UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 21 13.23 20

[HIGH][MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS

07/07, CHG 1: 11/19

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SECTION 23 21 13.23 20

[HIGH][MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS
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****
NOTE: This guide specification covers the requirements for high and medium temperature water piping systems inside of building mechanical rooms, including connections to interior existing piping and system terminal unit.

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: Project requirements may require addition of supplemental information to the paragraphs contained herein, however, designer is cautioned to verify additional references to ascertain applicability of materials to system design prior to inclusion.
****

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

1. Flow diagram of high or medium temperature water piping indicating connections to existing supply and return, pressure and temperature of existing supply

and return, (maximum and minimum or constant, applicable), valves and critical valve positions (including normally closed for bypass valve), any necessary flow rates, pressure drops not already in equipment schedule or specifications, and location of temperature and/or pressure sensors.

2. System Terminal Unit detail providing location of all piping including valves, strainers, flanges, fittings, connections, and supports (coordinate with Section 23 21 13.00 20 and Section 23 22 26.00 20).

3. Single line plan and any necessary sections indicating location, sizes, and routing of all associated piping.

4. Appropriate schedules for equipment, including any reset schedules.

5. Information necessary when asbestos material is involved (See second note in paragraph entitled "Description").

6. Detail of connections to existing high or medium temperature water piping, including air chambers and vents as required.

****

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.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems
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 B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2022) Power 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 WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
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 A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
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 A234/A234M	(2023a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

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-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z535.1	(2022) Safety Colors

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

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards

1.2 DEFINITIONS

1.2.1 Medium Temperature Water (MTW)

Heating hot water systems operating at 121 to 177 degrees C 250 to 350 degrees F.

1.2.2 High Temperature Water (HTW)

Heating hot water systems operating at greater than 177 degrees C but less than 232 degrees C 350 degrees F but less than 450 degrees F.

1.2.3 Terminal Unit

Heat exchanger or steam producer using [HTW][MTW] as the primary heating medium.

1.2.4 Steam Producer

Unfired steam generator.

1.3 GENERAL REQUIREMENTS

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

1.3.1 Associated Work

****

NOTE: Edit, specifying all associated sections for

the specific project.
****

Other work associated with this section including insulation, hot water piping, hot water distribution outside the building, steam, and painting is covered in other sections of this specification.

1.3.2 Description

****
NOTE: Work should be confined to inside of building mechanical rooms. Avoid running high or medium temperature water in occupied spaces or where hidden from access or view.
****

****
NOTE: This section requires connections to existing high or medium temperature water piping that may contain asbestos insulation or associated material. Sampling and testing of suspicious material and subsequent inclusion of Section 02 82 00 ASBESTOS REMEDIATION or Section 02 83 00 LEAD REMEDIATION and appropriate plans for asbestos material removal and disposal must be verified by the designer and provided as necessary.
****

The work shall include the furnishing, installing, and testing of high temperature water piping inside the building, as indicated, together with all fittings and appurtenances necessary for a complete and operable system. [The work also includes [modifications] [and] [[HTW][MTW] system connection] to the existing [HTW][MTW] piping.]

1.3.3 Classes and Maximum Working Pressures

Except as specified otherwise, piping components shall be suitable for use under the maximum working pressures indicated. Except as modified herein, the pressure temperature limitations shall be as specified in the referenced standards and specifications. All pressures in this specification are pressures in kilopascal (kPa) pounds per square inch (psi) above atmospheric pressure, and all temperatures are in degrees Celsius (C) degrees Fahrenheit (F).

1.3.4 Field Verification

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, verify the maximum operating temperature and pressure of the heating distribution system with the heating plant foreman, and advise the Contracting Officer of any discrepancy within 3 days and before performing any work.

1.3.5 Identification

Each major item of equipment shall have the manufacturer's name, address, type or style, and model or serial number on a plate secured to the item of equipment.

