UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION TABLE OF CONTENTS

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM

04/06, CHG 2: 11/19

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 SYSTEM DESCRIPTION
1.3.1 Hot Water Heating System
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Standard Commercial Product for Terminal Units
1.5.2 Welding
1.5.2.1 Report of Prior Installations
1.5.2.2 Welding Procedures
1.5.2.3 Welder's Qualifications
1.5.2.4 Identification of Welder's Work
1.5.2.5 Previous Qualifications
1.5.3 Brazing and Soldering
1.5.3.1 Brazing Procedure
1.5.3.2 Soldering, Soldering Preparation, and Procedures for Joints
1.5.4 Backflow Preventer Certification
1.6 SAFETY STANDARDS
1.6.1 Welding
1.6.2 Guards

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS
2.1.1 Hot Water Heating Pipe (Supply and Return)
2.1.2 Fittings
2.1.2.1 Steel or Malleable Iron Pipe
2.1.2.2 Steel, Cast Iron, or Bronze
2.1.2.3 Fittings for Copper Tubing
2.1.3 Unions
2.1.3.1 Steel Pipe
2.1.3.2 Copper Tubing

2.1.3.3 Dielectric Union
2.1.4 Flanges
2.1.4.1 Steel Flanges
2.1.4.2 Cast Iron Screwed Flanges
2.1.4.3 Bronze Screwed Flanges
2.1.5 Drains and Overflows
2.1.5.1 Steel Pipe
2.1.5.2 Copper Tubing
2.1.5.3 PVC Pipe
2.1.6 Valves
2.1.6.1 Gate Valves
2.1.6.2 Globe and Angle Valves
2.1.6.3 Check Valves
2.1.6.4 Temperature Regulating Valves
2.1.6.5 Water Pressure-Reducing Valves
2.1.6.6 Plug Valves
2.1.6.7 Ball Valves
2.1.6.8 Radiator Valves
2.1.6.9 Flow Control Balancing Valves
2.1.6.10 Butterfly Valves
2.1.6.11 Butterfly Valves 2 Millimeters 2 Inches and Smaller
2.1.6.12 Relief Valves
2.1.6.13 Valve Operating Mechanisms
2.1.6.14 Balancing Valves
2.1.7 End Connections
2.1.7.1 Flexible Connectors
2.1.7.2 Steel Piping
2.1.7.3 Joints for Copper Tubing
2.1.8 Expansion Joints
2.1.8.1 Packless Type
2.1.8.2 Guided Slip-Tube Type
2.1.9 Instrumentation
2.1.9.1 Pressure and Vacuum Gauges
2.1.9.2 Indicating Thermometers
2.1.9.3 Pressure/Temperature Test Ports
2.1.10 Miscellaneous Pipeline Components
2.1.10.1 Air Vent
2.1.10.2 Strainers
2.1.10.3 Hangers and Supports
2.1.10.4 Pipe Sleeves
2.1.10.5 Escutcheon Plates
2.2 CENTRAL MECHANICAL EQUIPMENT
2.2.1 Boilers
2.2.2 Hot Water Heat Exchangers
2.2.3 Converters
2.3 PIPING SYSTEM EQUIPMENT
2.3.1 Pumps
2.3.2 Expansion Tanks
2.3.3 External Air Separation Tanks
2.3.4 Backflow Preventers
2.3.5 Flow Measuring Equipment
2.4 TERMINAL UNITS
2.4.1 Finned Tube Radiators
2.4.2 Convectors
2.4.3 Unit Heaters
2.4.4 Heating and Ventilating Units
2.5 ELECTRICAL EQUIPMENT
2.6 CONTROLS
2.7 INSULATION

2.8 ASBESTOS PROHIBITION

PART 3 EXECUTION

3.1 PREPARATION
3.2 INSTALLATION
3.2.1 Hangers and Supports
3.2.2 Grading of Pipe Lines
3.2.3 Pipe Sleeves
3.2.4 Flashing for Buildings
3.2.5 Unions and Flanges
3.2.6 Connections for Future Equipment
3.2.7 Changes in Pipe Size
3.2.8 Cleaning of Pipe
3.2.9 Valves
3.2.9.1 Globe Valves
3.2.9.2 Radiators Valves
3.2.9.3 Relief Valves
3.2.10 Pressure Gage
3.2.11 Thermometers
3.2.12 Strainers
3.2.13 Pumps
3.2.14 Equipment Foundations
3.2.15 Equipment Installation
3.2.16 Cleaning of Systems
3.2.17 Painting of Piping and Equipment
3.2.18 Identification of Piping
3.3 FIELD QUALITY CONTROL
3.3.1 Hydrostatic Test of Piping System
3.3.2 Auxiliary Equipment and Accessory Tests
3.3.2.1 Backflow Preventers
3.4 TESTING, ADJUSTING, AND BALANCING
3.4.1 Markings of Settings
3.4.2 Sound Level Tests
3.5 SCHEDULE

