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05/20

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CENTRAL STEAM HEATING AND UTILITIES SYSTEMS
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****
NOTE: This guide specification covers the requirements for two types of central steam heating systems and one type of central steam utilities system.

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

****
NOTE: If the steam is required exclusively either for heating or for utilities, the specification will be revised by the deletion of requirements which are inapplicable to the system required for the project.

a. Steam heating systems: Operate steam heating systems at a pressure of approximately 35 kPa 5 psig. Supply steam from a central steam plant and reduce to the specified gauge pressure.

(1) Vacuum-return system: Retuen condensate from the heating system by vacuum to the vacuum pumping unit which will pump the condensate back to the

central steam plant.

(2) Gravity-return system: Return condensate from the heating system by gravity to a condensate pumping unit which will pump the condensate back to the central steam plant.

b. Steam utility systems: Steam utility systems must be of the two-pipe gravity-return type with steam supplied from a central plant at a gauge pressure of approximately 690 kPa 100 psig and reduced to a gauge pressure of approximately 275 kPa 40 psig. Supply steam to steam-using equipment without further reduction in pressure and return the condensate through medium-pressure traps, flash tanks, and a condensate pumping unit to the central system.

****

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.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

ANSI/AHRI 850	(2004) Performance Rating of Commercial and Industrial Air Filter Equipment

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 B16.15	(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 B16.39	(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
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes

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
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A504/A504M	(2018; R 2023) Standard Specification for Wrought Carbon Steel Wheels
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 A659/A659M	(2012; R 2017) Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled
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 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 C700	(2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene

	Plastics
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape

COMPRESSED AIR AND GAS INSTITUTE (CAGI)

CAGI B19.1	(2010) Safety Standard for Compressor Systems

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 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

UNDERWRITERS LABORATORIES (UL)

UL 94	(2023; Reprint May 2023) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

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

Drawings

Installation

Pipe Anchors

SD-03 Product Data

Welding

System Equipment

Framed Instructions

SD-06 Test Reports

Adjusting, Balancing, Testing and Inspecting

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G[, [_____]]

1.3 QUALITY ASSURANCE

1.3.1 Welding

****
NOTE: If need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.
****

[Submit a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Weld piping 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. Notify Contracting Officer 24 hours in advance of tests and perform tests 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. Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING.] [Welding and nondestructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

1.3.2 Use of Asbestos Products

Products which contain asbestos are prohibited. This prohibition includes items such as packings or gaskets, even though the item is encapsulated or the asbestos fibers are impregnated with binder material.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

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 the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Provide equipment supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

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

2.1.3 Prevention of Rust

Unless otherwise specified, surfaces of ferrous metal subject to corrosion must be factory prime painted with a rust inhibiting coating and subsequently factory finish painted in accordance with the manufacturer's standard practice. Equipment exposed to high temperature when in service must be prime and finish painted with the manufacturer's standard heat resistant paint to a minimum thickness of 0.025 mm 1 mil.

2.1.4 Equipment Guards and Access

****

NOTE: Catwalk, ladder, and guardrail will be indicated if required for access to equipment. If not applicable delete the entire sentence within the brackets.

****

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact. Properly guard or cover high temperature equipment and piping exposed to contact by personnel or where a fire hazard will be created with insulation of a type specified. Provide items such as catwalks, operating platforms, ladders, and guardrails where shown and construct them in accordance with Section [08 31 00 ACCESS DOORS AND PANELS][05 51 33 METAL LADDERS].

2.2 MATERIALS

****

NOTE: Copper tubing and steel pipe will be considered competitive unless one is not considered satisfactory for the project.

****

Submit spare parts data for each item of equipment provided, after approval of the drawings and not later than [_____] months before the date of beneficial occupancy. Include in the data a complete list of spare parts and supplies, with current unit prices and supply sources. Provide materials conforming to the following:

2.2.1 Filters

ANSI/AHRI 850.

2.2.2 Iron and Steel Sheets

2.2.2.1 Galvanized Iron and Steel

ASTM A659/A659M, ASTM A653/A653M with general requirements conforming to ASTM A504/A504M. Gauge numbers specified refer to manufacturer's standard gauge.

2.2.2.2 Uncoated (Black) Steel

Composition, condition, and finish best suited to the intended use. Gauge numbers specified refer to manufacturer's standard gauge.

