Preparing Activity: USACE Superseding
UFGS-23 57 10.00 10 (January 2008)

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 57 10.00 10

FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS

11/19

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALITY ASSURANCE
1.4 DELIVERY, STORAGE, AND HANDLING
1.5 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT
2.1.1 Standard Products
2.1.2 Nameplates
2.1.3 Equipment Guards and Access
2.1.4 Asbestos Prohibition
2.1.5 Electrical Work
2.2 PIPING, TUBING, AND FITTINGS
2.2.1 General
2.2.2 Steel Pipe
2.2.3 High Temperature Water Piping
2.2.4 Gauge Piping
2.2.5 Copper Tubing
2.2.6 High Temperature Water Fittings
2.2.7 Malleable Iron Pipe Fittings
2.2.8 Cast Iron Pipe Fittings
2.2.9 Steel Pipe Fittings
2.2.9.1 Welded Fittings
2.2.9.2 Grooved Mechanical Fittings
2.2.9.3 Grooved Mechanical Pipe Joints
2.2.10 Joints and Fittings for Copper Tubing
2.2.11 Steel Flanges
2.2.12 Pipe Threads
2.2.13 Nipples
2.2.14 Unions

2.2.15 Adapters
2.2.16 Dielectric Waterways
2.2.17 Grooved Mechanical Joints
2.2.18 Flexible Pipe Connectors
2.3 MATERIALS AND ACCESSORIES
2.3.1 Iron and Steel Sheets
2.3.1.1 Galvanized Iron and Steel
2.3.1.2 Uncoated (Black) Steel
2.3.2 Solder
2.3.3 Solder, Silver
2.3.4 Thermometers
2.3.5 Gauges
2.3.6 Gaskets for Flanges
2.3.7 Polyethylene Tubing
2.3.8 Bellows-Type Joints
2.3.9 Expansion Joints
2.3.10 Flexible Ball Joints
2.3.11 Pipe Hangers, Inserts, and Supports
2.4 VALVES FOR LOW TEMPERATURE WATER HEATING AND STEAM SYSTEMS
2.4.1 Check Valves
2.4.2 Globe Valves
2.4.3 Angle Valves
2.4.4 Gate Valves
2.4.5 Air Vents
2.4.6 Balancing Valves
2.4.7 Gravity Flow Control Valves
2.4.8 Radiator Valves
2.5 VALVES FOR HIGH AND MEDIUM TEMPERATURE WATER SYSTEMS
2.5.1 Check Valves
2.5.2 Globe Valves
2.5.3 Angle Valves
2.5.4 Gate Valves
2.6 COLD WATER CONNECTIONS
2.6.1 Strainers
2.6.2 Pressure Regulating Valve
2.7 FLASH TANK
2.8 EXPANSION TANK
2.9 AIR SEPARATOR TANK
2.10 STEAM TRAPS
2.10.1 Float Traps
2.10.2 Float-and-Thermostatic Traps
2.10.3 Bucket Traps
2.11 HEAT EXCHANGERS
2.11.1 Steam Heat Exchangers, Shell and U-Tube Type
2.11.2 High Temperature Water Heat Exchangers, Shell and U-tube Type
2.11.3 Steam Heat Exchangers, Plate and Frame Type
2.11.4 Medium Temperature Water Heat Exchangers, Plate and Frame Type
2.12 SYSTEM EQUIPMENT AND ACCESSORIES
2.12.1 Circulating Pumps
2.12.2 Condensate Pumping Unit
2.12.2.1 Controls
2.12.2.2 Factory Testing
2.12.3 Pressure Gauges and Thermometers
2.12.4 Vacuum Relief Valve
2.12.5 Pressure Relief Valves
2.12.6 Drains
2.12.7 Strainers
2.13 INSULATION
2.14 FACTORY PAINTED EXPOSED SPACE HEATING EQUIPMENT

2.15 RADIATORS AND CONVECTORS
2.15.1 Cast Iron Radiators
2.15.2 Extended-Surface, Steel, or Nonferrous Tube-Type Radiators
2.15.3 Convectors
2.15.4 Radiators and Convectors Control
2.16 UNIT HEATERS
2.16.1 Propeller Fan Heaters
2.16.2 Centrifugal Fan Heaters
2.16.3 Heating Elements
2.16.4 Motors
2.16.5 Motor Switches
2.16.6 Controls
2.17 HEATING AND VENTILATING UNITS
2.18 WATER TREATMENT SYSTEM
2.18.1 Chemical Shot Feeder
2.18.2 Make Up Water Analysis
2.18.3 Chemicals
2.18.4 Glycol Solutions
2.18.5 Test Kits

PART 3 EXECUTION

3.1 EXAMINATION
3.2 INSTALLATION
3.3 COLOR CODE MARKING AND FIELD PAINTING
3.4 WELDING
3.5 PIPING
3.5.1 Joints
3.5.2 Low Temperature Systems
3.5.3 Steam Systems
3.5.4 High And Medium Temperature Systems
3.5.5 Threaded Joints
3.5.6 Welded Joints
3.5.7 Flanged Joints or Unions
3.5.8 Flared and Sweated Pipe and Tubing
3.5.9 Mechanical Tee Joint
3.5.10 Grooved Joints for Copper Tube
3.6 CONNECTIONS TO EQUIPMENT
3.6.1 Low Temperature Water and Steam and Return Connections
3.6.2 High And Medium Temperature Water Connections
3.7 BRANCH CONNECTIONS
3.7.1 Low Temperature Water Branches
3.7.2 Steam Supply and Condensate Branches
3.7.3 High And Medium Temperature Water Branches
3.8 RISERS
3.9 SUPPORTS
3.9.1 General
3.9.1.1 Seismic Requirements for Pipe Supports, Standard Bracing
3.9.1.2 Structural Attachments
3.9.1.3 Multiple Pipe Runs
3.9.2 Pipe Hangers, Inserts, and Supports
3.9.2.1 Types 5, 12, and 26
3.9.2.2 Type 3
3.9.2.3 Type 18 Inserts
3.9.2.4 Type 19 and 23 C-Clamps
3.9.2.5 Type 20 Attachments
3.9.2.6 Type 24
3.9.2.7 Type 39 Saddle or Type 40 Shield
3.9.2.8 Horizontal Pipe Supports

3.9.2.9 Vertical Pipe Supports
3.9.2.10 Type 35 Guides
3.9.2.11 Pipe Hanger Size
3.9.3 Piping in Trenches
3.10 PIPE SLEEVES
3.10.1 Pipe Passing Through Concrete or Masonry
3.10.2 Pipes Passing Through Waterproofing Membranes
3.10.3 Mechanical Seal Assembly
3.10.4 Counterflashing Alternate
3.10.5 Waterproofing Clamping Flange
3.10.6 Fire Seal
3.10.7 Escutcheons
3.11 ANCHORS
3.12 PIPE EXPANSION
3.12.1 Expansion Loops
3.12.2 Slip-Tube Joints
3.12.3 Bellows-Type Joint
3.12.4 Flexible Ball Joints
3.13 VALVES AND EQUIPMENT ACCESSORIES
3.13.1 Valves and Equipment
3.13.2 Gravity Flow-Control Valve
3.13.3 Thermometer Socket
3.13.4 Air Vents
3.13.4.1 Water Air Vents
3.13.4.2 Steam Air Vents
3.14 STEAM TRAPS
3.15 UNIT HEATERS
3.16 INSULATION
3.17 MANUFACTURER'S SERVICES
3.18 TESTING AND CLEANING
3.18.1 Pressure Testing
3.18.2 Test of Backflow Prevention Assemblies
3.18.3 Cleaning
3.18.4 Water Treatment Testing
3.19 FRAMED INSTRUCTIONS
3.20 FIELD TRAINING
3.21 TESTING, ADJUSTING AND BALANCING

-- End of Section Table of Contents --

UNIFIED FACILITIES GUIDE SPECIFICATIONS

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

SECTION 23 57 10.00 10

FORCED HOT WATER HEATING SYSTEMS USING WATER AND STEAM HEAT EXCHANGERS
11/19

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NOTE: This guide specification covers the requirements for forced hot water heating system using a steam or high temperature water heat exchanger.

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).
****

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 B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
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 B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
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 B16.15	(2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250
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 B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250,

	and 300
ASME B31.1	(2022) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2022) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2021) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A234/A234M	(2023a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure

	Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B251/B251M	(2017) Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
ASTM B265	(2020a) Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate
ASTM B333	(2003; R 2018) Standard Specification for Nickel-Molybdenum Alloy Plate, Sheet, and Strip
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM B424	(2022) Standard Specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221, and UNS N06845) Plate, Sheet, and Strip
ASTM B650	(1995; R 2023) Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM B687	(1999; R 2023) Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B828	(2016) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM D596	(2001; R 2018) Standard Guide for Reporting Results of Analysis of Water
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1384	(2005; R 2019) Corrosion Test for Engine Coolants in Glassware
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2015) (10th Ed) EJMA Standards

HYDRONICS INSTITUTE DIVISION OF AHRI (HYI)

HYI-005	(2008) I=B=R Ratings for Boilers, Baseboard Radiation and Finned Tube (Commercial)

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

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment

(1000 Volts Maximum)

NEMA MG 1 (2021) Motors and Generators

PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION (PHCC)

NAPHCC NSPC (2015) National Standard Plumbing Code Illustrated

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01 (2023) Structural Engineering

1.2 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

Heating System

SD-03 Product Data

Spare Parts

Welding

Framed Instructions

SD-06 Test Reports

Testing and Cleaning

Water Treatment Testing

SD-07 Certificates

Bolts

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G[, [_____]]

1.3 QUALITY ASSURANCE

Procedures and welders must be qualified in accordance with the code under which the welding is specified to be accomplished.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.5 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than [_____] months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

****

NOTE: This guide specification covers low temperature forced hot water heating systems using water temperatures of 99 degrees C 210 degrees F and less, at a working pressure of 207 kPa 30 psig using a steam or high temperature water heat exchanger. A steam supply pressure of approximately 689 kPa 100 psig) and a high water temperature of 177 to 232 degrees C 350 to 450 degrees F were used in preparation of this specification. The high temperature water portion of this specification may be used for medium water temperature system of 121

to 177 degrees C 250 to 350 degrees F if the tests and class of valves, fittings, and piping are adjusted for the temperature and pressure required, but not less than 68 kg 150 pound class system. The designer should consider all pressure reductions such as pump suction and system cool-down effects and should not consider any pressure increases such as pump discharge heads and system heat-up effects when determining the high or medium temperature water system pressurization required to prevent flash steaming and water hammer.