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA	**UFGS-23 21 13.00 20 (April 2006)**
	Change 2 - 11/19

Preparing Activity: NAVFAC	**Replacing without change UFGS-15185N (September 1999)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION 23 21 13.00 20

LOW TEMPERATURE WATER (LTW) HEATING SYSTEM
04/06, CHG 2: 11/19

****
NOTE: This guide specification covers the requirements for complete low temperature water heating system including hot water piping (supply and return) and terminal units used for heating.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: This section does not include feedwater treatment equipment or process hot water terminal units. Piping as used in this specification includes pipe, tubes, flanges, bolting, gaskets, valves, relief devices, fittings, and pressure containing parts of other piping components, hangers and supports, and other equipment items necessary to prevent overstressing of the pressure containing parts.
****

****
NOTE: The following information should be shown on the drawings:

1. Layout of heating system.

2. Location, size, and capacity of finned tube radiators, convectors, unit heaters, flow meters, pumps, and expansion tanks.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.36	(2020) Orifice Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.9	(2020) Building Services Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2023) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM F1007	(2018; R 2022) Standard Specification for Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2019) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)

FCCCHR List	(continuously updated) List of Approved Backflow Prevention Assemblies

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

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves

MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

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

SMACNA 1780	(2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-V-12003	(1980; Rev F; Am 1; CANC Notice 1) Valves, Plug, Cast-Iron or Steel, Manually Operated

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689	(Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film)
CID A-A-50543	(Basic; Notice 2; Notice 3) Heaters, Convection, Steam or Hot Water
CID A-A-50544	(Basic; Notice 2; Notice 3) Radiators, Heating, Steam and Hot Water, Cast Iron
CID A-A-50545	(Basic; Notice 2; Notice 3) Radiator, Heating, Baseboard Panel, Steam and Hot Water
CID A-A-50560	(Basic) Pumps, Centrifugal, Water

	Circulating, Electric-Motor-Driven
CID A-A-59617	(Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections
FS S-R-2834	(Basic; Notice 1; CANC Notice 1) Radiators: Heating, Steel, Multifin Type
FS WW-H-191	(Rev E; Notice 2) Heater, Fluid, Industrial (Instantaneous, Steam, Water Converter Type)
FS WW-S-2739	(Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

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

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards
29 CFR 1910.219	Mechanical Power Transmission Apparatus

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

Except as specified otherwise, equipment and piping components shall be suitable for use in low temperature water heating system. Except as modified herein, the pressure temperature limitations shall be as specified in the referenced standards and specifications. Pressures in this specification are pressures in kilopascal (kPa) pounds per square inch above atmospheric pressure, and temperatures are in degrees Centigrade (C) Fahrenheit (F).

1.3.1 Hot Water Heating System

Submit plan, elevations, dimensions, capacities, and ratings. Include the following:

a. Unit heaters

b. Convectors

c. Finned tube radiators

d. Pumps

e. Valves

f. Expansion tanks

g. Flow measuring equipment

h. Backflow preventer

i. Air separating tank

[j. Boilers]

[k. Hot water heat exchangers]

[l. Converters]

1.4 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hot water heating system

SD-03 Product Data

Convectors

Finned tube radiators

Pumps

Include pump speed and characteristic curve for performance of impeller selected for each pump. Curves shall indicate capacity vs head, efficiency, and brake power for full range, from shut-off to free delivery.

Expansion tanks

Flow measuring equipment

Backflow preventers

External air separation tanks

Hot water heating pipe

SD-06 Test Reports

Hydrostatic test of piping system

Auxiliary equipment and accessory tests

Submit test reports in accordance with the paragraph entitled "Field Quality Control."

SD-07 Certificates

Backflow preventer certification

Report of prior installations

Welding procedures

Welder's qualifications

SD-10 Operation and Maintenance Data

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

Finned tube radiators, Data Package 3; G[, [_____]]

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit a list of qualified service organizations which includes addresses and qualifications.

1.5 QUALITY ASSURANCE

1.5.1 Standard Commercial Product for Terminal Units

Terminal units provided shall comply with features called out in this specification and shall be the manufacturer's standard commercial product. Additional or better features which are not prohibited by this

specification but which are a part of the manufacturer's standard commercial product, shall be included in the terminal units being furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs, or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

1.5.2 Welding

1.5.2.1 Report of Prior Installations

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project. Certificate shall be from the Foundation for Cross-Connection Control and Hydraulic 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 is not acceptable in lieu of the above.