2.2.3 Pipe and Pipe Fittings

2.2.3.1 Adapters

Provide brass or bronze adapters for copper tubing for soldered fittings.

2.2.3.2 Cast Iron Pipe Fittings

ASME B16.1 or ASME B16.4, Class 125, type to match adjacent piping.

2.2.3.3 Clay Sewer Pipe

ASTM C700, Class 1, Type I, Style a.

2.2.3.4 Copper Tubing

ASTM B88, ASTM B88M, Type K or L. For compressed air tubing, ASTM B251/B251M.

2.2.3.5 Fittings for Brass or Copper Pipe

ASME B16.15, Class A or B.

2.2.3.6 Fittings for Copper Tubing

Cast or wrought bronze or wrought copper, soldered-joint, brazed-joint, or flared-joint type, as specified, completely fabricated at the factory. Provide bronze threaded fittings conforming to the applicable requirements of ASME B16.15. Proide cast copper alloy solder joint pressure fittings conforming to ASME B16.18. Use fittings on Type L tubing that are brazed-joint type of cast or wrought bronze or wrought copper. Use fittings on Type K tubing that are cast bronze flared joint type. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to 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. Design grooved mechanical joints and fittings for no less than 862 kPa 125 psig service and must be the product of the same manufacturer. Provide ductile iron grooved fitting and mechanical coupling housing conforming to ASTM A536. Use gaskets in grooved joints that are molded synthetic polymer of pressure responsive design and conforming to ASTM D2000 for circulating medium up to 110

degrees C 230 degrees F. Provide grooved joints conforming to AWWA C606. Use steel coupling nuts and bolts in grooved joints conforming to ASTM A183.

2.2.3.7 Malleable Iron Pipe Fittings

ASME B16.3, type required to match adjacent piping.

2.2.3.8 Nipples

ASTM A733, standard weight.

2.2.3.9 Pipe

ASTM A53/A53M or ASTM A106/A106M, Grade A or B, black steel. Provide standard weight pipe unless otherwise specified.

2.2.3.10 Welding Fittings for Pipe

ASME B16.9.

2.2.3.11 Pipe Flanges and Flanged Fittings

Steel flanges, ASTM A181/A181M and ASME B16.5. Convoluted flanges must mate with ASME B16.5, Class 150 flanges. Affix the manufacturer's trademark to flanges and fittings in accordance with MSS SP-25 so as to permanently identify the manufacturer.

2.2.3.12 Pipe Hangers, Inserts, and Supports

MSS SP-58.

2.2.3.13 Pipe Threads

ASME B1.20.2MASME B1.20.1.

2.2.3.14 Solder, Silver

AWS A5.8/A5.8M, or the solder metal must conform to ASTM B32 95-5 tin antimony.

2.2.3.15 Unions

ASME B16.39, type to match adjacent piping.

2.2.3.16 Gaskets

ASME B16.21. Approved metallic self-centering style and ring style gasket consisting of metallic retainer and sealing gland may be used for intended service.

2.2.4 Polyethylene Tubing

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

2.2.5 Valves

2.2.5.1 Check Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 3 or 4, Class 125.

b. Sizes 50 mm 2 inches through 600 mm 24 inches, cast iron: MSS SP-71, Type III or IV, Class 125.

2.2.5.2 Globe Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 1, 2, and 3, Class 125.

b. Sizes 50 mm 2 inches through 300 mm 12 inches, cast iron: MSS SP-85, Type III, Class 125.

2.2.5.3 Angle Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 1, 2, or 3, Class 125.

b. Sizes 50 mm 2 inches through 300 mm 12 inches, cast iron: MSS SP-85, Type IV, Class 125.

2.2.5.4 Gate Valves

a. Sizes 80 mm 3 inches and less, bronze: MSS SP-80, Type 1 or 2, Class 125.

b. Sizes 50 mm 2 inches through 1200 mm 48 inches, cast iron: MSS SP-70, Type I, Class 125, Design OT or OF (OS & Y), bronze trim.

2.2.5.5 Radiator Valves

Quick-opening disk type, angle-patterned, and constructed of brass. Provide valves with union radiator connections, spring-retained packing, and composition mushroom handles.