In order to comply with Executive Order 13423 and Public Law 109-58 (Energy Policy Act of 2005), designs must achieve energy consumption levels that are at least 30 percent below the level required by the 2013 publication of ASHRAE 90.1. In accordance with P.L. 109-58 (Energy Policy Act of 2005), Executive Order 13423, and Federal Acquisition Regulation (FAR) 23.203 Energy-efficient Products must meet or exceed the performance criteria for ENERGY STAR®-qualified or FEMP-designated products as long as these requirements are nonproprietary. The FEMP and ENERGY STAR product requirements are available on the web at www.eere.energy.gov/femp/procurement **and** www.energystar.gov/products**. Where ENERGY STAR or FEMP products are not applicable, energy consuming products and systems must meet or exceed the requirements of ASHRAE 90.1.**

****

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Place a plate on each major item of equipment having the manufacturer's name, address, type or style, model or serial number, and catalog number secured to the item of equipment.

2.1.3 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard must be properly guarded or covered with insulation of a type specified. [Catwalks, operating platforms, ladders, and guardrails must be provided where shown and must be constructed in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].]

2.1.4 Asbestos Prohibition

Asbestos and asbestos-containing products will not be accepted.

2.1.5 Electrical Work

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Electric equipment (including motor efficiencies), and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide integral size motors of the premium efficiency type in accordance with NEMA MG 1. Electrical characteristics must be as specified or indicated. Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor must be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring, conduit, and connection to power required for controls and devices but not shown must be provided.

2.2 PIPING, TUBING, AND FITTINGS

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NOTE: Copper tubing and steel pipe will be considered as competitive unless one is not applicable for service.
****

2.2.1 General

Piping, tubing, and fittings must be as follows:

a. Low temperature water piping must be black steel or copper tubing with cast iron, malleable iron or steel, solder-joint, flared-tube or grooved mechanical joint fittings.

b. Steam pipe must be black steel with malleable iron or steel fittings.

c. Condensate return piping must be black steel Schedule 80 with cast iron or malleable iron, Class 250 minimum.

d. High temperature water piping must be black steel, Schedule 40.

e. Vent piping must be black steel, Schedule 40, with black malleable iron fittings.

2.2.2 Steel Pipe

Pipe must conform to ASTM A53/A53M or ASTM A106/A106M, Grade A or B, black steel, Schedule 40, unless otherwise specified. Steel pipe to be bent must be ASTM A53/A53M, Grade A, standard, or Grade B, extra strong weight. Steam pipe must be ASTM A53/A53M Grade A.

2.2.3 High Temperature Water Piping

Piping must be Type S for 40 mm 1-1/2 inches and smaller, Type S or Type E for pipe 50 mm 2 inches and larger, schedule 40 steel conforming to

ASTM A53/A53M, Grade B; or to ASTM A106/A106M, Grade B.

2.2.4 Gauge Piping

Piping must be copper tubing for [steam] [and] [low temperature water]. [Use black steel, ASTM A106/A106M, seamless, Grade A pipe for high temperature.]

2.2.5 Copper Tubing

Tubing must conform to ASTM B88, ASTM B88M, Type K or L. Tubing for compressed air tubing must conform to ASTM B251/B251M.

2.2.6 High Temperature Water Fittings

Fittings must be steel welding fittings conforming in physical and chemical properties to ASTM A234/A234M. Buttwelding fittings must conform to ASME B16.9. Socket welded fittings must conform to ASME B16.1. Screwed fittings, when required, must be black forged steel, 2000-pound class, conforming to ASME B16.11. Flanges must be serrated or raised-faced type.

2.2.7 Malleable Iron Pipe Fittings

Fittings must conform to ASME B16.3, type required to match adjacent piping.

2.2.8 Cast Iron Pipe Fittings

Fittings must conform to ASME B16.1 or ASME B16.4 type required to match adjacent piping.

2.2.9 Steel Pipe Fittings

Fittings must have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.2.9.1 Welded Fittings

Welded fittings must conform to ASTM A234/A234M with WPA marking. Butt welded fittings must conform to ASME B16.9, and socket welded fittings must conform to ASME B16.11.

2.2.9.2 Grooved Mechanical Fittings

Standard fittings must be of malleable iron conforming to ASTM A47/A47M, Grade 32510, or ductile iron conforming to ASTM A536, Grade 65-45-12. Fittings may also be constructed of steel, conforming to ASTM A106/A106M, Grade B or ASTM A53/A53M.

2.2.9.3 Grooved Mechanical Pipe Joints

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NOTE: Gasket material must be specified: EPDM for temperatures to 110 degrees C 230 degrees F; Buna-N for temperatures to 82 degrees C 180 degrees F. Review manufacturer's data for other requirements and limits. Do not use for steam.

****

Pipe joints must conform to AWWA C606. Grooved mechanical joint fittings must be full flow factory manufactured forged steel fittings. Fittings, couplings, gaskets, and pipe grooving tool or grooved end pipe must be products of the same manufacturer. Mechanical pipe couplings must be of the bolted type and must consist of a housing fabricated in two or more parts, a synthetic rubber gasket, and nuts and bolts to secure unit together. Housings must be of malleable iron conforming to ASTM A47/A47M, Grade 32510 or ductile iron conforming to ASTM A536, Grade 65-45-12. Coupling nuts and bolts must be of steel and conform to ASTM A183. Submit written certification that the bolts furnished comply with the requirements of this specification, provided by the bolt manufacturer. The certification must include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification. Gaskets must be of molded synthetic rubber, Type [EPDM] [Buna-N] with central cavity, pressure responsive configuration and must conform to ASTM D2000.

2.2.10 Joints and Fittings for Copper Tubing

Wrought copper and bronze fittings must conform to ASME B16.22 and ASTM B75/B75M. Cast copper alloy fittings must conform to ASME B16.18 and ASTM B828. Flared fittings must conform to ASME B16.26 and ASTM B62. Adaptors may be used for connecting tubing to flanges and threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Cast bronze threaded fittings must conform to ASME B16.15. Grooved mechanical joints and fittings must be designed for not less than 862 kPa 125 psig service and must be the product of the same manufacturer. Grooved fitting and mechanical coupling housing must be ductile iron conforming to ASTM A536. Gaskets for use in grooved joints must be molded synthetic polymer of pressure responsive design and must conform to ASTM D2000 for circulating medium up to 110 degrees C 230 degrees F. Grooved joints must conform to AWWA C606. Coupling nuts and and bolts for use in grooved joints must be steel and must conform to ASTM A183.

2.2.11 Steel Flanges

Flanged fittings including flanges, bolts, nuts, bolt patterns., etc. must be in accordance with ASME B16.5 class 150 and must have the manufacturers trademark affixed in accordance with MSS SP-25. Flange material must conform to ASTM A105/A105M. Flanges for high temperature water systems must be serrated or raised-face type. Blind flange material must conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts must be high strength or intermediate strength with material conforming to ASTM A193/A193M.

2.2.12 Pipe Threads

Pipe threads must conform to ASME B1.20.2MASME B1.20.1.

2.2.13 Nipples

Nipples must conform to ASTM A733 or ASTM B687, standard weight.

2.2.14 Unions

Unions must conform to ASME B16.39, type to match adjacent piping.

2.2.15 Adapters

Adapters for copper tubing must be brass or bronze for soldered fittings.

2.2.16 Dielectric Waterways

Dielectric waterways must conform to the tensile strength and dimensional requirements specified in ASME B16.39. Waterways must have metal connections on both ends to match adjacent piping. Metal parts of dielectric waterways must be separated so that the electrical current is below 1 percent of the galvanic current which would exist upon metal-to-metal contact. Dielectric waterways must have temperature and pressure rating equal to or greater than that specified for the connecting piping. Dielectric waterways must be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges must meet the performance requirements described herein for dielectric waterways.