1.5.2.2 Welding Procedures

Before performing welding, submit three copies of welding procedure specification for all metals to be used in the work, together with proof of welder's qualification as outlines in ASME B31.9.

1.5.2.3 Welder's Qualifications

Before welder or operator performs welding, submit three copies of Welder's Performance Qualification Record in conformance with ASME B31.9 showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder.

1.5.2.4 Identification of Welder's Work

Ensure that each welder's assigned number, letter or symbol is affixed immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a requalification test. Upon failing to pass the test, do not permit welder to work in this contract.

1.5.2.5 Previous Qualifications

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

1.5.3 Brazing and Soldering

1.5.3.1 Brazing Procedure

ASME B31.9. Brazing procedure for joints shall be as outlined in CDA A4015.

1.5.3.2 Soldering, Soldering Preparation, and Procedures for Joints

ASME B31.9 and as outlined in CDA A4015.

1.5.4 Backflow Preventer Certification

Submit a Certificate of Full Approval or a current Certificate of Approval for backflow preventers.

1.6 SAFETY STANDARDS

1.6.1 Welding

Safety in welding and cutting of pipe shall conform to AWS Z49.1.

1.6.2 Guards

Couplings, motor shafts, gears and other moving parts shall be guarded, in accordance with OSHA 29 CFR 1910.219. Guards shall be cast iron or expanded metal. Guard parts shall be rigid and removable without disassembling the guarded unit.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Hot Water Heating Pipe (Supply and Return)

****

NOTE: Specify Schedule 40, 80, or 120 steel or Type K or L copper as required for temperature and pressure involved. Type M copper should only be specified for drain piping.

****

ASTM A53/A53M electric resistance welded or seamless Schedule [_____] steel pipe [or ASTM B88M ASTM B88 Type [_____] hard drawn Copper tubing].

2.1.2 Fittings

Provide fittings compatible with the pipe being provided and shall conform to the following requirements.

2.1.2.1 Steel or Malleable Iron Pipe

Sizes 3 to 50 mm 1/8 to 2 inches. ASME B16.11 steel socket welding or screwed type or ASME B16.3 for screwed type malleable iron fittings.

2.1.2.2 Steel, Cast Iron, or Bronze

Sizes 65 mm 2 1/2 inches and above. Steel fitting butt welding type ASME B16.9 or ASME B16.5 flanged type. Cast iron fittings flanged type ASME B16.1. Bronze fittings up to 200 mm 8 inch size flanged type ASME B16.24.

2.1.2.3 Fittings for Copper Tubing

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type. Fittings may be flared or compression joint type.

2.1.3 Unions

2.1.3.1 Steel Pipe

Provide ASME B16.39, malleable iron unions, threaded connections.

2.1.3.2 Copper Tubing

Provide CID A-A-59617, bronze unions, solder joint end.

2.1.3.3 Dielectric Union

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

2.1.4 Flanges

Remove raised faces when used with flanges having a flat face.

2.1.4.1 Steel Flanges

ASME B16.5 forged steel, welding type.

2.1.4.2 Cast Iron Screwed Flanges

ASME B16.1.

2.1.4.3 Bronze Screwed Flanges

ASME B16.24.

2.1.5 Drains and Overflows

2.1.5.1 Steel Pipe

ASTM A53/A53M, [Electric resistance welded] [Seamless] Schedule 40, Malleable iron or forged steel fittings, screwed or welded joints.

2.1.5.2 Copper Tubing

ASTM B88M ASTM B88, Type [K,] [L,] [M,] hard drawn, cast brass or wrought copper fittings, Grade Sb5 solder joints.

2.1.5.3 PVC Pipe

ASTM D1785, Schedule 40, [and Schedule 80 for sizes 200 mm 8 inch and larger,] solvent weld joints.

2.1.6 Valves

Valves shall have rising stems and shall open when turned counterclockwise.

2.1.6.1 Gate Valves

a. Bronze Gate Valves: MSS SP-80, 50 mm 2 inches and smaller, wedge disc, inside screw type not less than Class 150. Use solder joint ends with copper tubing.

b. Steel Gate Valves: ASME B16.34, provide with open stem and yoke type with solid wedge or flexible wedge disc and heat and corrosion-resistant steel trim.

c. Cast Iron Gate Valves: MSS SP-70, 65 mm 2 1/2 inches and larger, open stem and yoke type with bronze trim.