1.3.6 Welding Safety

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

1.3.6.1 Procedures and Qualifications

Before any welding is performed, the Contractor shall submit welding procedure specifications for all metals included in the work, together with proof of its qualification as outlined in ASME B31.1.

Before any welder or operator performs any welding, submit Welder's Performance Qualification Record in conformance with ASME B31.1showing that the welder was rated 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, and affix immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a qualification test and upon failing to pass the test, do not permit to work this contract.

Welders and welding operators previous qualifications on welding procedures test may be accepted for the contract without requalification subject to the approval and provided that all the conditions specified in ASME B31.1 are met before a procedure can be used.

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-01 Preconstruction Submittals

Valves

Packing

Gaskets

SD-02 Shop Drawings

[HTW][MTW] System connection diagrams (within building)

SD-03 Product Data

Valves

Strainers

Pipe

Pipe fittings

[Heat exchanger]

[Steam producer]

[Expansion joints]

Information shall show details, dimensions, capacities, and ratings.

SD-07 Certificates

Welding procedure specifications

Performance qualification record

Previous qualifications

Valves

Gaskets

PART 2 PRODUCTS

2.1 PIPE AND PIPE SYSTEM

****
NOTE: When individual branch loops require circulating pumps due to constant volume plant system design or insufficient available differential pressure for terminal unit control valve in a variable volume plant system design, designer must provide appropriate pump specifications herein. Pumps shall be carefully sized for the specific loop only such that operation of the main plant system and other branch loops is not affected.
****

****
NOTE: If it is necessary to provide for additional thermal expansion of piping, designer may provide design and specification for either expansion loop(s) or mechanical expansion joints for the particular service, however, expansion loop(s) are preferred.
****

2.1.1 High Pressure Piping System

****
NOTE: Specify the maximum pressure and temperature leaving the central heating plant. Note that some operating pressures may be substantially higher than corresponding saturation pressures at the supply temperature, depending upon the method of plant generator pressurization (Booster pumps and compressed gas pressurization methods produce distribution pressures considerably higher than steam buffer type method). Select design pressure equal or greater than one and one half (1-1/2) times the maximum operating pressure.
****

ASME B31.1; Maximum operating pressure of [_____] kPa psi at [_____] degrees C degrees F; design pressure of [2068] [2758] [4136] [_____] kPa [300] [400] [600] [_____] psi.

2.1.2 Pipe

Pipe 50 mm 2 inches in diameter and larger: schedule 80, black steel plain end beveled, ASTM A53/A53M, Grade B, Type E (electric resistance welded) or S (seamless), or ASTM A106/A106M, Grade B. Pipe sizes through 40 mm 1 1/2 inches in diameter: schedule 80, black steel, ASTM A106/A106M, Grade B.

2.1.3 Pipe Fittings

Fittings shall be compatible in thickness with the pipe being used, shall be used in conformance with ASME B31.1, and shall conform to the following requirements. Steel welded fittings: ASTM A234/A234M. Flanges shall be serrated or raised-faced type. In horizontal lines, reducing fittings shall be the eccentric type and installed to ensure that the system can

be thoroughly drained. Remove raised faces when used with existing flanges having a flat face.

2.1.3.1 Fittings for Steel Pipe Sizes 3 to 50 mm 1/8 to 2 inches

ASME B16.11, Class 300 steel socket welding type.

2.1.3.2 Fittings for Steel Sizes 65 mm 2 1/2 inches and Above

Steel fitting butt welding type ASME B16.9 or ASME B16.5flanged type, Class 300.

2.1.4 Gaskets

The Contractor shall submit the manufacturers published temperature and pressure ratings and provide materials recommended by the manufacturer for the maximum operating temperature, system design pressure, and service specified herein.

2.1.5 Bolting

Bolt studs for flanged joints shall be alloy steel studs, threaded on both ends and fitted with two hexagon nuts per stud. Bolt shall be ASME B18.2.1 and material shall conform to ASTM A193/A193M, Grade B-7, threads Class 7 fit. Nuts shall be American Standard Heavy semi-finished hexagonal (ASME B18.2.2) and material shall conform to ASTM A194/A194M, Grade 7.

