubing. Install globe and angle valves with stems horizontal where necessary to avoid trapping of fluid.

3.3.1.7 Air Vent Valves

Provide at high points in water piping and at water coils and water heat exchangers. Provide isolation valves and pipe to run off into the nearest floor drain.

3.3.1.8 Orifice Flanges

Provide in the main [chilled water] [and] [condensing water] piping, [and] [chilled water coils]. Provide orifice flange conforming to ASME B16.36, with tapped openings and pipe extensions with shutoff valves. Provide venturi or pitot flow tubes in lieu of orifice plates. Provide each orifice plate, venturi tube or pitot tube, with an integral tab, or a tag on a chain, extending outside pipe covering on which shall be stamped or printed in a plainly visible position the manufacturer's name and address, serial number of meter to which it is to be connected, name or number of equipment served or its location, specified rate of flow and multiplier, if any, to be applied to meter reading. Specified rate of flow will be that of connected pump and cooling coil or as indicated. Select venturi tube, pitot tube, or orifice sizes from the manufacturer's latest published flow versus differential pressure tables.

3.3.1.9 Automatic Flow Control Valve

When necessary, increase system pump head to obtain proper operating

differential between body tappings for control of maximum flow; minimum allowance 14 kPa 2 psi, maximum allowance 21 kPa 3 psi. Verify correct flow by establishing that operating pressure differential across valve tappings is within tag range. Pressure measuring apparatus shall be portable and consist of a carrying case, instructions, hoses and connections, and a push-button, three way valve which transmits either of two pressures to a pressure gage. Pressure gage shall have a 115 mm 4 1/2 inch minimum diameter dial calibrated in increments of 5 kPa one psi or less, and shall have a range of minus 101 kPa 14.7 psi to design pressure. Where flow-rate-pressure differential is marginal or deficient, use a portable flowmeter to verify flow rate, when requested by the Contracting Officer.

3.3.1.10 Automatic Water Regulating Valves

When indicated, install a solenoid valve upstream of the regulating valve to completely open or completely shutoff water supply when compressor starts and stops. Solenoid valves will not be required on cooling tower lines running from automatic water regulating valve. Regulating valve shall limit flow of cooling water to actual requirements of system load. Size valves so that head loss at maximum flow will not exceed that of 3 running meters 10 running feet of pipe or half the head loss through condenser, whichever is greater. Install a three-way automatic regulating valve with common outlet piped to cooling tower, bypass piped to one inlet and condenser water outlet to other inlet. Common outlet shall have balancing cocks provided in upstream piping for required equal pressure adjustment.

3.3.1.11 Closed Expansion Tank

Provide automatic water makeup, and automatic relief to drain with air gap between relief outlet and drain. Pneumatically pressurize tank during charging of water, so that system is fully charged with water and with level in expansion tank at normal level at normal operating conditions.

3.3.1.12 Instrumentation

Locate gages and thermometers as indicated.

a. Pressure and vacuum gage: Provide a shutoff valve or pet cock between pressure gages and pipe line.

b. Thermometers: Provide thermometers and thermal sensing elements of control valves with a separate socket. Install separable sockets in pipe lines in such a manner to sense temperature of flowing fluid and minimize obstruction to flow.

3.4 MISCELLANEOUS DRAINS

3.4.1 Condensate Drains

Provide drain piping from cooling coils to drain condensate. Trap drains at exit point of cooling coil and connect to area drain system, in accordance with ICC IPC.

3.4.2 Cooling Coil Drain Pans

Provide drain connections and lines to remove condensate collected on cold coil surface from air stream. Pipe condensate from drain pan bottom to a

disposal point outside of coil casings and trap to ensure complete pan drainage. Provide double drain pans where possible.

3.5 MISCELLANEOUS PIPING

3.5.1 Make-up Water Piping

Provide make-up water piping to water control float assembly of [evaporative condensers] [and] [cooling towers], [expansion tanks]. Protect potable water system at cross-connection to make-up water piping by a backflow preventer of type specified in paragraph entitled "Backflow Preventers."

3.5.2 Drain and Overflow Piping

Provide drain and overflow piping for [cooling towers] [evaporative condensers] [evaporative coolers]. Connect drain piping to area drain system.

3.5.3 Water Bleedoff Piping

Provide a constant restricted water bleedoff during operation of [cooling tower] [evaporative condenser] [evaporative coolers] by means of a bleed connection in pump discharge with a regrinding type globe valve, or interchangeable type orifice so that bleed quantity may be set for local water conditions, to prevent accumulation of undesirable concentration of salts and acids. Route bleedoff piping to nearest area drain system [or as indicated.]