2.1.6.2 Globe and Angle Valves

a. Bronze Globe and Angle Valves: MSS SP-80, 50 mm 2 inches and smaller, Class 200, except use Class 150 with solder ends for copper tubing. Valves shall have renewable seat and discs except solder end valves which shall have integral seats.

b. Steel Globe and Angle Valves: ASME B16.34, provide with heat and corrosion-resistant trim.

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

2.1.6.3 Check Valves

a. Bronze Check Valves: MSS SP-80, 50 mm 2 inches and smaller, regrinding swing check type, Class 200.

b. Steel Swing Check Valves: [ASME B16.34], regrinding swing check type, Class 200.

(1) Swing check valves shall have bolted caps.

(2) Steel Lift check valves 50 mm 2 inches and smaller shall have bolted caps. Lift check valves 65 mm 2 1/2 inches and larger shall have pressure seal caps.

c. Cast Iron Check Valves: ASME B16.34, 65 mm 2 1/2 inches and larger, bronze trim, non-slam, eccentric disc type for centrifugal pump discharge service.

2.1.6.4 Temperature Regulating Valves

Provide ASSE 1017 copper alloy body with adjustable range thermostat.

2.1.6.5 Water Pressure-Reducing Valves

ASSE 1003.

2.1.6.6 Plug Valves

MIL-V-12003, except that a replaceable valve seat will not be required. [Type I - lubricated, tapered plug] [Type II - non-lubricated, lift-plug] valves.

2.1.6.7 Ball Valves

Flanged or butt-welding ends ball valve shall conform to MSS SP-72, [bronze] [steel]. Threaded, socket-welding, solder joint, grooved and flared ends shall conform to MSS SP-110.

2.1.6.8 Radiator Valves

Radiator valves shall be angle or straightway pattern, with packed or packless bonnet shutoff globe type, designed especially for hot water heating system. Valve shall be constructed of brass or bronze or copper alloy conforming to ASTM specifications for materials with non-metallic renewable disc and plastic wheel handle for shutoff service.

2.1.6.9 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.

2.1.6.10 Butterfly Valves

Conform with MSS SP-67, Type I - Tight shut off valve, and [flanged] [screwed] [single flange] [flangeless] valve ends. Valve body material shall be [cast iron] [steel] [bronze] and shall be bubble tight for shutoff at 1034 kPa (gage) 150 psig. Flanged and flangeless type valves shall have Type 300 series corrosion resistant steel stems and corrosion resistant or bronze discs with molded elastomer disc seals. Flow conditions shall be for the regulation from maximum flow to complete shutoff by way of throttling effect. Valves shall be provided in [closed] [open] system. 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 7 locking positions and shall be suitable for water temperatures up to 93 degrees C 200 degrees F.

2.1.6.11 Butterfly Valves 2 Millimeters 2 Inches and Smaller

Valves shall be one-piece and three-piece design with male or female threaded or soldered end connections and shall be bubble tight for shutoff at 1034 kPa (gage) 150 psig. Stem and disc assembly shall be of 300 series corrosion resistant steel. Disc seal assembly shall be of 300 series corrosion resistant steel. Disc seal shall be suitable for the liquid being used in the system in which the valve is to be installed. Valves shall be suitable for water temperature up to 93 degrees C 200 degrees F and shall be capable of operating at the rated pressure of [_____] kPa (gage) psig. Valves shall be designed for throttling service use by valve lever and indicator adjustment.

2.1.6.12 Relief Valves

Bronze body, teflon seat, stainless steel stem and springs, automatic,

direct pressure actuated, capacities ASME certified and labelled.

2.1.6.13 Valve Operating Mechanisms

****
NOTE: Show location of each floor stand, chainwheel or power operator required in the project. Delete paragraph entitled "Valve Operating Mechanisms" and its subparagraphs if these items are not required in the project.
****

Provide [floor stands] [chainwheels] [power operators] [and extension stems] where indicated and as specified.