2.2.6 Electrical Motors

Provide motors as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls. Provide electrical equipment and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics must be as specified or indicated. Provide premium efficiency type integral size motors in accordance with NEMA MG 1. 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. Provide manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

2.4 SYSTEM EQUIPMENT

2.4.1 Condensate Pumping Unit

****

NOTE: The number of pumps and the type of unit required for the condensate pumping unit will be specified, and the inapplicable requirements will be deleted. If a vertical-type unit is specified, the motor may be mounted on the receiving tank top. Indicate size and location of vent pipe. If a condensate pumping unit is not required for the project, delete this paragraph. Requirements relative to the capacity of the condensate pumping unit will be supplied in brackets as follows.

Minimum Capacity for Condensate Pumps and Receivers		
EDR, sq m sq ft	Pump capacity, L/s gpm	Capacity Receiving Tank, liters gallons
93 1000	0.10 1.5	75 20
186 2000	0.19 3.0	75 20
372 4000	0.38 6.0	114 30
557 6000	0.57 9.0	170 45
744 8000	0.76 12.0	227 60
929 10,000	0.95 15.0	284 (75)
1394 15,000	1.4 22.5	435 115
1858 20,000	1.9 30.0	568 150
2323 25,000	2.4 37.5	719 190)
2787 30,000	2.8 45.0	852 225
3716 40,000	3.8 60.0	1136 300
4645 50,000	4.7 75.0	1420 375
6968 75,000	7.1 112.5	2158 570

****

Each pump must have a minimum capacity of [_____] L/second gpm when discharging against the specified pressure. Minimum capacity of the tank must be [_____] liters gallons. Provide condensate pumping unit of the [single] [duplex], [horizontal-shaft] [vertical-shaft] type. Provide unit consisting of [one pump] [two pumps] [one electric motor] [two electric motors] and a single receiver. Pump must be centrifugal or turbine type,

bronze-fitted throughout, with impellers of bronze or other corrosion-resistant metal. Use pumps that are free from air-binding when handling condensate up to 95 degrees C 200 degrees F. Connect pumps directly to drip-proof enclosed motors. Provide cast iron receiver with condensate return, vent, overflow, and pump suction connections, water level indicator and automatic air vent. Provide strainer in the inlet line to tank. Provide galvanized steel vent pipe with galvanized malleable iron fittings. Install vent pipe as indicated. Flash vent piping as specified. Pump, motor, and receiving tank may be mounted on a single base with the receiver pipe to the pump suction. Provide a gate valve and check valve in the discharge connection from each pump. Install enclosed float switches complete with float mechanism in the head of the receiver. Control each condensate pump automatically by means of the respective float switch that will automatically start or stop the motor when the water in the receiver reaches the high or low level respectively. Provide motors with magnetic across-the-line starters equipped with general purpose enclosure and "Automatic-Manual-Off" selector switch in the cover. Provide automatic alternator for duplex units.

2.4.2 Vacuum Pumping Unit

****

NOTE: The number of pumps for the vacuum pumping unit will be specified; and the inapplicable material in brackets will be deleted. If a vacuum pumping unit is not required for the project, delete the paragraph.

****

Provide vacuum pumping unit consisting of a [single pump, motor, and receiving tank, [pumps, motors, and other functioning parts in duplicate, and a single receiving tank, as indicated]]. Arrange unit for automatic operation. Each pump must be suitable for the number of square feet of equivalent direct radiation (EDR) and the discharge pressure indicated. Provide a two-compartment type receiver, constructed of close-grained cast iron with multijet vacuum producers. Pumping unit must be close coupled vertical design, bronze-fitted with stainless steel shafts, enclosed bronze impeller, renewable bronze case ring, and mechanical shaft seal. Mount equipment, including pumps, motors, and receiver preferably on a single base. Accessories consist of a compound gauge, inlet strainer, thermometer, water level gauge with stopcocks, adjustable vacuum relief valve, air and condensate discharge check valves, and companion flanges for all flanged connections. Provide pump discharge line with a check valve and globe valve.

2.4.2.1 Capacity

****

NOTE: The following information will be used as a guide for information, relative to the capacity of the vacuum pumping unit.