2.2.17 Grooved Mechanical Joints

Rigid grooved pipe joints may be provided in lieu of unions, welded, flanges or screwed piping connections at chilled water pumps and allied equipment, and on aboveground pipelines in serviceable locations, if the temperature of the circulating medium does not exceed 110 degrees C 230 degrees F. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints must incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to insure positive rigid clamping of the pipe. Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications, will not be permitted. Rigid grooved pipe couplings must be used with grooved end pipes, fittings, valves and strainers. Rigid couplings must be designed for not less than 862 kPa 125 psi service and appropriate for static head plus the pumping head, and must provide a water-tight joint. Grooved fittings and couplings, and grooving tools must be provided from the same manufacturer. Segmentally welded elbows must not be used. Grooves must be prepared in accordance with the coupling manufacturer's latest published standards. Grooving must be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations. The Contracting Officer must be notified 24 hours in advance of test to demonstrate operator's capability, and the test must be performed at the work site, if practical, or at a site agreed upon. The operator must demonstrate the ability to properly adjust the grooving tool, groove the pipe, and verify the groove dimensions in accordance with the coupling manufacturer's specifications.

2.2.18 Flexible Pipe Connectors

Flexible pipe connectors must be designed for 1.034 MPa 125 psi or 1.034 MPa 150 psi service as appropriate for the static head plus the system head, and 121 degrees C 250 degrees F. Connectors must be installed where indicated. The flexible section must be constructed of rubber, tetrafluoroethylene resin, or corrosion-resisting steel, bronze, monel, or galvanized steel. Materials used and the configuration must be suitable for the pressure, vacuum, temperature, and circulating medium. The flexible section may have threaded, welded, soldered, flanged, grooved, or socket ends. Flanged assemblies must be equipped with limit bolts to

restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors must be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, must be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.3 MATERIALS AND ACCESSORIES

2.3.1 Iron and Steel Sheets

2.3.1.1 Galvanized Iron and Steel

Galvanized iron and steel must conform to ASTM A653/A653M, with general requirements conforming to ASTM A653/A653M. Gauge numbers specified are Manufacturer's Standard Gauge.

2.3.1.2 Uncoated (Black) Steel

Uncoated (black) steel must conform to ASTM A653/A653M, composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to Manufacturer's Standard Gauge.

2.3.2 Solder

Solder must conform to ASTM B32. Solder and flux must be lead free. Solder flux must be liquid or paste form, non-corrosive and conform to ASTM B813.

2.3.3 Solder, Silver

Silver solder must conform to AWS A5.8/A5.8M.

2.3.4 Thermometers

Mercury must not be used in thermometers. Thermometers must have brass, malleable iron, or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 225 mm 9 inch scale, and thermometers must have rigid stems with straight, angular, or inclined pattern.

2.3.5 Gauges

Provide gauges conforming to ASME B40.100.

2.3.6 Gaskets for Flanges

Composition gaskets must conform to ASME B16.21. Gaskets must be nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full face or self-centering flat ring type. Gaskets must contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder must be used for hydrocarbon service. Gaskets must be suitable for pressure and temperatures of piping system.

2.3.7 Polyethylene Tubing

Low-density virgin polyethylene must conform to ASTM D1248, Type I, Category 5, Class B or C.

2.3.8 Bellows-Type Joints

****
NOTE: Select bellows-type or slip-type to satisfy specific design conditions.
****

Joints must be flexible, guided expansion joints. Expansion element must be of stainless steel. Bellows-type expansion joints must be in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.3.9 Expansion Joints

Expansion joints must provide for either single or double slip of connected pipes, as required or indicated, and for not less than the traverse indicated. Joints must be designed for hot water working pressure not less than [_____] kPa psig and must be in accordance with applicable requirements of EJMA Stds and ASME B31.1. Joints must be designed for packing injection under full line pressure. End connections must be flanged or beveled for welding as indicated. Provide joints with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip must be seamless steel plated with a minimum of 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Joint components must be fabricated from material equivalent to that of the pipeline. Initial settings must be made in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides must be installed as recommended by joint manufacturer, but in any case must not be more than 1.5 m 5 feet from expansion joint except for lines 100 mm 4 inches or smaller, guides must be installed not more than 600 mm 2 feet from the joint. Provide service outlets where indicated.

2.3.10 Flexible Ball Joints

Flexible ball joints must be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint must be designed for packing injection under full line pressure to contain leakage. Joint ends must be threaded (to 50.8 mm 2 inches only), grooved, flanged or beveled for welding as indicated or required and must be capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation. Balls and sockets must be of equivalent material as the adjoining pipeline. Exterior spherical surface of carbon steel balls must be plated with 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Ball type joints must be designed and constructed in accordance with ASME B31.1 and ASME BPVC SEC VIII D1, where applicable. Flanges where required must conform to ASME B16.5. Gaskets and compression seals must be compatible with the service intended.

2.3.11 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58.

2.4 VALVES FOR LOW TEMPERATURE WATER HEATING AND STEAM SYSTEMS

****
NOTE: Valves apply to low temperature water heating or low pressure steam systems. Delete for high or

medium temperature water systems.
****

2.4.1 Check Valves

****
NOTE: Indicate the type of valves, vertical lift or horizontal, on the drawings.
****

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 3 or 4, Class 125. Sizes 80 mm 3 inches through 300 mm 24 inches, cast iron must conform to MSS SP-71, Type III or IV, Class 125.

2.4.2 Globe Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm 3 inches through 300 mm 12 inches, cast iron must conform to MSS SP-85, Type III, Class 125.

2.4.3 Angle Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 125. Sizes 80 mm 3 inches through 300 mm 12 inches, cast iron must conform to MSS SP-85, Type III, Class 125.

2.4.4 Gate Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1 or 2, Class 125. Sizes 80 mm 3 inches through 1200 mm 48 inches, cast iron must conform to MSS SP-70, Type I, Class 125, Design OT or OF (OS&Y), bronze trim.

2.4.5 Air Vents

****
NOTE: Air vent locations will be indicated on drawings; distinguish between manual vents and automatic air vents.
****

Provide air vents at all piping high points in water systems, with block valve in inlet and internal check valve to allow air vent to be isolated for cleaning and inspection. Outlet connection must be piped to nearest open site or suitable drain, or terminated 300 mm 12 inches above finished grade. Pressure rating of air vent must match pressure rating of piping system. Body and cover must be cast iron or semi-steel with stainless steel or copper float and stainless steel or bronze internal parts. Air vents installed in piping in chase walls or other inaccessible places must be provided with an access panel.

2.4.6 Balancing Valves

Balancing valves must have meter connections with positive shutoff valves. An integral pointer must register degree of valve opening. Valves must be calibrated so that flow in L/minute gpm can be determined when valve opening in degrees and pressure differential across valve is known. Each balancing valve must be constructed with internal seals to prevent leakage and must be supplied with preformed insulation. Valves

must be suitable for 121 degrees C 250 degrees F temperature and working pressure of the pipe in which installed. Valve bodies must be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions must be provided with quick connecting hose fittings for a portable meter to measure the pressure differential. One portable differential meter must be furnished. The meter suitable for the operating pressure specified must be complete with hoses, vent, and shutoff valves and carrying case. In lieu of the balancing valve with integral metering connections, a ball valve or plug valve with a separately installed orifice plate or venturi tube may be used for balancing. Provide plug valves and ball valves 200 mm 8 inches or larger with manual gear operators with position indicators.

2.4.7 Gravity Flow Control Valves

Ends must be soldered, threaded, or flanged type as applicable, and designed for easy cleaning without disconnecting piping. Valves for copper tubing must be bronze. Valves must prevent flow due to gravity when circulators are off.

2.4.8 Radiator Valves

Automatic thermostatic radiator valves must be self-contained [direct sensor] [remote sensor] [wall thermostat] controlled nonelectric temperature control valves. Valve bodies must be constructed of chrome plated brass and must be angle or straight pattern as indicated, with threaded or brazed end connections. Valve disc must be of ethylene propylene or composition material. Thermostatic operators must be a modulating type consisting of a sensing unit counter balanced by a spring setting.

2.5 VALVES FOR HIGH AND MEDIUM TEMPERATURE WATER SYSTEMS

****

NOTE: Valves apply to high and medium temperature water systems and high pressure steam systems. Delete for low temperature water heating systems or low pressure steam systems.

****

2.5.1 Check Valves

****

NOTE: Indicate the type of valves, vertical lift or horizontal, on the drawings.

****

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Class 300 Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends, swing disc; water, oil gas or steam service to 454 degrees C 850 degrees F.

2.5.2 Globe Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 454 degrees C 850 degrees F.

2.5.3 Angle Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, 2 or 3, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas, or steam service to 454 degrees C 850 degrees F.

2.5.4 Gate Valves

Sizes 65 mm 2-1/2 inches and less, bronze must conform to MSS SP-80, Type 1, or 2, Class 300 minimum. Sizes 80 mm 3 inches through 600 mm 24 inches, steel must conform to ASME B16.34, Class 300 minimum, flanged ends; water, oil, gas or steam service to 454 degrees C 850 degrees F. Gate must be split wedge (double disc) type.

2.6 COLD WATER CONNECTIONS

Connections must be provided which include consecutively in line a strainer, backflow prevention device, and water pressure regulator. The backflow prevention device must be provided as indicated and in compliance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.6.1 Strainers

Basket or Y-type strainers must be the same size as the pipelines in which they are installed. Strainer bodies must be rated for [0.862] [1.72] MPa [125] [250] pound service, with bottoms drilled and plugged. Bodies must have arrows cast on the sides to indicate the direction of flow. Each strainer must be equipped with a removable cover and sediment basket. Basket must not be less than 0.795 mm (22 gauge) 22 gauge and must have perforations to provide a net free area through the basket of at least four times that of the entering pipe.