****
NOTE: Show floor stand details including distance from centerline of valve to top of floor, floor thickness, and handwheel height.
****

a. Floor Stands: Construct for bolting to the floor and include an extension stem and an operating handwheel. Design an adequately supported and guided extension stems for connection to the valve stem by a sleeve coupling or universal joint. Floor stands shall be cast iron or steel. Handwheel shall identify rotation direction for closing the valve and shall be of such diameter as to permit operation of the valve with a force of not more than 178 N 40 pounds.

b. Chainwheel Operator: Shall be fabricated of cast iron or steel and shall include a wheel, endless chain and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending to within one meter 3 feet of the floor.

c. Power Operators: Shall be [electric] [pneumatic]. Power operated valves shall open and close at rates no slower than 4 mm per second 10 inches per minute for gate valves and 1.70 mm per second 4 inches per minute for globe and angle valves. Valves shall open fully or close tightly without requiring further attention when the actuating control is moved to the open or close position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve shall cause the motor to automatically stop. Power operators shall be complete with all gearing and controls necessary for the size of valve being provided. Power operators shall be designed to operate on the [electric] [compressed air] power supply indicated.

d. Extension Stem: Corrosion resisting steel designed for rising and non-rising stems. Provide in length required to connect the valve stem and the [handwheel] [operating mechanism] and of sufficient cross section to transfer the torque required to operate the valve.

2.1.6.14 Balancing Valves

Balancing valves shall be calibrated bronze body balancing valves with integral ball valve and venturi or valve orifice and valve body pressure taps for flow measurement based on differential pressure readings. Valve pressure taps and meter connections shall have seals and built-in check valves with threaded connections for a portable meter. Meter shall be

provided by the same manufacturer and be capable of reading system pressures and shall meet the requirements of the paragraph entitled "Flow Measuring Equipment." Valves shall have internal seals to prevent leakage around rotating element and be suitable for full shut-off rated pressure. Valves shall have an operator with integral pointer and memory stop. Balancing valves shall be selected for the required flows as indicated on the plans.

2.1.7 End Connections

2.1.7.1 Flexible Connectors

Provide 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.

2.1.7.2 Steel Piping

Screwed or socket welded for 50 mm 2 inches and smaller and flanged or butt welded for 65 mm 2 1/2 inches and larger.

a. Screwed Joints With Taper Threads: ASME B1.20.1.

b. Flanged Joints: Bolting and gaskets shall be as follows:

(1) Bolting: Bolt and stud material ASTM A307, Grade B, and nut material ASTM A194/A194M, Grade 2. Bolt, stud, and nut dimensions ASME B18.2.2 threads ASME B1.1coarse type with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt studs shall extend completely through the nuts and may have reduced shanks of a diameter not less than the 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 conforming to ASME B18.2.2.

(2) Gaskets: ASME B16.21, Nonasbestos compressed material 1 1/2 mm 1/16 inch thickness full face or self-centering flat ring type and suitable for pressure and temperature of the piping system.

c. Butt Weld Joints: ASME B31.9. Backing rings shall conform to ASME B31.9. Ferrous rings shall not exceed 0.05 percent sulfur; for alloy pipe, backing rings shall be of material compatible with the chemical composition of the parts to be welded and preferably of the same composition. Provide continuous machined or split band backing rings.

d. Socket Weld Joints: ASME B31.9.

2.1.7.3 Joints for Copper Tubing

a. Solder conforming to ASTM B32 alloy grade Sb5 or Sn96. Solder and flux shall be lead free (less than 0.2 percent of lead).

b. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints shall not be permitted.

2.1.8 Expansion Joints

2.1.8.1 Packless Type

Provide ASTM F1120, Type III with fabricated corrosion-resistant steel bellows.

2.1.8.2 Guided Slip-Tube Type

Provide ASTM F1007, Type IV internally-externally guided, injected semiplastic type packing.

2.1.9 Instrumentation

2.1.9.1 Pressure and Vacuum Gauges

Provide ASME B40.100 with restrictor.

2.1.9.2 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 mm 3 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.

2.1.9.3 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 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS 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.

2.1.10 Miscellaneous Pipeline Components

2.1.10.1 Air Vent

Provide float type air vent in hydronic systems. Vent shall be

constructed of brass or semi-steel body, copper float, and stainless steel valve and valve seat. Design air vent to suit system operating temperature and pressure. Provide isolating valve to permit service without draining the system. Pipe discharge of vent to a drain.

2.1.10.2 Strainers

Strainers for classes 125 and 250 piping in IPS 15 to 200 mm 1/2 to 8 inches, inclusive, FS WW-S-2739 and locate as indicated.

2.1.10.3 Hangers and Supports

****
NOTE: In project locations with Environmental Severity Classification (ESC) of C4 or C5 or high humidity areas as identified in ASHRAE 90.1 as climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C,include bracketed sentence below to require hot-dipped galvanized hangers where ferrous metals are used. See UFC 1-200-01 for determination of ESC for project locations.
****

Design and fabrication of pipe hangers, supports, and welding attachments shall conform to MSS SP-58 and ASME B31.9. Hanger types and supports for bare and covered pipe shall conform to MSS SP-69 for the temperature range.[If ferrous materials are used, provide hot dipped galvanized hangers, inserts and supports.]