Vacuum Pump Sizing Guide, Metric Inch-Pound			
A	B	C	D
2,500 232	3.8 0.24	1.3 0.08	1.3 0.04
5,000 465	7.5 0.47	2.5 0.16	2.5 0.07
10,000 929)	15.0 0.95	5.0 0.32	4.0 0.11
15,000 1394	22.5 1.4)	7.5 0.47	5.4 0.15
20,000 1858	30.0 1.9	10.0 0.63	6.8 0.19
25,000 2323	37.5 2.4	12.5 0.79	8.3 0.24
30,000 2787	45.0 2.8	15.0 0.95	9.7 0.27
40,000 3716	60.0 3.8	20.0 1.3	12.6 0.36
65,000 6039	97.5 6.2	32.5 2.1	19.8 0.56
100,000 9290	150.0 9.5	50.0 3.2	30.0 0.85
Column A - Square meters feet equivalent direct radiation (EDR).			
Column B - Minimum water capacity (liters per second gallons per minute) only at 71 degrees C 160 degrees F, with 140 mm 5-1/2 inch heating vacuum and the required discharge pressure.			
Column C - Minimum capacity liters per second gpm from system with simultaneous pumping of both water and air, maintaining 140 mm 5-1/2 inch vacuum at 71 degrees C 160 degrees F.			
Column D - Minimum liters cubic feet of air handled by the pump with simultaneous pumping of both water and air, maintaining 140 mm 5-1/2 inch vacuum at 71 degrees C 160 degrees F.			
The condensate receiving tank will have a capacity between the float-switch start and stop of not less than 1/2 the flow capacity of the pump listed in column B.			

****

Minimum capacity, water only, of the pumping unit must be [_____] L/second gpm, at 70 degrees C 160 degrees F with 139.7 mm 5-1/2 inch heating vacuum and the required discharge pressure. Minimum capacity of the pumping unit must be [_____] liters gallons of water and [_____] L/second cfm of air with simultaneous pumping of both water and air and with a 139.7 mm 5-1/2 inch vacuum at 70 degrees C 160 degrees F. Provide condensate receiver with a capacity, between float-switch start and stop, of no less than [_____] liters gallons.

2.4.2.2 Motor and Controls

Drive each pump by a sleeve- or ball-bearing motor of such size that the brake horsepower required by the pumping unit under the specified rated capacities does not exceed the nameplate rating of motor. Motor must be drip-proof type and conform to the requirement specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide fully automatic controls for each pump motor, consisting of a float in the receiving tank, a float switch, an adjustable vacuum switch, an automatic across-the-line magnetic starter providing thermal-overload protection, and a Float and Vacuum (fully automatic control) Float Only-Continuous-Off selector switch.

2.4.3 Space Temperature Controls

****

NOTE: The space temperature controls shown will be reviewed and the inappropriate paragraphs will be deleted. Indicate on the drawings the locations where metallic raceway or electric metallic tubing is not required for protection of nonmetallic tubing. Delete air dryer and standby compressor when not required.

****

Provide pneumatic, electric, or electronic space temperature control system. Include control wiring and tubing required to complete the space temperature control system.

2.4.3.1 Air Compressor

Where pneumatic controls are furnished, provide an air compressor of the standard piston type complete with air tanks, air dryer, and other appurtenances. Compressor and installation must comply with CAGI B19.1. Compressor must be of sufficient capacity to provide continuous control air when operating on a 1/3-on 2/3-off cycle and provide with a visible oil-level sight glass and oil filter. Use air dryers of the silicagel type with reactivation, or of the refrigerated type, and maintain the air in the system with a dew point low enough to prevent condensation (minus 11 degrees C 13 degrees F at 125 kPa 18 psi main pressure). Locate air dryer at the outlet of the tank. Provide a standby compressor of capacity equal to the basic compressor with interlocked control system to provide automatic changeover upon the malfunction or failure of basic compressor. Provide a manual selector switch to index the lead compressor including the automatic changeover.