2.6.2 Pressure Regulating Valve

Valve must be a type that will not stick nor allow pressure to build up on the low side. Valve must be set to maintain a terminal pressure approximately 35 kPa 5 psi in excess of the static head on the system and must operate within a 138 kPa 20 psi variation regardless of initial pressure and without objectionable noise under any condition of operation.

2.7 FLASH TANK

Tank must be sized and installed as indicated, and must be of welded construction utilizing black steel sheets not less than 3.175 mm (11 gauge) 11 gauge. Provide tank with a handhole and with tapping for the condensate returns, drip lines, vent line, and condensate discharge line to the condensate receiver. Discharge line must be equipped with a float trap. Tank must be ASME rated for [_____] kPa psig in accordance with ASME BPVC SEC VIII D1.

2.8 EXPANSION TANK

Pressurization system must include a replaceable diaphragm-type captive air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. The only air in the system must be the

permanent sealed-in air cushion contained in the diaphragm-type tank. Sizes must be as indicated. Expansion tank must be welded steel, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of [862] [_____] kPa [125] [_____] psig and precharged to the minimum operating pressure. Tank air chamber must be fitted with an air charging valve. Tank must be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations.

2.9 AIR SEPARATOR TANK

External air separation tank must be steel, constructed, tested, and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of [862] [_____] kPa [125] [_____] psi. The capacity of the air separation tank indicated is minimum.

2.10 STEAM TRAPS

****
NOTE: Applicable to steam systems only. A schedule of steam trap selection will be located on drawings showing trap orifice size, capacity (kg/hr#/hr), and pressure drop (kPapsi), for each trap required. Delete steam traps not required.
****

2.10.1 Float Traps

Capacity, working pressure, and differential pressure of the traps must be as indicated.

2.10.2 Float-and-Thermostatic Traps

Traps must be designed for a steam working pressure of approximately 103 kPa 15 psig, but must operate with a supply pressure of approximately 35 kPa 5 psig. The capacity of the traps must be as indicated. Trap capacity must be based on a pressure differential of 2 kPa 1/4 psi. Provide each float-and-thermostatic trap a hard bronze, monel, or stainless steel valve seat and mechanism and brass float, all of which can be removed easily for inspection or replacement without disturbing the piping connections. Inlet to each trap must have a cast iron strainer, either an integral part of the trap or a separate item of equipment.

2.10.3 Bucket Traps

Traps must be inverted or vertical bucket type with automatic air discharge. Traps must be designed for a working pressure of 1034 kPa 150 psig, but must operate under a steam supply pressure of approximately 276 to 690 kPa 40 to 100 psig as required. Each trap must have a heavy body and cap of fine-grained, gray cast iron. The bucket must be made of brass; the mechanism of hard bronze; the valve and seat of stainless or monel; or each of equivalent material. Traps must be tested hydrostatically under a pressure of 1.38 MPa 200 psig. Traps must have capacities as indicated when operating under the specified working conditions. A strainer must be installed in the suction connection of each trap. Impact operated traps, impulse-operated traps, or thermodynamic traps with continuous discharge may be installed in lieu of bucket traps, subject to approval. Thermostatic traps designed for a steam working pressure suitable for the application may be furnished in

lieu of the traps specified above. Thermostatic traps must be equipped with valves and seats of stainless steel or monel metal, and must have capacities based on a pressure differential not in excess of the following:

Steam Working Pressure, kPa (psi) psi	Differential, kPa (psi) psi
172 - 345 (25-50)25-50	138 (20)20
621 - 689 (90-100)90-100	552 (80)80

2.11 HEAT EXCHANGERS

****

NOTE: The following information applicable to the project will be indicated on the drawings:

a. Capacity of heat exchanger in liters per minute (gpm).

b. Supply and return temperatures of low temperature water in degrees C degrees F.

c. Supply and return temperatures of high or medium temperature water in degrees C degrees F.

d. Steam pressure in kPa psig.

e. Pressure drops in mm feet of water or kPa psig.

f. Fouling allowances for steam or high temperature water and for low temperature water will be determined by the system designer. Recommended allowances are listed in the Tubular Exchanger Manufacturers Association (TEMA) Standards. Insert system fouling allowance in blank space.

****

Heat exchangers must be multiple pass shell and U-tube type or plate and frame type as indicated, to provide low temperature hot water for the heating system when supplied with [steam] [or] [high temperature hot water] [or] [medium temperature hot water] at the temperatures and pressures indicated. Temperature and pressure for plate and frame exchangers must not exceed 138 degrees C 280 degrees F and 1.93 MPa 280 psig for medium temperature hot water, or 138 degrees C 280 degrees F and 241 kPa 35 psig for steam. Temperature and pressure for shell and U-tube exchangers must not exceed 170 degrees C 338 degrees F and 689 kPa 100 psig for steam or 221 degrees C 430 degrees F and 2.76 MPa 400 psig for high temperature hot water. Exchangers must be constructed in accordance with ASME BPVC SEC VIII D1 and certified with ASME stamp secured to unit. U-tube bundles must be completely removable for cleaning and tube replacement and must be free to expand with shell. Shells must be of seamless steel pipe or welded steel construction and tubes must be seamless tubing as specified below unless otherwise indicated. Tube connections to plates must be leakproof. Provide saddles or cradles to mount shell and U-tube exchangers. Frames of plate and frame type exchangers must be fabricated of carbon steel and finished with baked epoxy enamel. Design fouling factor must be [_____].

2.11.1 Steam Heat Exchangers, Shell and U-Tube Type

Exchangers must operate with steam in shell and low temperature water in tubes. Shell and tube sides must be designed for 1.03 MPa 150 psig working pressure and factory tested at 2.02 MPa 300 psig. Steam, water, condensate, and vacuum and pressure relief valve connections must be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm 3 inches must be ASME 1.03 MPa 150 pound flanged. Water pressure loss through clean tubes must not exceed 41 kPa 6 psi and water velocity must not exceed 1.8 m/second 6 fps unless otherwise indicated. Minimum water velocity in tubes must be not less than 300 mm/second 1 fps and assure turbulent flow. Tubes must be seamless copper or copper alloy, constructed in accordance with ASTM B75/B75M or ASTM B395/B395M, suitable for the temperatures and pressures specified. Tubes must be not less than 19 mm 3/4 inch unless otherwise indicated. Maximum steam inlet nozzle velocity must not exceed 30.5 m/second 6000 fpm.

2.11.2 High Temperature Water Heat Exchangers, Shell and U-tube Type

Exchangers must operate with low temperature water in shell and high temperature water in tubes. Shell side must be designed for 1.03 MPa 150 psig working pressure and factory tested at 2.07 MPa 300 psig. Tubes must be designed for 2.76 MPa 400 psig working pressure and an operating temperature of 232 degrees C 450 degrees F. High and low temperature water and pressure relief connections must be located in accordance with the manufacturer's standard practice. Water connections larger than 80 mm 3 inches must be ASME 4.14 MPa 600 pound flanged for high temperature water, and ASME 4.03 MPa 150 pound flanged for low temperature water. Water pressure loss through clean tubes must not exceed 41 kPa 6 psig unless otherwise indicated. Minimum water velocity in tubes must be 300 mm/second 1 fps and assure turbulent flow. Tubes must be cupronickel or inhibited admiralty, constructed in accordance with ASTM B395/B395M, suitable for the temperatures and pressures specified. Tubes must be not less than 19 mm 3/4 inch unless otherwise indicated.

2.11.3 Steam Heat Exchangers, Plate and Frame Type

Plates, frames and gaskets must be designed for a working pressure of 2.07 MPa 300 psig and factory tested at 3.10 MPa 450 psig. Steam, low temperature water, condensate, and vacuum and pressure relief valve connections must be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm 3 inches must be ASME 4.03 MPa 150 pound flanged. Water pressure drop through clean plates and headers must not exceed [_____] kPa psig at the flow rates and temperatures indicated. Plates must be designed to assure turbulent flow at a minimum rate of [_____] L/minute gpm through any 2 plate segment. Plates must be corrugated [Type 304 stainless steel] [Type 316 stainless steel] [nickel-iron-chromium alloy conforming to ASTM B424] [nickel-molybdenum alloy conforming to ASTM B333] [titanium alloy conforming to ASTM B265]. Plate thickness must be not less than [_____] mm inch.

2.11.4 Medium Temperature Water Heat Exchangers, Plate and Frame Type

Plates, frames and gaskets must be designed for a working pressure of 2.07 MPa 300 psig and factory tested at 31.0 MPa 450 psig. Medium temperature water, low temperature water, and pressure relief valve connections must be located in accordance with the manufacturer's standard practice. Connections larger than 80 mm 3 inches must be ASME 2.07 MPa 300 pound

flanged. Water pressure drop through clean plates and headers must not exceed [_____] kPa psi at the flow rates and temperatures indicated. Plates must be designed to assure turbulent flow at a minimum rate of [_____] L/second gpm through any 2 plate segment. Plates must be corrugated [Type 304 stainless steel] [Type 316 stainless steel] [nickel-iron-chromium alloy conforming to ASTM B424] [nickel-molybdenum alloy conforming to ASTM B333] [titanium alloy conforming to ASTM B265]. Plate thickness must be not less than [_____] mm inch.