2.1.6 Vents

****

NOTE: Air chambers may be deleted if branch connections are made to bottom half of existing overhead supply and return mains. See paragraph entitled "Branch Connections" herein.

****

Provide air chambers and manual air vent valves as indicated at all high points in the [HTW][MTW] system. Provide a 15 mm 1/2 inch vent line from each air vent to the nearest drain. Vent lines shall be provided with two 15 mm 1/2 inch bar stock globe valves as indicated.

2.1.7 Valves; Gate, Globe, Ball, Check, Angle, and Control

All valve materials shall conform to ASME B16.34. Valve bodies shall be carbon or stainless steel (Type 304 or 316) with stainless steel trim. All valves shall be Class 300. Ends shall be butt welding or raised face flanged type conforming to ASME B16.34. Valve pressure and temperature design values shall not be exceeded. The Contractor shall submit the manufacturers recommended materials list for valves, packing, and gaskets with certification that all meet the system design pressure at maximum operating temperature and the service as specified herein.

2.1.7.1 Globe Valves

Globe type valves shall have outside screw and yoke with bolt bonnets, and flat seats, but shall not be of the reversed-cup type. The stuffing boxes shall be large and deep. Valves 50 mm 2 inches and larger shall have at

least six U or V type [teflon-impregnated braided non-asbestos] [_____] packing rings, specifically designated as suitable for high-temperature water. Valves smaller than 50 mm 2 inches shall have four or five rings. Spiral or continuous packing will not be acceptable. A metal insert shall be provided having proper clearance around the stem at the bottom of the stuffing box and acting as a base for the packing materials. Packing glands shall be furnished with liner of noncorrosive material and shall be of one piece with not less than two bolts. Valves 32 mm 1 1/4 inches and smaller need not have yokes or bolted screws and deep stuffing boxes. Stems shall be provided with bevel above the disk for cutoff and repacking valve under pressure when fully open. On the underside side of the bonnet a pack-under-pressure bushing of stainless steel shall be provided. The bushing shall be screwed into place.

2.1.7.2 Gate Valves

Gate valves, wedge gate type, outside screw and yoke, valve body with straight through ports without recesses except between seats to assure minimum turbulence, erosion, and resistance to flow. The bonnet shall be equipped with a bonnet bushing. The valves shall have a self-centering male and female joint equipped with a gasket.

2.1.7.3 Temperature Control Valves

****

NOTE: Provide valve operating conditions based upon the type of control maintained at the central heating plant for the distribution system, and the arrangement of piping at the system terminal unit. Three-way valves and balancing valves are not recommended, nor any arrangement that may allow a drop in temperature/pressure sufficient to cause flash to steam. The delta P at design load should not be less than one half the available pressure drop across the valve in order for the equal-percentage type valve to function properly.

****

****

Note: Control valve delta P at design load (valve full open) shall not be less than 34 kPa 5 psi. If the control valve available differential pressure drop with valve full open is less than 34 kPa 5 psi, it is necessary to provide a pump sized for the specific branch (loop) only, which does not affect other system branches, to boost the available pressure.

****

Two-way, single seated, equal percentage-flow type, industrial quality flow regulating (control) valve conforming to the materials specified herein, and size selected by the valve manufacturer for the following conditions:

a. Maximum flow rate: [_____] L/s Gpm

b. Minimum flow rate: [_____] L/s Gpm

c. Internal pressure: [_____](maximum operating) kPa Psi

d. Pressure differential at design load: [_____](open) delta p, kPa Psi

e. Pressure Differential at minimum load: [_____] (closed) delta p, kPa Psi (Equal to pump head or controlled differential pressure in variable volume flow system)

Provide automatic operator with manual override (handwheel) and position indicator.