2.4.3.2 Air Lines

Air lines for pneumatic controls must be seamless copper tubing or nonmetallic tubing. Conceal piping except in mechanical rooms or areas where other piping is exposed. Use hard-drawn copper tubing in exposed areas and either hard-drawn or annealed in concealed intervals and run parallel to the lines of the building. Only tool-made bends will be acceptable. Fittings for copper tubing must be brass or copper solder joint-type except at connections to apparatus, where fittings must be brass compression-type. Nonmetallic tubing must be polyethylene, meeting the stress crack test of ASTM D1693. Individual tube polyethylene or multitube instrument tubing bundle must be classified as flame retardant under UL 94 and the polyethylene material must be rated as self-extinguishing when tested in accordance with ASTM D635. Run

nonmetallic tubing within securely supported rigid metallic raceway or electric metallic tubing except as indicated. Single nonmetallic tubing in a protective sheath may be used above accessible ceilings and in other concealed accessible locations. Tubing concealed in walls containing insulation, fill, or other packing materials must be hard-drawn copper tubing or nonmetallic tubing run in conduit. Terminal single lines must be hard-drawn copper tubing, except if the run is less than 300 mm 12 inches, flexible polyethylene may be used. Do not use nonmetallic tubing for applications where the tubing could be subjected to a temperature exceeding 55 degrees C 130 degrees F. Multitube instrument bundle may be used in place of single tube where a number of tubes run to the same points. Periodically test tubing for leaks during installation and verify all tubing is free of installation impurities and moisture before connecting to the control instrument. Fittings for polyethylene tubing must be for instrument service and may be brass or acetal homopolymer of the compression or barb push-on type. Tubing must be number coded or color coded and keyed to the submittal drawings for future identifying and servicing of the control system.

2.4.3.3 Room Thermostats

Provide standard commercial type thermostats with an adjustable differential and a set-point range of [15 to 30 degrees C 60 to 90 degrees F] [5 to 20 degrees C 40 to 70 degrees F].

2.4.3.4 Outdoor Reset Thermostat

Provide adjustable type thermostat set for a design temperature of [_____] degrees C degrees F with a heating supply water temperature of [_____] degrees C degrees F. Provide a suitable ventilated weather shelter for the outside sensing element. Mount unit indoors with its sensing element located in the outside air. Unit must proportionally reset the control point of a remote sensing temperature controller.

2.4.3.5 Seven-Day Program Timer

Provide timer with the proper switching action so that one timer will switch all zones. Provide timer schedule for each zone to raise and lower the temperature twice during each 24-hour period throughout the week. During the weekend, there must be one cycle of raising and lowering the zone temperature.

2.4.4 Control Valves and Controllers

****

NOTE: Use the thermostatic steam regulating valve for constant temperature applications such as domestic hot water. Use steam pressure reducing valves where reduced constant downstream pressure is required. A central steam plant often requires this type of valve to reduce pressure prior to the distribution system.

****

2.4.4.1 Thermostatic Steam Regulating Valve

Provide adjustable valve with an operating range of approximately 38 to 95 degrees C 100 to 200 degrees F and furnish with a thermostatic element, steam valve, connecting capillary tubing, and all required accessories.

Insert thermostatic element in a separable socket in the hot-water supply main. Construct parts subject to wear of noncorrodible metal and ensure parts are easily replaceable.

2.4.4.2 Pressure-Reducing Valves

Provide valves designed for a working pressure of no less than 860 kPa 125 psig where indicated or otherwise required. Adjust each reducing valve to maintain the desired terminal pressure within 20 kPa 3 psi, regardless of fluctuations in the initial pressure. Valves must be quiet in operation. Reducing valves provided in lines for space heating only must be of the double disk and seat type or sliding gate and plate type. Provide single-seated or sliding gate and plate type reducing valves for dead-end service. Construct parts subject to wear of noncorrodible metal and ensure parts are easily replaceable.

2.4.4.3 General Purpose Control Valves and Controllers

Provide control valves and controllers as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.4.5 Flash Tank

****
NOTE: If no flash tanks are required for the project, this paragraph will be deleted.
****

Size and install tank as indicated. Provide tank of welded construction utilizing black steel sheets no less than [_____] mm inches thick. Provide tank with a handhole and with tapping for the condensate returns, drip lines, vent line, and condensate discharge line. Equip discharge line with a float trap. Provide galvanized steel vent pipe and galvanized malleable iron fittings. Install vent pipe as indicated. Flash vent piping as specified.

2.4.6 Steam Traps

2.4.6.1 Float Traps

****
NOTE: Indicate steam trap capacities, working pressures, and differential pressures on drawings.
****

Provide capacity, working pressure, and differential pressure of the traps as indicated.