2.12 SYSTEM EQUIPMENT AND ACCESSORIES

2.12.1 Circulating Pumps

Pumps for hot water must be of the single-stage centrifugal type, electrically driven. Pumps must be supported [on a concrete foundation] [or] [by the piping on which installed] [as indicated]. Pumps must be either integrally mounted with the motor or direct-connected by means of a flexible-shaft coupling on a cast iron, or steel sub-base. Pump housing must be of close grained cast iron. Shaft must be carbon or alloy steel, turned and ground. Shaft seal must be mechanical-seal or stuffing-box type. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve must be bronze. Bearings must be ball-, roller-, or oil-lubricated, bronze-sleeve type, and must be sealed or isolated to prevent loss of oil or entrance of dirt or water. Motor must be of a type approved by the manufacturer of the pump.

2.12.2 Condensate Pumping Unit

****

NOTE: Size condensate pumping rate for three times the expected condensate flow. Size receiver for five times the expected condensate flow for expected condensate flow up to 30 liters per minute 8 GPM. Size receiver two times the expected condensate flow for expected condensate flow over 30 liters per minute 8 GPM.

****

Pump must have a minimum capacity, as indicated, of [_____] L/second gpm when discharging against the specified pressure. The minimum capacity of the tank must be [_____] liters gallons. Condensate pumping unit must be of the [single] [duplex], [horizontal-shaft] [vertical-shaft] type, as indicated. Unit must consist of [one pump] [two pumps], [one electric motor] [two electric motors] and a single receiver. Pumps must be centrifugal or turbine type, bronze-fitted throughout with impellers of bronze or other corrosion-resistant metal. Pumps must be free from air-binding when handling condensate with temperatures up to 93 degrees C 200 degrees F. Pumps must be connected directly to dripproof enclosed motors. Receiver must be cast iron and must be provided with condensate return, vent, overflow, and pump suction connections, and water level indicator and automatic air vent. Inlet strainer must be provided in the inlet line to the tank. Vent pipe must be galvanized steel, and fittings must be galvanized malleable iron. Vent pipe must be installed as indicated or directed. Vent piping must be flashed as specified. Pump, motor, and receiving tank may be mounted on a single base with the receiver piped to the pumps suctions. Provide a gate valve and check valve in the discharge connection from each pump.

2.12.2.1 Controls

Install enclosed float switches complete with float mechanisms in the head of the receiver. The condensate pump must be controlled automatically by means of the [respective] float switch that will automatically start the motor when the water in the receiving tank reaches the high level and stop the motor when the water reaches the low level. Provide motors with magnetic across-the-line starters equipped with general purpose enclosure and Automatic-Manual-Off selector switch in the cover.

2.12.2.2 Factory Testing

Submit a certificate of compliance from the pump manufacturer covering the actual test of the unit and certifying that the equipment complies with the indicated requirements.

2.12.3 Pressure Gauges and Thermometers

Provide gauges for each heat exchanger and piping as indicated. Provide a thermometer and pressure gauge on the high temperature water supply and return mains. Thermometers must be separable socket type.

2.12.4 Vacuum Relief Valve

Install a vacuum relief valve on the shell of each shell and U-tube steam heat exchanger and on the factory supplied steam inlet nozzle of each plate and frame heat exchanger. On shutoff of steam supply and condensing of steam, the vacuum relief valve must automatically admit air to the heat exchanger.

2.12.5 Pressure Relief Valves

Provide one or more pressure relief valves for each heat exchanger in accordance with ASME BPVC SEC VIII D1. The aggregate relieving capacity of the relief valves must be not less than that required by the above code. Discharge from the valves must be installed as indicated. Pressure relief valves for steam heat exchangers must be located on the low temperature water supply coming from near the heat exchanger as indicated. Relief valves for high temperature water heat exchanger must be installed on the heat exchanger shell.

2.12.6 Drains

****

NOTE: Drawings must indicate low-point drains.

****

Install a drain connection with 19 mm 3/4 inch hose bib at the lowest point in the low temperature water return main near the heat exchanger. In addition, install threaded drain connections with threaded cap or plug wherever required for thorough draining of the low temperature water system.

2.12.7 Strainers

****

NOTE: Select the correct piping and pipe fittings (steam or high-temperature water) and delete the inapplicable system.

****

Basket or Y-type strainer-body connections must be the same size as the pipe lines in which the connections are installed. The bodies must have arrows clearly cast on the sides to indicate the direction of flow. Each strainer must be equipped with an easily removable cover and sediment basket. The body or bottom opening must be equipped with nipple and gate valve for blowdown. The basket for steam systems must be of not less than 0.635 mm 0.025 inch thick stainless steel, or monel with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow must be into the basket and out through the perforations. [For high temperature water systems, only cast steel bodies must be used.] [The strainer bodies for steam systems must be of cast steel or gray cast iron with bottoms drilled and plugged.]

2.13 INSULATION

Shop and field applied insulation must be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.14 FACTORY PAINTED EXPOSED SPACE HEATING EQUIPMENT

Radiator and convector enclosures must be coated with the manufacturer's standard rust inhibiting primer for painting in the field as specified in Section 09 90 00 PAINTS AND COATINGS. All other exposed heating equipment must be painted at the factory with the manufacturer's standard primer and enamel finish.

2.15 RADIATORS AND CONVECTORS

****

NOTE: Drawings must indicate the types, sizes, and capacities of radiators and convectors. Show typical piping details on drawings for radiators and convectors.

****

The radiator and convector must be the type and size indicated. The supply and return connections must be the same size. Cast iron radiators and nonferrous convectors must be tested hydrostatically at the factory and proved tight under a pressure of not less than [207 kPa][30 psig] [[_____] kPa][[_____] psig] or 150 percent of the system operating pressure, whichever is greater. Furnish a certified report of these tests in accordance with paragraph SUBMITTALS.

2.15.1 Cast Iron Radiators

Cast iron radiators must be gray cast iron, free from sandholes and other defects. The sections must be connected with malleable iron nipples not less than 2.286 mm 0.09 inch thick at any point. Cast iron radiators must be the legless type mounted on the walls by means of hangers as specified. Adjustable radiator hangers must be secured to the wall and must hold the radiators near both ends, at both top and bottom, in such a manner that the radiators cannot be removed without the use of tools. Not less than two bolts must be used to secure each hanger to the wall. Necessary angles, bolts, bearing plates, toggles, radiator grips, and other parts required for complete installation of the radiators must be provided.

2.15.2 Extended-Surface, Steel, or Nonferrous Tube-Type Radiators

****

NOTE: The type of cover grille selected for fin-type radiators must suit the particular building involved.

****

Radiators must consist of metal fins permanently bonded to steel or nonferrous pipe cores, with threaded or sweat fittings at each end for connecting to external piping. Radiators must have capacities not less than those indicated, determined in accordance with HYI-005. Radiators must be equipped with [expanded-metal cover grilles fabricated from black steel sheets not less than 1.519 mm (16 gauge) 16 gauge, secured either directly to the radiators or to independent brackets.] [solid-front, slotted horizontal-top cover grilles fabricated from black steel sheets not less than 1.214 mm (18 gauge) 18 gauge, secured either directly to the radiators or to independent brackets.] [solid-front, slotted sloping-top cover grilles fabricated from black steel sheets not less than 1.519 mm (16 gauge) 16 gauge, independently secured to masonry with brackets.]

2.15.3 Convectors

Convectors must be constructed of cast iron or of nonferrous alloys, and must be installed where indicated. Capacity of convectors must be as indicated. Overall space requirements for convectors must not be greater than the space provided. Convectors must be complete with heating elements and enclosing cabinets having bottom recirculating opening, manual control damper and top supply grille. Convector cabinets must be constructed of black sheet steel not less than 0.912 mm (20 gauge) 20 gauge.

2.15.4 Radiators and Convectors Control

[The space temperature must be maintained automatically by regulating water flow to the radiators and convectors by the self contained, automatic thermostatic radiator control valves.] [Provide controls as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.]

2.16 UNIT HEATERS

****

NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings. Show typical piping details on drawings for these units.

In critical areas where maximum noise level limits are required, the sentence in brackets will be retained and the brackets deleted. The maximum acceptable noise limits for these critical areas will be determined in NC level or dbA and should be indicated on the drawings. The sentence in brackets will be deleted for noncritical areas. Sound values will be selected by the designer based on a study of the design goal. The ASHRAE Handbook, Fundamentals, shows the range of sound pressure values for speech communications as being 50 dB for fair, 44 dB for very good, and 38 dB for perfect speech intelligibility.

****

Heaters must be as specified below, and must have a heating capacity not in excess of 125 percent of the capacity indicated. [Noise level of each unit heater for areas noted must not exceed the criteria indicated.]

2.16.1 Propeller Fan Heaters

Heaters must be designed for suspension and arranged for [horizontal] [vertical] discharge of air as indicated. Casings must be not less than 0.912 mm (20 gauge) 20 gauge black steel and finished with lacquer or enamel. Suitable [stationary] [rotating air] deflectors must be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. [Fans for vertical discharge type heaters must operate at speeds not in excess of 1,200 rpm, except that units with 84.4 MJ 80,000 Btu output capacity or less may operate at speeds up to 1,800 rpm.] [Horizontal discharge type unit heaters must have discharge or face velocities not in excess of the following:

Unit Capacity, Liters per Second cfm	Face Velocity, Meters per Second fpm
Up to 472 (1000) 1000	4.06 (800)800
473 (1001)1001	4.57 (900)900
1417 (3001) 3001 and over	5.08 (1,000)1000

]

2.16.2 Centrifugal Fan Heaters

Heaters must be arranged for floor or ceiling mounting as indicated. Heating elements and fans must be housed in steel cabinets of sectionalized steel plates or reinforced with angle-iron frames. Cabinets must be constructed of not lighter than 1.27 mm (18 gauge) 18 gauge black steel. Provide each unit heater with a means of diffusing and distributing the air. Fans must be mounted on a common shaft, with one fan to each air outlet. Fan shaft must be equipped with self-aligning ball, roller, or sleeve bearings and accessible means of lubrication. Fan shaft may be either directly connected to the driving motor or indirectly connected by adjustable V-belt drive rated at 150 percent of motor capacity. All fans in any one unit heater must be the same size.