2.1.10.4 Pipe Sleeves

Sleeves in masonry and concrete walls, floors, and roof slabs shall be ASTM A53/A53M, Schedule 40 or Standard Weight, hot-dip galvanized steel [ductile-iron or cast-iron] pipe. Sleeves in partitions shall be zinc-coated sheet steel having a nominal weight of not less than 4.40 kilogram per square meter 0.906 pound per square foot.

2.1.10.5 Escutcheon Plates

Provide one piece or split hinge metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces and paint finish on metal plates in unfinished spaces.

2.2 CENTRAL MECHANICAL EQUIPMENT

2.2.1 [Boilers

Provide as specified in [Section 23 52 43.00 20 LOW PRESSURE WATER HEATING BOILERS UNDER 800,000 BTU/HR OUTPUT][Section 23 52 46.00 20 LOW PRESSURE WATER HEATING BOILERS OVER 800,000 BTU/HR OUTPUT].

]2.2.2 [Hot Water Heat Exchangers

Provide as specified in Section 23 21 13.23 20 [HIGH] [MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS.

]2.2.3 [Converters

Steam to hot water converters shall conform to FS WW-H-191 and shall have capacity as indicated for the design conditions. The converters shall be designed for support by separate pipe hangers, and [temperature regulator] [vent valve] shall be provided.

]2.3 PIPING SYSTEM EQUIPMENT

2.3.1 Pumps

Provide hot water circulating pumps, CID A-A-50560, Service A. Pump casing and flange shall be made of close-grained cast iron. Shaft shall be carbon or alloy steel with lubricated bearings and impeller shall be bronze. Select pumps so that the operating point on selected impeller-curve will lie at or to the left of shutoff side of, and not more than 5 percent below, point of maximum efficiency for impeller. Provide motors of [open] [splash proof] [totally enclosed] type conforming to NEMA MG 1 and suitable for electrical characteristic as indicated. Motor starters shall conform to 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.

2.3.2 Expansion Tanks

Provide welded steel, constructed and tested hydrostatically in accordance with ASME BPVC SEC VIII D1. Tank shall be equipped with all necessary fittings. The tank and fittings shall be pressure rated at least equal to the test pressure of the total system. Zinc coat the tank inside and out after fabrication by the hot dip process ASTM A123/A123M.

2.3.3 External Air Separation Tanks

Provide tank constructed of steel, designed for not less than 517 kPa (gage) 75 psig, and constructed and tested in accordance with the requirements of ASME BPVC SEC VIII D1. Provide tangential inlet and outlet connections, flanged for sizes 65 mm 2 1/2 inches and larger. Each unit shall have an internal design suitable for creating the required vortex and subsequent air separation. Provide with automatic air release device and galvanized steel strainer. Provide a blow down connection with a gate valve and piped to nearest floor drain.

2.3.4 Backflow Preventers

****
NOTE: If contract specifications includes Section 22 00 00 PLUMBING, GENERAL PURPOSE in which backflow preventers are specified, delete this paragraph entitled "Backflow Preventers."
****

Reduced pressure principle type. Furnish proof that each make, model/design, and size of backflow preventer being furnished for the project is approved by and has a current "Certificate of Approval" from the [FCCCHR List] [or] [local code]. Listing of a particular make, model/design, and size in the current [FCCCHR List] [or] [local code] will be acceptable as the required proof.

2.3.5 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 1830 mm 6 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 kPa 50

inches water gage for tubular type or 25 kPa 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 liters per second gallons per minute. Dials of portable meters shall have square root scales reading from 0 to 6 L/s 0 to 100 gpm for use with multiplier stamped on orifice or tubular type. Provide meters designed for not less than 1378 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 4.60 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 861 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.

2.4 TERMINAL UNITS

2.4.1 Finned Tube Radiators

[Steel tube and steel fin type FS S-R-2834]. [Copper tube and aluminum fin type CID A-A-50545, [shall have an adjustable damper].]

2.4.2 Convectors

CID A-A-50543 and CID A-A-50544, of design and capacity not less than that indicated.

2.4.3 Unit Heaters

Provide hot water unit heaters as specified in Section 23 82 00.00 20 TERMINAL HEATING UNITS.

2.4.4 Heating and Ventilating Units

Provide fan-coil units, induction units, unit ventilators, and gravity ventilators as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5 ELECTRICAL EQUIPMENT

Provide complete with motors, motor starters, thermal overload protection, and controls. Equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.6 CONTROLS

Provide controls as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

2.7 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.8 ASBESTOS PROHIBITION

Asbestos and asbestos containing products are prohibited.