2.4.6.2 Float-and-Thermostatic Traps

Design traps for a steam working pressure of approximately 105 kPa 15 psig, but operate with a supply pressure of approximately 35 kPa 5 psig. Capacity of the traps must be as indicated. Base trap capacity on a pressure differential of 2 kPa 1/4 psig. Provide each float-and-thermostatic trap with a hard-bronze, monel, or stainless steel valve seat and mechanism and brass float, easily removable 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.

2.4.6.3 Bucket Traps

Provide inverted or vertical bucket type traps with automatic air discharge. Design traps for a working pressure of 1.03 MPa 150 psig, but operate under a steam supply pressure of approximately 275 to 690 kPa 40 to 100 psig. Each trap must have a heavy body and cap of fine-grained, gray cast iron. Make bucket of brass; the mechanism of hard bronze; the valve and seat of stainless or monel; or each of equivalent material. Test traps hydrostatically under a pressure of 1.5 MPa 200 psig. Traps must have capacities as indicated when operating under the specified working conditions. Provide strainer on the inlet 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. Equip thermostatic traps with valves and seats of stainless steel, or monel metal, and base capacities on a pressure differential not in excess of the following:

Steam Working Pressure, kPa psig	Differntial, kPa psig
170-34525-50	14020
620-69090-100	55080

2.4.6.4 Thermostatic Traps

Install traps in the return connection from each radiator. Provide size and capacity of the traps as indicated. Install drip traps for mains, risers, and similar live lines with a cooling leg of 1.5 m 5 feet of bare 19 mm 3/4 inch pipe. Base capacity of all traps on a pressure differential of 20 kPa 3 psi. Design traps for a steam working pressure of 105 kPa 15 psig, but operate with a supply pressure of approximately 35 kPa 5 psig. Traps must be of the angle pattern with union inlet connections. Trap bodies and covers must be brass.

2.5 SPACE HEATING EQUIPMENT

2.5.1 Radiators and Convectors

****
NOTE: Delete references to types of radiation not required for the project. Indicate test pressures desired. Indicate types and sizes of radiators and convectors on drawings.
****

Provide radiators and convectors that are the types and sizes indicated. Provide each radiator and convector with a top supply and a bottom return connection at opposite ends. Supply connection to each radiator and convector must contain the radiator control valve, and the return connection must contain the thermostatic trap. Test radiators and nonferrous convectors hydrostatically at the factory under a pressure of [_____]kPa psig. Test cast iron convectors, after assembly, pneumatically under water at a pressure of no less than [_____] kPa psig.

2.5.1.1 Cast-Iron Radiators

Provide be gray cast iron radiators, free from sandholes and other defects. Connect sections with malleable iron nipples no less than 2.3 mm 0.09 inch thick at any point. Provide legless type cast-iron radiators, wall mounted by means of hangers as specified. Secure adjustable radiator hangers to the wall and hold the radiators near both ends, at both top and bottom, in such manner that the radiators cannot be removed without the use of tools. Use no less than two bolts to secure each hanger to the wall. Provide necessary angles, bolts, bearing plates, toggles, radiator grips, and other parts required for complete installation of the radiators.

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

****

NOTE: The types of cover grille selected for fin-type radiators will suit the particular building involved, and the bracketed portions of the paragraph which are not desired will be deleted.

****

Provide radiators consisting of metal fins permanently bonded to steel or nonferrous pipe cores, with threaded or sweat fittings at each end for connecting to external piping. Provide radiators with capacities no less than those indicated, determined in accordance with HYI-005. Equip radiators with [expanded-metal cover grilles fabricated from black steel sheets no 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 steel sheets no 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 no less than 1.519 mm (16 gauge) 16 gauge, independently secured to wall with brackets.]

2.5.1.3 Convectors

Construct convectors of cast iron or of nonferrous alloys, and install where indicated. Capacity of convectors must be as indicated. Overall space requirements for convectors must not be greater than the space provided. Provide convectors complete with heating units and enclosing cabinets having bottom recirculating opening, manual control damper and top supply grille. Construct convector cabinets of sheet steel no less than 0.91 mm (20 gauge) 20 gauge.

2.5.2 Unit Heaters

****

NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings.

If the project has 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 should be determined in NC level or dBA and should be indicated on drawings. The sentence in brackets will be deleted for noncritical areas. Sound values used should be selected based on a careful study of the design goal by the design

engineer. Recommended sound values for speech communication, based on normal voice are, according to ASHRAE FUN SI ASHRAE FUN IP, as follows: 50 for fair; 44 for very good; and 38 for perfect speech intelligibility.
****

Provide heaters with 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.]