2.1.7.4 Emergency Shutoff Valve

[HTW] [MTW] automatic, quick closing, ball valve located between the manual [HTW] [MTW] supply shutoff valve and the system terminal unit inlet, with pressure/temperature sensor located on the shell side. Emergency valve shall automatically close when the pressure/temperature setting of the shell side safety relief valve is reached. Emergency Valve shall be normally open.

2.1.8 Strainers

Body materials shall conform to ASME B16.34, Fine Mesh type strainer and trim shall be Type 304 or 316 stainless steel, selected for the service specified herein.

2.1.9 Joints

2.1.9.1 Welded Joints

Joints between sections of pipe and between pipe and fittings shall be welded. Joints between pipe and valves shall be welded or flanged. The welding shall conform to requirements of paragraph entitled "Responsibility of Contractor for Fusion Welding." Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitations. Branch outlet fittings where used shall be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe-bursting strength.

2.1.9.2 Flanged Joints

Joints for connection to valves in high or medium temperature water system shall be welded or flanged, faced true, provided with gaskets, and made perfectly square and tight. Flanges shall be forged steel, raised face, weld-neck type. Slip-on flanges will not be allowed. Gaskets for [HTW] [MTW] systems shall be [metallic non-asbestos] [_____].

2.1.10 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 if ferrous materials are used. See UFC 1-200-01 for determination of ESC for project locations.

****

ASME B31.1, MSS SP-58, MSS SP-69, and as specified herein.[If ferrous materials are used, provide hot-dipped galvanized hangers, inserts and supports.]

2.1.11 Pipe Sleeves

Schedule 80 steel pipe, and as specified herein.

2.1.12 Caulking and Sealants

Materials as recommended by the manufacturer for the service specified herein.

2.1.13 Instrumentation

2.1.13.1 Pressure Gages

ASME B40.100, with corrosion resistant steel trim for high temperature water service. Dial range shall be 0 kPa psi to the system design pressure specified herein. Provide stainless steel isolation petcock.

2.1.13.2 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 127 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.

2.1.14 System Terminal Units

2.1.14.1 Heat Exchanger, [HTW][MTW]

****
NOTE: Since the hot water heat exchanger and associated hot water piping is specified in Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and high or medium temperature water piping herein, coordination for the heat exchanger details indicating arrangement of piping is necessary. Avoid redundancy between Section 23 21 13.23 20 [HIGH] [MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS, Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and other related specifications sections. When paragraph entitled "Pressure Gages" is used, provide auxiliary piping and accessories in other sections, including relief valve, thermal measuring element (sensor), and auxiliary piping and wiring, alarms, controllers, and flow switches.
****

Designed for an operating pressure of 2758 kPa 400 psi [_____] and a

temperature of 204 degrees C 400 degrees F [_____]; factory tested hydraulically to 4136 kPa 600 psi [_____]; welded steel support brackets or flanges; Class 300 steel primary water flanges; stainless steel or seamless, stress relieved, cupro-nickel (90-10) U-tubes; steel head and flanged opening for easy tube bundle removal; tube sheets and baffles of [same material as tubes][steel]; steel shell designed for a pressure of 4136 [2758] [2068] kPa 600 [400] [300] psi; openings for ASME pressure relief valve, thermal measuring element (sensor), pressure gage, vent, thermometer, and drain, provided by welded fittings to shell; handholes provided where indicated or recommended by manufacturer. Arrangement of heat exchanger piping shall be as indicated such that [HTW] [MTW] (primary heating medium) is connected to the U-tube side (with offset flanges) and secondary water to the shell side. The heat exchanger shall be designed in accordance with ASME BPVC SEC VIII D1, and carry the code stamp.