PART 3 EXECUTION

3.1 PREPARATION

Provide storage for equipment and material at the project site. All parts shall be readily accessible for inspection, repair, and renewal. Protect material and equipment from the weather.

3.2 INSTALLATION

Piping fabrication, assembly, welding, soldering, and brazing shall conform to ASME B31.9. Piping shall follow the general arrangement shown. Route piping and equipment within buildings out of the way of lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit welding of joints and application of insulation. Make provision for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate until piping has been inspected, tested, and approved. Do not run piping concealed in walls, partitions, underground, or under the floor except as otherwise indicated. Where pipe passes through building structure, locate pipe joints and expansion joints where they may be inspected. Provide flanged joints where necessary for normal maintenance and where required to match valves and equipment. Furnish gaskets, packing, and thread compounds suitable for the service. Provide long radius ells where possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and shall be free from appreciable

flattening, wrinkling, or thinning of the pipe. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make branch connections over 50 mm 2 inches with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.9 may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Branch connections 50 mm 2 inches and under can be threaded or welded. Run vertical piping plumb and straight and parallel to walls. Provide sleeves for lines passing through building structure. Provide a fire seal where pipes pass through fire wall, fire partitions, fire rated pipe chase walls, or floors above grade. Install piping connected to equipment with flexibility for thermal stresses and for vibration, and support and anchor so that strain from weight and thermal movement of piping is not imposed on the equipment.

3.2.1 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58. Band and secure insulation protection shields without damaging pipe insulation. Continuous inserts and expansion bolts may be used.

3.2.2 Grading of Pipe Lines

Unless otherwise indicated, install horizontal lines of hot water piping to grade down in the direction of flow with a pitch of not less than 25 mm in 9 meters one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction.

3.2.3 Pipe Sleeves

Provide sleeves where pipes and tubing pass through masonry or concrete walls, floors, roof, and partitions. Annular space between pipe, tubing, or insulation and the sleeve shall not be less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs shall extend 50 mm 2 inches above finished floor. Firmly pack space between pipe or tubing and sleeve with oakum and caulk on both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a [mechanically adjustable] segmented elastomeric seal. Seal both ends of penetrations through fire walls and fire floors to maintain fire resistive integrity with UL listed fill, void, or cavity material.

3.2.4 Flashing for Buildings

Provide flashing where pipes pass through building roofs, and make outside walls tight and waterproof.

3.2.5 Unions and Flanges

Provide unions and flanges to permit easy disconnection of piping and apparatus. Each connection having a screwed-end valve shall have a union. Place unions and flanges no farther apart than 30 meters 100 feet. Install unions downstream of valves and at equipment or apparatus connections. Provide unions on piping under 50 mm 2 inches in diameter, and provide flanges on piping 50 mm 2 inches and over in diameter. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings

may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous-to-non-ferrous connections.

3.2.6 Connections for Future Equipment

Locate capped or plugged outlets for connections to future equipment as indicated.

3.2.7 Changes in Pipe Size

Provide reducing fittings for changes in pipe size; reducing bushings are not permitted. In horizontal lines, provide eccentric reducing fittings to maintain the top of the lines in the same plane.

3.2.8 Cleaning of Pipe

Thoroughly clean each section of pipe, fittings, and valves free of foreign matter before erection. Prior to erection, hold each piece of pipe in an inclined position and tap along its full length to loosen sand, mill scale and other foreign matter. For pipe 50 mm 2 inches and larger, draw wire brush, of a diameter larger than that of the inside of the pipe, several times through the entire length of pipe. Before making final connections to apparatus, wash out interior of piping thoroughly with water. Plug or cap open ends of mains during shutdown periods. Do not leave lines open where foreign matter might enter the pipe.

3.2.9 Valves

Install valves in conformance with ASME B31.9. Provide gate valves unless otherwise directed. Install valves with stems horizontal or above. Locate or equip stop valves to permit operation from floor level, or provide with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair.

3.2.9.1 Globe Valves

Install globe valves so that the pressure is below the disk and the stem horizontal.

3.2.9.2 Radiators Valves

Provide radiator valves on water inlet and balancing valves on water outlet of terminal heating units such as radiation, unit heaters, and fan coil unit.

3.2.9.3 Relief Valves

Provide valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks. Select system relief valve so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment. Pipe relief valve outlet to the nearest floor drain.

3.2.10 Pressure Gage

Provide a shut-off valve or pet cock between pressure gages and the line.