3.5.4 Cooling Towers and Evaporative Condensers

Roof installations, where ambient temperature is seasonally below freezing, shall have basin overflow connected to basin drain, and drain line shall immediately enter the building where it is not subjected to freezing, in route to drain sewer. Towers and condensers at grade level shall have overflow and drain similarly connected, and drain shall then run underground to nearest available drain sewer. Towers and condensers installed on a roof area, and where ambient temperature does not subject them to freezing, may drain on roof, when rain water conductors are of ample size to accept flow when draining.

3.6 ELECTRICAL EQUIPMENT

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NOTE: Where applicable, provide sensors for tie-in to Energy Monitoring Control System including testing of sensor points. This should be coordinated with the applicable NFGS-EMCS section where used.

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[Motor starters shall be provided complete with properly sized thermal overload protection and other appurtenances necessary for motor control specified.]

3.7 CLEANING OF SYSTEMS

When installations of various components of piping systems are completed, clean before final closing. Clean piping and components of scale and

thoroughly flush out foreign matter. Provide temporary bypasses for water coils to prevent flushing water from passing through coils. Clean strainers and valves thoroughly. Wipe equipment clean, removing traces of oil, dust, dirt, or paint spots. Maintain system in this clean condition until final approval. Clean and paint piping and equipment.

3.7.1 Safety Procedure

Ventilate work area, avoiding skin contact by using solvent-resistant gloves. Observe precautions and warnings on the manufacturer's product labels. Conform to requirements of 29 CFR 1910.1200.

3.8 IDENTIFICATION OF PIPING AND PHYSICAL HAZARDS

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NOTE: When the project specification does not have a painting section, include requirements in Section 09900, "Paints and Coatings" for cleaning and painting of piping and equipment, and stencilling of piping in this section.
****

Identify piping and physical hazards in accordance with CFR 29 CFR 1910.144, ANSI A13.1, ANSI Z53.1. Spacing of identification marks on runs shall not exceed 15 meters 50 feet. Painting and stencilling shall conform to Section 09900 PAINTS AND COATINGS. Colors shall conform to ANSI Z53.1. Tag equipment, gages, thermometers, valves, and controllers with tags of brass or approvable nonferrous material and securely mount or attach.

3.9 FIELD INSPECTIONS

Prior to initial operation examine and inspect piping system[s] for conformance to plans and specifications, ASME B31.9. Equipment, material, or work rejected because of defects or nonconformance with plans, specifications, and ANSI Codes for pressure piping shall be corrected as directed by the Contracting Officer.

3.10 FIELD TESTS

After completion of piping installation and prior to initial operation, conduct tests on piping system. Furnish materials and equipment required for tests. Correct defects disclosed by test. Perform test after installation and prior to acceptance in presence of the Contracting Officer and subject to his approval.

3.10.1 Water Piping

Hydrostatically test in accordance with requirements of ASME B31.9. Test piping system at twice the design pressure with water not exceeding 38 degrees C 100 degrees F. Before tests, remove or isolate gages, traps, and other apparatus in [new system] [existing piping system] which may be damaged. Repair leaks [tightening] [rewelding joints] [or] [renewing pipe or fittings]. Do not caulk joints. Install a calibrated, test pressure gage in system to observe loss in pressure. Maintain required test pressure for a sufficient amount of time to enable an inspection of joints and connections. Correct defects disclosed by test.

3.11 STARTUP AND OPERATIONAL TESTS

Start up and initially operate [chilled water] [and] [condenser water] system. During this time, periodically clean various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of water occurs when strainers are cleaned. Adjust safety and automatic control instruments as necessary to place them in required operation and sequence.

3.12 TESTING, ADJUSTING, AND BALANCING

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NOTE: Use the first sentence for simple hydronic systems and where Section 15950, "HVAC Testing/Adjusting/Balancing" is not included in the specification. Use the second sentence for all specifications with Section 15950.
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[Except as specified herein, perform in accordance with SMACNA HVACTAB, Chapter VIII "Hydronic System TAB Procedures," drawings and specifications; prepare complete report of final test results.] [Test, adjust and balance the hydronic system in accordance with Section 15950N HVAC TESTING/ADJUSTING/BALANCING.]

3.13 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurement, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Pressure Gages		
Dial Size	4 1/2 or 6 inches	114 or 150 mm
b. Thermometers		
Fluid-Filled		
Nominal Scale Diameter	= 5 inches	= 125 mm
Bimetal		
Nominal Scale Diameter	= 3 1/2 inches	= 90 mm

-- End of Section --