2.1.14.2 Steam Producer, [HTW][MTW]

****

NOTE: When paragraph entitled "Indicating Thermometers" is used, coordination with Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS and other related sections is necessary. Designer must provide specifications for the following accessories:

1. Feedwater pump(s).

2. Condensate receiver.

3. Blowdown tank.

4. Chemical feed.

5. Makeup water.

6. Auxiliary piping & wiring.

7. Magnetrol water column pump controller/low water cutoff.

8. Proportional pressure controller with pressure sensing element for control valve.

****

Arranged with [HTW] [MTW] on the U-tube side and steam on the shell side, designed for an operating pressure of 2758 kPa 400 psi [_____] and a temperature of 204 degrees C 400 degrees F [_____], factory tested hydraulically to 4136 kPa 600 psi [_____]; welded steel support brackets or flanges; Class 300 steel water connections (offset); stainless steel or seamless, stress relieved, cupro-nickel (90-10) U-tubes; steel head and flanges opening for easy tube bundle removal; steel shell designed for a minimum pressure of 862 kPa 125 psi; openings for feedwater/makeup water, drain, blowdown, steam outlet, water level gage, water level control mechanism (pneumatic or electric), ASME safety relief valve [one] [two], pressure gage, [manhole] [handholes], chemical feed, and vent; internal water separator welded to shell at steam exit. The steam producer shall be designed in accordance with ASME BPVC SEC VIII D1, and carry the code stamp.

PART 3 EXECUTION

3.1 INSTALLATION

Arrange work in a neat and orderly manner so that minimum storage of equipment and material is required at the project site. All parts shall be readily accessible for inspection, repair, and renewal. Protect material and equipment from the weather.

3.2 PIPING

Unless specifically stated to the contrary, fabrication, assembly, welding, soldering, and brazing shall conform to ASME B31.1 for all piping of the hot water system. All piping shall follow the general arrangement shown; cut accurately to measurements established for the work by the Contractor, and work into place without springing or forcing, except where cold-springing is specified. Install piping within buildings entirely out of the way of lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in the most inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit the welding of joints; at least 150 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 the pipe and one wall. 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 piping until it has been inspected, tested, and approved. Protect materials and equipment from the weather. Do not run piping concealed in walls or partitions or underground or under the floor except as otherwise indicated. Where pipe passes through building structure, do not conceal pipe joints but locate where they may be readily inspected. Run all pipe to be insulated as shown and as required with sufficient clearance to permit application of insulation. Use flanged joints only where necessary for normal maintenance and where required to match valves. Provide gaskets, packing, and thread compounds suitable for the service. Use long radius ells wherever 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 must be free from any appreciable flattening, wrinkling, or thinning of the pipe. Changes in direction may be made by bending of pipe provided that a hydraulic pipe bender is used. Pipe to be bent shall be steel conforming to ASTM A53/A53M, Class required to match adjoining pipe. Bent pipe showing kinks, wrinkles, or malformations will not be acceptable. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make all branch connections with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1. Open ends of pipe lines and equipment shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system. Pipe not otherwise specified shall be uncoated.

3.2.1 Branch Connections

Branches from supply and return mains shall be taken off as indicated or as approved. Connections shall be carefully made to ensure unrestricted circulation, eliminate air pockets, and permit the complete drainage of the system. Changes in horizontal piping sizes shall be made through eccentric reducing fittings.

3.2.2 Cleaning of Piping (Pre-Erection)

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

3.2.3 Cleaning of Piping (Post-Erection)

Prior to the hydrostatic, performance and operating tests, the interior of the heat-carrying piping shall be flushed with water until the piping is free of all foreign materials to the satisfaction of the [Contractor Quality Control representative] [Contracting Officer].

3.2.4 Valves

3.2.4.1 General

Install valves in conformance with ASME B31.1 and as required herein at the locations indicated. 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.

3.2.4.2 System Terminal Unit Piping

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NOTE: Ascertain that the flow in the hot water side (shell) is continuous to preclude overheating, that the hot water supply side is provided with appropriate safety relief valve piped to drain, and that any necessary alarms and flow switches are provided on the hot water supply of the heat exchanger. Ascertain also that the high or medium temperature water is on the tube side of the heat exchanger and hot water on the shell side.