3.2.11 Thermometers

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

3.2.12 Strainers

Provide strainers, with meshes suitable for the services, where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

3.2.13 Pumps

Select pumps for specified fluid temperatures, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve. Support piping adjacent to pump such that no weight is carried on pump casings. Install close coupled and base mounted pumps on concrete base, with anchor bolts, set and level, and grout in place and provide supports under elbows on pump suction and discharge line sizes 100 mm 4 inches and over. Lubricate pump before start-up.

3.2.14 Equipment Foundations

Locate equipment foundations as shown on the drawings. Size, weight, and design shall preclude shifting of equipment under operating conditions. Foundations shall meet the requirements of the equipment manufacturer. Concrete shall conform to Section 03 30 00 CAST-IN-PLACE CONCRETE, and grout shall be approved non-shrinking.

3.2.15 Equipment Installation

Install equipment in accordance with installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on the equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets.

3.2.16 Cleaning of Systems

As installation of the various system components is completed, fill, start, and vent prior to cleaning. Place terminal control valves in open position. Add cleaner to closed system at concentration as recommended by manufacturer. Apply heat while circulating, slowly raising temperature to 71 degrees C 160 degrees F and maintain for 12 hours minimum. Remove heat and circulate to 38 degrees C 100 degrees F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed. Use neutralizer agents on recommendation of system cleaner supplier and approval of Contracting Officer. Remove, clean, and replace strainer screens. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Preliminary or final tests are not permitted until cleaning is approved.

3.2.17 Painting of Piping and Equipment

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NOTE: When the project specification does not have a section on field painting, the requirements in Section 09 90 00 PAINTS AND COATINGS for cleaning and painting of pipe and equipment, and for painting and stenciling of piping shall be included in this section.

****

Provide in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.18 Identification of Piping

****

NOTE: When the project specification does not have a section on field painting, the requirements in Section 09 90 00 for cleaning and painting of pipe and equipment, and for painting and stenciling of piping shall be included in this section.

****

Identify piping in accordance with OSHA 29 CFR 1910.144, except that labels or tapes may be used in lieu of painting or stenciling. Spacing of identification marking on runs shall not exceed 15 meters 50 feet. Materials for labels and tapes shall conform to CID A-A-1689, and shall be general purpose type and color class. Painting and stenciling shall conform to Section 09 90 00 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that piping and equipment, as installed, is in compliance with contract requirements. Start up and operate the system. During this time, periodically clean the 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 to place them in proper operation and sequence.

3.3.1 Hydrostatic Test of Piping System

****

NOTE: Test piping systems at one and one-half times system pressure or 345 kPa (gage) 50 psig whichever is greater.

****

Test piping system hydrostatically using water not exceeding 38 degrees C 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.9 and as follows. Test piping system after all lines have been cleaned and before applying insulation covering. Remove or valve off from the system, gages, and other apparatus which may be damaged by the test before the tests are made. Install calibrated test pressure gage in the system to observe any loss in pressure. Maintain test pressure for a sufficient length of time to enable an inspection of each joint and connection. Perform tests after installation and prior to acceptance. Notify the Contracting Officer in writing [_____] days prior to the time scheduled for the tests.

3.3.2 Auxiliary Equipment and Accessory Tests

Observe and check pumps, accessories, and equipment during operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading.

3.3.2.1 Backflow Preventers

Backflow preventers shall be tested by locally approved and certified backflow assembly testers. A copy of the test report shall be provided to the Contracting Officer prior to placing the domestic water system into operation, or no later than 5 days after the test.

3.4 TESTING, ADJUSTING, AND BALANCING

****
NOTE: Use the first sentence for simple hydronic systems and where Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVACis not included in the specifications. Use the second sentence for all specifications with Section 15996.
****

[Except as specified herein, perform in accordance with SMACNA 1780, 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 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC.]

3.4.1 Markings of Settings

Following final acceptance of the balancing report, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at anytime.

3.4.2 Sound Level Tests

Upon completion of testing and balancing of hydronic systems, conduct sound level tests of conditioned spaces. Use sound level meter required by ASA S1.4, Type 2, calibrated in accordance with NBS standards and guidelines, and accompanied by a certificate of calibration. Record sound levels in dBA with heating systems off and with heating systems operating. Record the following data for each room and system:

a. Background sound level (systems off);

b. Total sound level corrected for background; and

c. Sound power rating by manufacturer of the respective outlet.

Test Locations: Take sound level reading at location 2 meters 6 feet from face of each outlet on a line at 45 degrees with face of outlet. Remedial Action: If sound level at any observation point exceeds [20] [45] [_____] dBA, take remedial action as directed.

3.5 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.	[_____]	[_____]

-- End of Section --