2.16.3 Heating Elements

****

NOTE: For project designs requiring air-supply and distribution systems, consider using the optional choice of referencing Section 23 30 00 HVAC AIR DISTRIBUTION for the equipment in this paragraph.

****

[Heating coils and radiating fins must be of suitable nonferrous alloy with [threaded] [brazed] fittings at each end for connecting to external piping. The heating elements must be free to expand or contract without developing leaks and must be properly pitched for drainage. The elements must be tested under a hydrostatic pressure of 1.38 MPa 200 psig and a certified report of the test must be submitted to the Contracting

Officer.] [Heating coils must be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION for types indicated.] Coils must be suitable for use with water up to 121 degrees C 250 degrees F.

2.16.4 Motors

Provide motors with NEMA 250 general purpose enclosure. Motors and motor controls must otherwise be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.16.5 Motor Switches

Provide motors with manual selection switches with "Off," and "Automatic" positions and must be equipped with thermal overload protection.

2.16.6 Controls

Provide controls as specified in 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.17 HEATING AND VENTILATING UNITS

Heating and ventilating units must be as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.18 WATER TREATMENT SYSTEM

****

NOTE: Typically, large amounts of makeup water will not be required for new closed loop heating systems. However, if a large amount of makeup water is anticipated, an automatic chemical feed system should be used in lieu of a shot feeder. The automatic system can be found in Section 23 52 00 HEATING BOILERS.

****

The water treatment system must be capable of [manually] [automatically] feeding chemicals into the heating system to prevent corrosion and scale within the heat exchanger and piping system. Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Also show on the drawings complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show on the drawings proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances for maintenance and operation. All water treatment equipment and chemicals must be furnished and installed by a water treatment company regularly engaged in the installation of water treatment equipment and the provision of water treatment chemicals based upon water condition analyses. The water treatment company must provide a water sample analysis taken from the building site, each month for one year.

2.18.1 Chemical Shot Feeder

Provide a shot feeder indicated. Size and capacity of feeder must be based upon local requirements and water analysis. The feeder must be

furnished with an air vent, gauge glass, funnel, valves, fittings, and piping. All materials of construction must be compatible with the chemicals being used.

2.18.2 Make Up Water Analysis

****

NOTE: A water analysis may be available from the user. If an analysis is not available, an analysis will be performed during the design, and appropriate data will be entered.

****

The make up water conditions reported as prescribed in ASTM D596 are as follows:

Date of Sample	[_____]
Temperature	[_____] degrees C F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] ppm (mg/1)
Noncarbonate Hardness	[_____] epm (mg/1)
Total Hardness	[_____] epm (mg/1)
Dissolved Solids	[_____] ppm (mg/1)

Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microsiemens/cm

2.18.3 Chemicals

The chemical company must provide pretreatment chemicals that will remove and permit flushing of mill scale, oil, grease, and other foreign matter from the water heating system. The chemical company must also provide all treatment chemicals required for the initial fill of the system and for a period of one year of operation. The chemical company must determine the correct chemicals and concentrations required for the water treatment. The chemicals must not be proprietary and must meet required federal, state, and local environmental regulations for the treatment of heating water systems and discharge to the sanitary sewer. The chemicals must remain stable throughout the operating temperature range of the system, and must be compatible with pump seals and other elements of the system.

2.18.4 Glycol Solutions

****

NOTE: If freeze protection is not required, this paragraph should be deleted. When a glycol system is used, the size of the HVAC systems should be corrected due to changes in specific heat and viscosity. ASHRAE's "HVAC Systems and Equipment Handbook" should be consulted for the appropriate calculation procedures. The glycol solution will decrease the heat transfer capacity of the system. Ethylene glycol should be used for HVAC systems. However, if the heat transfer media has the possibility of mixing with a potable water system, propylene glycol should be used. The required concentration should be entered based upon the anticipated ambient temperature. The concentration of the glycol solution should not go below 20 percent due to the degradation of the corrosion inhibitors at lower concentrations.

****

Provide a [_____] percent concentration by volume of industrial grade [ethylene] [propylene] glycol. The glycol must be tested in accordance with ASTM D1384 with less than 0.013 mm 0.5 mils penetration per year for all system metals. The glycol must contain corrosion inhibitors. Silicate based inhibitors must not be used. The solution must be compatible with pump seals, other elements of the system, and all water treatment chemicals used within the system.

2.18.5 Test Kits

Provide all required test kits and reagents for determining the proper water conditions.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install all work as indicated and in accordance with the manufacturer's diagrams and recommendations.

3.3 COLOR CODE MARKING AND FIELD PAINTING

****

NOTE: Designer will coordinate color code marking with Section 09 90 00. Color code marking for piping not listed in Table I of Section 09 90 00, will be added to the table.

****

Color code marking, field painting of exposed pipe, and field painting of factory primed equipment must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 WELDING

****

NOTE: If the need exists for more stringent pipe welding requirements, delete the sentences in the first set of brackets.

****

Submit [_____] copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations. [Piping must be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders must be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer must be notified 24 hours in advance of tests and the tests must be performed at the work site if practical. The welder or welding operator must apply his assigned symbol near each weld he makes as a permanent record.] Structural members must be welded in accordance with Section 05 05 23.16 STRUCTURAL WELDING. [Welding and nondestructive testing procedures for piping must be as specified in Section 40 05 13.96 WELDING, PRESSURE PIPING.]

3.5 PIPING

****

NOTE: Indicate on the drawings, the direction of piping pitch, details of branch take-offs from mains, and pipe size reductions.

****

Unless otherwise specified, pipe and fittings installation must conform to the requirements of ASME B31.1. Pipe must be cut accurately to

measurements established at the job site and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cuttings or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing must be cut square, must have burrs removed by reaming, and must be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Changes in direction must be made with factory made fittings, except that bending of pipe up to 100 mm 4 inches will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bends must not be less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. Vent pipes must be installed through the roof as indicated and must be flashed as specified. Horizontal mains must pitch up or down in the direction of flow as indicated. The grade must be not less than 25 mm in 12 m 1 inch in 40 feet. Reducing fittings must be used for changes in pipe sizes. Open ends of pipelines and equipment must be capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified must be uncoated. Unions and other components for copper pipe or tubing must be brass or bronze. Connections between ferrous and copper piping must be electrically isolated using dielectric unions.

3.5.1 Joints

Except as otherwise specified, joints used on steel pipe must be threaded for fittings 25 mm 1 inch and smaller; threaded or welded for 32 mm 1-1/4 inches up through 65 mm 2-1/2 inches; and flanged or welded for 80 mm3 inches and larger. Joints between sections of copper tubing or copper pipe must be flared or sweated. Pipe and fittings 32 mm 1-1/4 inches and larger installed in inaccessible conduits or trenches beneath concrete floor slabs must be welded. Unless otherwise specified, connections to equipment must be made with black malleable iron unions for pipe 65 mm 2-1/2 inches or smaller in diameter, and with flanges for pipe 80 mm 3 inches or larger in diameter.

3.5.2 Low Temperature Systems

Piping may have threaded, welded, flanged or flared, sweated, or grooved mechanical joints as applicable and as specified. Reducing fittings must be used for changes in pipe sizes. In horizontal lines, reducing fittings must be the eccentric type to maintain the top of the adjoining pipes at the same level.

3.5.3 Steam Systems

Piping may have threaded, welded, or flanged joints as applicable and as specified. Reducing fittings must be used for changes in pipe sizes. In horizontal steam lines, reducing fittings must be the eccentric type to maintain the bottom of the lines at the same level. Grooved mechanical joints must not be used.

3.5.4 High And Medium Temperature Systems

Temperature systems must have welded joints to the maximum extent practicable, except screwed joints and fittings may be used at connections to equipment and on piping 65 mm 2-1/2 inches and smaller. Equipment connections 80 mm 3 inches and larger must be flanged. Piping connections 80 mm 3 inches and larger may be welded or flanged. In horizontal lines,

reducing fittings must be the eccentric type to maintain the tops of adjoining pipes at the same level. Grooved mechanical joints must not be used.

3.5.5 Threaded Joints

Threaded joints must be made with tapered threads properly cut, and must be made tight with PTFE tape complying with ASTM D3308, or equivalent thread joint compound applied to the male threads only, and in no case to the fittings.

3.5.6 Welded Joints

Joints must be fusion-welded unless otherwise required. Changes in direction of piping must be made with welding fittings only. Branch connection may be made with either welding tees or branch outlet fittings. Branch outlet fittings must be forged, flared for improvement of flow where attached to the run, and reinforced against external strains.

3.5.7 Flanged Joints or Unions

Provide flanged joints or unions in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and similar items. Flanged joints must be faced true, provided with gaskets, and made square and tight. Full-faced gaskets must be used with cast iron flanges.