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

1. Flow diagram of high or medium temperature water piping indicating connections to existing supply and return, pressure and temperature of existing supply and return, (maximum and minimum or constant, applicable), valves and critical valve positions (including normally closed for bypass valve), any necessary flow rates, pressure drops not already in equipment schedule or specifications, and location of temperature and/or pressure sensors.

2. System Terminal Unit detail providing location

of all piping including valves, strainers, flanges, fittings, connections, and supports (coordinate with Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS).

3. Single line plan and any necessary sections indicating location, sizes, and routing of all associated piping.

4. Appropriate schedules for equipment, including any reset schedules.

5. This section requires connections to existing high or medium temperature water piping that may contain asbestos insulation or associated material. Provide plans for removal and disposal of such material.

6. Detail of connections to existing high or medium temperature water piping, including air chambers and vents as required.

Since the hot water heat exchanger and associated hot water piping is specified in Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEM and high or medium temperature water piping herein, coordination for the heat exchanger details indicating arrangement of piping is necessary. Avoid redundancy between Section 23 21 13.23 20 [HIGH] [MEDIUM] TEMPERATURE WATER SYSTEM WITHIN BUILDINGS, Section 23 21 13.00 20 LOW TEMPERATURE WATER (LTW) HEATING SYSTEM and other related specifications sections. When paragraph entitled "Pressure Gages" is used, provide auxiliary piping and accessories in other sections, including relief valve, thermal measuring element (sensor), and auxiliary piping and wiring, alarms, controllers, and flow switches.

When paragraph entitled "Indicating Thermometers" is used, coordination with Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS and other related sections is necessary. Designer must provide specifications for the following accessories:

1. Feedwater pump(s).

2. Condensate receiver.

3. Blowdown tank.

4. Chemical feed.

5. Makeup water.

6. Auxiliary piping & wiring.

7. Magnetrol water column pump controller/low water

cutoff.

8. Proportional pressure controller with pressure sensing element for control valve.

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All associated [HTW] [MTW] piping shall conform to the requirements specified herein and arrangement be as indicated and specified. Install control valve in the return side providing an upstream strainer, gate isolation valves, and a bypass with a globe or plug valve (Do not install control valve in supply with a check valve in the return). Install automatic emergency shutoff valve to provide quick [HTW] [MTW] shutoff in case of U-tube rupture and to protect the secondary piping. Install gate isolation valve in the supply. Provide a dirt leg with a gate isolation valve and capped end for the supply line drop. All valves shall be installed in horizontal lines. Arrange connections to system terminal units with offset flanges such that adequate clearance is provided for pulling tubes and maintenance without requiring breaking of pipe.

3.2.5 Cleaning and Painting of Piping and Equipment

Clean and paint piping in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.2.6 Identification of Piping and Physical Hazards

Identify all piping & physical hazards in accordance with 29 CFR 1910.144, ASME A13.1, and NEMA Z535.1. Spacing of identification marks on runs shall not exceed 15 meters 50 feet. Painting and stenciling shall conform to Section 09 90 00 PAINTS AND COATINGS. Colors shall conform to NEMA Z535.1.

3.2.7 Hangers and Supports

The design and fabrication of pipe hangers, supports, and welding attachments shall conform to MSS SP-58 and ASME B31.1. Hanger types and supports for bare and covered pipe shall conform to MSS SP-69for the temperature range. Unless otherwise indicated, horizontal and vertical piping attachments shall conform to MSS SP-58. Continuous inserts and expansion joints may be used.

3.2.8 Pipe Sleeves

Provide sleeves where pipes pass through masonry or concrete walls. Sleeves in outside walls below and above grade, shall be steel pipe, Schedule 80. Space between pipe or insulation and the sleeve shall be not less than 6 mm 1/4 inch. Hold sleeves securely in proper position and location before and during construction. All sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Firmly pack space between the pipe and the sleeve with oakum and caulk on both ends of the sleeve with elastic cement.