3.5.8 Flared and Sweated Pipe and Tubing

Pipe and tubing must be cut square and burrs must be removed. Both inside of fittings and outside of tubing must be cleaned with an abrasive before sweating. Care must be taken to prevent annealing of fittings and hard drawn tubing when making connection. Installation must be made in accordance with the manufacturer's recommendations. Changes in direction of piping must be made with flared or soldered fittings only. Solder and flux must be lead free. Joints for soldered fittings must be made with silver solder or 95:5 tin-antimony solder. Cored solder must not be used. Joints for flared fittings must be of the compression pattern. Provide swing joints or offsets on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing.

3.5.9 Mechanical Tee Joint

An extracted mechanical tee joint may be made in copper tube. Joint must be produced 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. The branch tube must be notched for proper penetration into fitting to assure a free flow joint. Joints must be brazed in accordance with NAPHCC NSPC. Soldered joints will not be permitted.

3.5.10 Grooved Joints for Copper Tube

Grooves must be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools must be products of the same manufacturer. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter

of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints must not be used in concealed locations.

3.6 CONNECTIONS TO EQUIPMENT

Provide supply and return connections unless otherwise indicated. Valves and traps must be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment must be not smaller than the connections on the equipment. Bushed connections are not permitted. Change in sizes must be made with reducers or increasers only.

3.6.1 Low Temperature Water and Steam and Return Connections

Connections, unless otherwise indicated, must be made with malleable iron unions for piping 65 mm 2-1/2 inches or less in diameter and with flanges for pipe 80 mm 3 inches or more in diameter.

3.6.2 High And Medium Temperature Water Connections

Connections must be made with 13.8 MPa 2000 pound black malleable iron unions for pipe 19 mm 3/4 inch or less in diameter and with flanges for pipe 25 mm 1 inch and larger in diameter.

3.7 BRANCH CONNECTIONS

****

NOTE: Indicate on the drawings the direction of piping pitch, details of branch take-offs from mains, and pipe size reductions.

****

Branches must pitch up or down as indicated, unless otherwise specified. Connection must be made to insure unrestricted circulation, eliminate air pockets, and permit drainage of the system.

3.7.1 Low Temperature Water Branches

****

NOTE: If the system is not to be a one-pipe system, reference to the special flow fittings brackets will be deleted.

****

Branches taken from mains must pitch with a grade of not less than 25 mm in 3 m 1 inch in 10 feet. [Special flow fittings must be installed on the mains to bypass portions of water through each radiator. Special flow fittings must be installed as recommended by the manufacturer.]

3.7.2 Steam Supply and Condensate Branches

Branches taken from mains must pitch with a grade of not less than 25 mm in 3 m 1 inch in 10 feet, unless otherwise indicated.

3.7.3 High And Medium Temperature Water Branches

****

NOTE: The following is recommended in the sizing of branch line connections to a high or medium temperature water main:

The following table will be used in metric projects.

Diameter of main, mm inches	Diameter of branch line connection, mm (inches)
200 8	80 3 minimum
100, 125, 150 4, 5, 6	50 2 minimum
50, 65, 80 2, 2-1/2, 3	one pipe size larger than sized branch line, but not more than 50 mm 2 inches in diameter

****

Branches must take off at 45 degrees in the direction of the fluid flow from the supply and return lines and should be branched from the top or upper half of the main line unless otherwise indicated. Abrupt reduction in pipe sizes must be avoided.

3.8 RISERS

The location of risers is approximate. Exact locations of the risers must be as approved. [Steam supply downfeed risers must terminate in a dirt pocket and must be dripped through a trap to the return line.]

3.9 SUPPORTS

****

NOTE: Steam and high or medium temperature water piping layout must be analyzed for thermal stresses due to expansion. Spring hangers will be indicated on drawings and used to absorb vertical expansion of piping. Drawings must detail anchors and pipe guide and indicate location. Submit expansion calculations, including guide and anchor reactions for review.

****

3.9.1 General

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 22 kg 50 pounds must have the excess hanger loads suspended from panel points.

****

Hangers used to support piping 50 mm 2 inches and larger must be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors must be installed to keep pipes in

accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, must be supported by variable spring hangers and supports or by constant support hangers. Where threaded rods are used for support, they must not be formed or bent.

3.9.1.1 Seismic Requirements for Pipe Supports, Standard Bracing

****

NOTE: Provide seismic requirements, if a Government designer (either Corps office or A/E) is the Engineer of Record and show on the drawings. Delete the bracketed phrase if seismic details are not included. UFC 3-301-01 and Sections 13 48 73 and 23 05 48.19, properly edited, must be included in the contract documents.

****

All piping and attached valves must be supported and braced to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT [and 23 05 48.19 [SEISMIC] BRACING FOR HVAC] [as shown on the drawings]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown must be provided under this section. Material used for supports must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.9.1.2 Structural Attachments

Structural steel brackets required to support piping, headers, and equipment, but not shown, must be provided under this section. Material and installation must be as specified under Section 05 12 00 STRUCTURAL STEEL. [Pipe hanger loads suspended from steel joist panel points must not exceed 222 N 50 pounds. Loads exceeding 222 N 50 pounds must be suspended from panel points.]

3.9.1.3 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp must be used where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.

3.9.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports must conform to MSS SP-58, except as specified as follows:

3.9.2.1 Types 5, 12, and 26

Use of these types is prohibited.

3.9.2.2 Type 3

Type 3 is prohibited on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

3.9.2.3 Type 18 Inserts

Type 18 inserts must be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

3.9.2.4 Type 19 and 23 C-Clamps

Type 19 and 23 C-clamps must be torqued in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.9.2.5 Type 20 Attachments

Provide Type 20 attachments used on angles and channels with an added malleable iron heel plate or adapter.

3.9.2.6 Type 24

Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.9.2.7 Type 39 Saddle or Type 40 Shield

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle must be used on all pipe 100 mm 4 inches and larger.

3.9.2.8 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and install a support not over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Do not space pipe supports over 1.5 m 5 feet apart at valves.

3.9.2.9 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet, except support pipe not more than 2.4 m 8 feet from end of risers, and at vent terminations.

3.9.2.10 Type 35 Guides

Provide Type 35 guides using steel, reinforced PTFE or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Slide materials must be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 100 mm 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe must be separated from the slide material by at least 100 mm 4 inches or by an amount adequate for the insulation, which ever is greater.

3.9.2.11 Pipe Hanger Size

Except for Type 3, pipe hangers on horizontal insulated pipe must be the size of the outside diameter of the insulation.

3.9.3 Piping in Trenches

****
NOTE: Detail the methods of supporting pipe in trenches.
****

Support piping as indicated.

3.10 PIPE SLEEVES

3.10.1 Pipe Passing Through Concrete or Masonry

Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Sleeves must not be installed in structural members except where indicated or approved. Rectangular and square openings must be as detailed. Each sleeve must extend through its respective wall, floor, or roof, and must be cut flush with each surface. Unless otherwise indicated, sleeves must provide a minimum of 6 mm 1/4 inch annular space between bare pipe or insulation surface and sleeves. Sleeves in bearing walls, waterproofing membrane floors, and wet areas must be steel pipe or cast iron pipe. Sleeves in nonbearing walls, floors, or ceilings may be steel pipe, cast iron pipe, or galvanized sheet metal with lock-type longitudinal seam and of the metal thickness indicated. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire rated walls and floors must be sealed as indicated and specified in Section 07 92 00 JOINT SEALANTS. Seal penetrations in fire walls and floors in accordance with Section 07 84 00 FIRESTOPPING.

3.10.2 Pipes Passing Through Waterproofing Membranes

****
NOTE: Indicated on drawings details of pipes through flashing or waterproof membrane, and method of sealing.
****

Install pipes passing through waterproofing membranes through a 19.5 kg/square meter 4 pound lead-flashing sleeve, a 4.9 kg/square meter 16 ounce copper sleeve, or a 0.813 mm 0.032 inch thick aluminum sleeve, each having an integral skirt or flange. Flashing sleeve must be suitably formed, and the skirt or flange must extend 200 mm 8 inches or more from the pipe and must be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve must extend up the pipe a minimum of 50 mm 2 inches above the highest flood level of the roof or a minimum of 250 mm 10 inches above the roof, whichever is greater, or 250 mm 10 inches above the floor. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation must be sealed as indicated. At the Contractor's option, pipes up to and including 250 mm 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs,

flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane must be clamped into place and sealant must be placed in the caulking recess.

3.10.3 Mechanical Seal Assembly

In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. The seals must consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. The links must be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolts must cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly must be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.10.4 Counterflashing Alternate

As an alternate to caulking and sealing the annular space between the pipe and flashing sleeve or metal-jacket-covered insulation and flashing sleeve, counterflashing may be by standard roof coupling for threaded pipe up to 150 mm 6 inches in diameter; lead-flashing sleeve for dry vents and turning the sleeve down into the pipe to form a waterproof joint; or tack-welded or banded-metal rain shield round the pipe and sealing as indicated.

3.10.5 Waterproofing Clamping Flange

Pipe passing through wall waterproofing membrane must be sleeved as specified. In addition, a waterproofing clamping flange must be installed as indicated.

3.10.6 Fire Seal

****

NOTE: Fire walls and fire partitions must be designated on the drawings.

****

Where pipes pass through fire walls, fire partitions, fire rated pipe chase walls or floors above grade, provide a fire seal as specified in Section 07 84 00 FIRESTOPPING.

3.10.7 Escutcheons

Provide escutcheons at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons must be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons must be used. Escutcheons must be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.11 ANCHORS

****
NOTE: Detail and indicate locations of pipe anchors.
****

Provide anchors where necessary or indicated to localize expansion or prevent undue strain on piping. Anchors must consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces must be installed using turnbuckles where required. Supports, anchors, or stays must not be attached in places where construction will be damaged by installation operations or by the weight or expansion of the pipeline.

3.12 PIPE EXPANSION

****
NOTE: Whenever possible, provisions for the expansion of piping will be made by offsets or changes in the direction of the run of pipe or by expansion loops. Expansion joints, when used, must be installed in readily accessible locations. Location and details of offsets, expansion joints, and expansion loops will be shown.
****

The expansion of supply and return pipes must be provided for by changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated. Low temperature water and steam expansion joints may be one of the types specified. [High] [Medium] temperature water system expansion joints may be one of the joints specified, except slip-tube type.

3.12.1 Expansion Loops

Expansion loops must provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. The loops must be cold-sprung and installed where indicated. Provide pipe guides as indicated.

3.12.2 Slip-Tube Joints

****
NOTE: Type I and III slip joint, packed expansion joints are adjustable gland type and require continuing maintenance to contain leakage and are now manufactured by only one company, making them proprietary.
****

Slip-tube type expansion joints must be used for steam and low temperature water systems only and must be installed where indicated. The joints must provide for either single or double slip of the connected pipes as indicated and for the traverse indicated. The joints must be designed for a working temperature and pressure suitable for the application and in no case less than [_____] kPa psig. The joints must be in accordance with applicable requirements of EJMA Stds and ASME B31.1. End connections must be flanged. Provide anchor bases or support bases must be provided as indicated or required. Initial setting must be made in accordance with the manufacturer's recommendations to allow for ambient temperature at

time of installation. Pipe alignment guides must be installed as recommended by the joint manufacturer, but in any case must be not more than 1.5 m 5 feet from expansion joint, except in lines 100 mm 4 inches or smaller where guides must be installed not more that 600 mm 2 feet from the joint.

3.12.3 Bellows-Type Joint

Bellows-type joint design and installation must comply with EJMA Stds standards. The joints must be designed for the working temperature and pressure suitable for the application and must be not less than 1.03 MPa 150 psig in any case.

3.12.4 Flexible Ball Joints

****

NOTE: Ball joints may often be used to advantage instead of loops and expansion joints. Where used, they must be indicated on drawings in detail. Guides for ball joints will be as recommended by the manufacturer. Design details will include dimension between ball center-points in offset leg, and the distance and direction of desired cold set from offset leg centerline. Each expansion unit will consist of two, three, or four joints, but in no case less than two joints, as required to handle the system expansion. The ball joint arrangement at each expansion location must provide for total movement. The ball joint only moves in an angular offset or rotation mode. The configuration of the ball joint link will permit a 2 or 3 ball joint offset to absorb axial and/or lateral movement, but not a single ball joint; therefore, if axial and/or lateral movement is expected, use a 2 or 3 ball joint offset.

****

Flexible ball joints may be threaded (to 50 mm 2 inches only), flanged, or welded end as required. The ball-type joint must be designed and constructed in accordance with the generally accepted engineering principle stated in ASME B31.1, and ASME BPVC SEC VIII D1, where applicable. Flanges must conform to the diameter and drilling of ASME B16.5. Molded gaskets furnished must be suitable for the service intended.

3.13 VALVES AND EQUIPMENT ACCESSORIES

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NOTE: Indicate type and location of valves on the drawings.

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3.13.1 Valves and Equipment

Install valves at the locations shown or specified, and where required for the proper functioning of the system as directed. Gate valves must be used unless otherwise indicated, specified, or directed. Valves must be installed with their stems horizontal to or above the main body of the valve. Valves used with ferrous piping must have threaded or flanged ends

and sweat-type connections for copper tubing.

3.13.2 Gravity Flow-Control Valve

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NOTE: Paragraph will be deleted if the system is not to be used for heating domestic hot water or if the system is not an up-feed type with intermittent operation of the circulating pump. A flow-control valve is not required in such instances.

****

Install the valve to control the flow of water in the supply main near the heat exchanger. The valve must operate so that when the circulating pump starts, the increased pressure within the main will open the valve; when the pump stops, the valve will close. The valve must be constructed with a cast iron body and must be provided with a device whereby the valve can be opened manually to allow gravity circulation. The flow-control valve must be designed for the intended purpose, and must be installed as recommended by the manufacturer.

3.13.3 Thermometer Socket

Provide a thermometer well in each return line for each circuit in multicircuit systems.

3.13.4 Air Vents

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NOTE: Indicate location of all air vents on the drawings and include details for high or medium temperature water vents.

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Install vents where indicated, and on all high points and piping offsets where air can collect or pocket.

3.13.4.1 Water Air Vents

[High] [Medium] temperature water air vents must be as indicated. Vent discharge lines must be double-valved with globe valves and must discharge into a funnel drain.

3.13.4.2 Steam Air Vents

Steam air vents must be a quick-acting valve that continuously removes air. Valve must be constructed of corrosion-resisting metal, must be designed to withstand the maximum piping system pressure, and must automatically close tight to prevent escape of steam and condensate. Vent must be provided with a manual isolation valve. Provide a vent on the shell of each steam heat exchanger.

3.14 STEAM TRAPS

Install float Traps in the condensate line as indicated. Other steam traps must be installed where indicated.

3.15 UNIT HEATERS

Install unit heaters as indicated and in accordance with the manufacturer's instructions.

3.16 INSULATION

Thickness of insulation materials for piping and equipment and application must be in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.17 MANUFACTURER'S SERVICES

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, and testing of the equipment.

3.18 TESTING AND CLEANING

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

3.18.1 Pressure Testing

Notify the Contracting Officer [_____] days before the tests are to be conducted. Perform the tests in the presence of the Contracting Officer. Furnish all instruments and personnel required for the tests. Electricity, steam, and water will be furnished by the Government. All test results must be accepted before thermal insulation is installed. The entire low temperature heating system, including heat exchanger, radiators and fittings, must be hydrostatically tested and proved tight under a pressure of 310 kPa 45 psig for a period of four hours.

3.18.2 Test of Backflow Prevention Assemblies

Test backflow prevention assemblies in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.18.3 Cleaning

After the hydrostatic and backflow prevention tests have been made and prior to the operating tests, the heat exchanger and piping must be thoroughly cleaned by filling the system with a solution of 0.5 kg 1 pound of caustic soda or 0.5 kg 1 pound of trisodium phosphate per 200 L 50 gallons of water. Observe the proper safety precautions in the handling and use of these chemicals. Heat the water to approximately 66 degrees C 150 degrees F, and circulate the solution in the system for a period of 48 hours, then drain and flush the system thoroughly with fresh water. Wipe clean all equipment , and remove all traces of oil, dust, dirt, or paint spots. The Contractor will be responsible for maintaining the system in a clean condition until final acceptance. Lubricate bearings with oil or grease as recommended by the manufacturer.

3.18.4 Water Treatment Testing

Identify in the water quality test report the chemical composition of the heating water. The report must include a comparison of the condition of the water with the chemical company's recommended conditions. Document any required corrective action within the report. Analyze the heating water [prior to the acceptance of the facility] [and] [a minimum of once a month for a period of one year] by the water treatment company. The analysis must include the following information recorded in accordance with ASTM D596.

Date of Sample	[_____]
Temperature	[_____] degrees C F
Silica (SiO2)	[_____] ppm (mg/1)
Insoluble	[_____] ppm (mg/1)
Iron and Aluminum Oxides	[_____] ppm (mg/1)
Calcium (Ca)	[_____] ppm (mg/1)
Magnesium (Mg)	[_____] ppm (mg/1)
Sodium and Potassium (Na and K)	[_____] ppm (mg/1)
Carbonate (HCO3)	[_____] ppm (mg/1)
Sulfate (SO4)	[_____] ppm (mg/1)
Chloride (C1)	[_____] ppm (mg/1)
Nitrate (NO3)	[_____] ppm (mg/1)
Turbidity	[_____] unit
pH	[_____]
Residual Chlorine	[_____] ppm (mg/1)
Total Alkalinity	[_____] ppm (mg/1)
Noncarbonate Hardness	[_____] epm (mg/1)
Total Hardness	[_____] epm (mg/1)
Dissolved Solids	[_____] ppm (mg/1)
Fluorine	[_____] ppm (mg/1)
Conductivity	[_____] microsiemens/cm

3.19 FRAMED INSTRUCTIONS

Submit proposed diagrams, instructions, and other sheets, prior to posting. Show in the instructions wiring and control diagrams and complete layout of the entire system. The instructions must include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Post framed instructions, containing wiring and control diagrams under glass or in laminated plastic, where directed. Condensed operating instructions, prepared in typed form, must be framed as specified above and posted beside the diagrams. Post the framed instructions before acceptance testing of the system.

3.20 FIELD TRAINING

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time starting after the system is functionally complete but prior to final acceptance tests. Field training must cover all of the items contained in the approved Operation and Maintenance Manuals. Submit [6] [_____] copies of operation and [6] [_____] copies of maintenance manuals for the equipment furnished. One complete set, prior to performance testing and the remainder upon acceptance. Operating manuals must detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals must include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals must list routine maintenance procedures, water treatment procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals must include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Provide manuals prior to the field training course.

3.21 TESTING, ADJUSTING AND BALANCING

Except as specified herein, testing, adjusting, and balancing must be in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

-- End of Section --