3.2.9 Instrumentation

Provide a thermometer and pressure gage, as specified herein, on both the high or medium temperature water supply and return piping located on the system terminal unit side of the isolation valves.

3.3 WELDING

3.3.1 Responsibility of Contractor for Fusion Welding

The Contractor is entirely responsible for the quality of the welding and shall:

a. Conduct tests not only of the welding procedure used by his organization to determine the suitability of the procedure to insure welds that will meet the required tests, but also of the welding operators to determine the ability of the operators to make sound welds under standard conditions.

b. Be thoroughly familiar with ASME B31.1 and with AWS B2.1/B2.1M.

c. Be capable of performing all welding operations required for construction and installation of the heating system.

3.3.2 Qualifications of Welders

Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1, or with AWS B2.1/B2.1M, and also as outlined below.

3.3.2.1 Examining Welders

Each welder shall be examined at the jobsite by the Contractor in the presence of a representative of the Contracting Officer to determine the ability of the welder to meet the qualifications required. Welders for piping shall be tested and qualified for all applicable positions. Each welder shall be required to identify his weld with his specific code marking signifying his name and number assigned.

3.3.2.2 Examination Results

The Contracting Officer shall be provided with a listing of names and corresponding code markings. Where a welder fails to meet the prescribed welding qualifications, that welder shall be retested, and if he fails the second test, he shall be disqualified for work on the project.

3.3.3 Beveling, Alignment, and Erection

Fabrication of welded pipe joints shall be in accordance with ASME B31.1.

3.3.4 Weld Inspection

Welds shall be inspected for defects in accordance with the following:

a. Cracks shall not be acceptable regardless of length or location;

b. Undercut shall not be deeper than 5 percent of the base-metal thickness or 0.79 mm 1/32 inch, whichever is less;

c. Overlap shall not be permitted. The Contracting Officer reserves the right to further examine the welds by other means to establish the soundness of any weld. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and repairs made to the weld at no additional cost to the Government. Repairing defective welds by adding weld material over the defect or by peening

will not be permitted. Welders responsible for defective welds may be required to requalify under paragraph entitled "Qualifications of Welders."

3.3.5 Electrodes

Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.4 QUALITY CONTROL

3.4.1 General Test Requirements

Tests shall be conducted before, during, and after the installation of the system. All instruments, equipment, facilities, and labor required to properly conduct the tests shall be provided by the Contractor. Test pressure gages for a specific test shall be approved by the Contracting Officer and shall have dials indicating not less than 1 1/2 times nor more than 2 times the test pressure. Any deficiencies shall be corrected at the Contractor's expense. Failure to correct any deficiencies will be cause for rejection of the system.

3.4.2 Field Tests

The following field tests shall be conducted when applicable to the system involved. If any failures occur, the Contractor shall make such adjustments or replacements as directed by the Contracting Officer, and the tests shall be repeated at the Contractor's expense until satisfactory installation and operation are achieved.

3.4.2.1 Hydrostatic Tests of Service Piping

All service piping shall be tested hydrostatically before insulation is applied at field joints, and shall be proved tight at a pressure 1 1/2 times the maximum operating pressure or 1379 kPa 200 psi, whichever is greater, except hot water lines shall not be tested at more than 4136 kPa 600 psi. Hydrostatic test pressures shall be held for a minimum of 4 hours.

3.4.2.2 Operational Tests

After completion of the system, or testable portions thereof, operational tests shall be conducted as in service to demonstrate satisfactory function and operating effectiveness. The tests on each system, or portion thereof, shall last not less than 6 hours.

3.5 SCHEDULE

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

Products	Inch-Pound	Metric
a. Fluid Filled Thermometer: Nominal Scale Diameter	= 5 inches	= 127 mm
b. Bimetal Thermometer: Scale Diameter	= 3 1/2 inches	= 90 mm
c. Heat Exchanger: Operating Condition	= 400 psi	= 2758 kPa
	= 400 degrees F	= 204 degrees C

-- End of Section --