2.5.2.1 Propeller Fan (Type I) Heaters

Design heaters for suspension and arrange for [horizontal] [vertical] discharge of air. Provide casings that are no less than 0.91 mm (20 gauge) 20 gauge black steel and finished with lacquer or enamel. Provide suitable stationary or rotating air deflectors to ensure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Operate fans for vertical discharge type heaters at speeds not in excess of 1,200 rpm, except that units with 53 Megajoules (50,000 Btu) 50,000 Btu output capacity or less may operate at speeds up to 1,800 rpm. Use horizontal discharge type unit heaters that 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	4.1800
473-14001001-3000	4.6900
1401 3001 and over	5.11000

2.5.2.2 Centrifugal Fan (Type II) Heaters

Arrange heaters for floor or ceiling mounting. House heating elements and fans in steel cabinets of sectionalized steel plates or reinforce with angle-iron frames. Construct cabinets of no lighter than 1.214 mm (18 gauge) 18 gauge black steel. Provide each unit heater with a means of diffusing and distributing the air. Mount fans on a common shaft, with one fan to each air outlet. Equip fan shaft with self-aligning ball or roller 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. Fans in any one unit heater must be the same size.

2.5.2.3 Heating Elements

Provide heating coils and radiating fins consisting of nonferrous alloy. Ensure heating elements are free to expand or contract and pitched for drainage. Test elements under a hydrostatic pressure of 1.4 MPa 200 psig.

2.5.2.4 Motors

Provide motors with manual selection switches for [On-Off-Automatic] [On-Off] [High/Low-Off] operation and equip with thermal overload protection.

2.5.3 Heating and Ventilating Units

****
NOTE: Indicate capacity of unit heaters and heating and ventilating units on drawings.
****

Provide ceiling- or floor-mounted type, self-contained, units with the heating coils, fans, dampers, and filters completely encased in a steel housing of sectionalized steel plates or reinforced with an angle-iron frame. Provide each unit with latched, removable access panels located so that any equipment within the housing can be removed for cleaning or maintenance. Insulate fan section of the housing internally with no less than 40 mm 1-1/2 inches of fibrous glass insulation of no less than 12 kg/cubic meter 3/4 pound/cubic foot density and maximum K-factor of 0.26.

2.5.3.1 Heating Coil

Use nonferrous alloy coil that is free to expand and contract, and pitched for drainage. Test coil hydrostatically after assembly of the unit and provide tight under a gauge pressure of 1.4 MPa 200 psig.

2.5.3.2 Fans and Drive

Provide multiblade centrifugal type fans, one to each air outlet, mounted on a common shaft. Use the same size fans within any one unit. Install fan units on vibration isolators and completely isolate from the building structure. Provide ball, roller, or taper type bearings with lubrication fittings, externally accessible at the drive side of the unit. Connect fans directly or indirectly to the driving motors through V-belt drive. V-belt drive must be rated for 150 percent of motor capacity. Provide adjustable sheaves to produce at least 20 percent fan speed adjustment. Select sheaves to produce specified fan capacity at the midpoint of the adjustment.

2.5.3.3 Motor

Provide motor with general purpose type enclosure. Operate direct-connected motors at a speed not in excess of 1,200 rpm, and operate motors using V-belt drives at 1,750 rpm. Provide adjustable base rails for motors of V-belt driven fans.

2.5.3.4 Filters

****
NOTE: Where the number of filters required is too small to justify the installation of washing tanks, disposable filters will be specified and cleanable filters will be deleted. Otherwise disposable will be deleted. The requirement for washing and charging tanks will be deleted if centralized washing and charging facilities are available, and the sentences in brackets will be deleted.
****

Provide filters and filter racks of the V- or flat-type arrangement. Use filters that are removable from one accessible side of the unit. Filters must be [[25 mm 1 inch] [50 mm 2 inches] thick replaceable throw-away

type, in accordance with ANSI/AHRI 850] [of cleanable type, in accordance with ANSI/AHRI 850, 25 mm 1 inch thick, or the size required to suit the application. Furnish viscous adhesive in 19 L 5 gallon containers in sufficient quantity for 12 cleaning operations; provide no less than one quart for each filter section. [Provide one washing and charging tank for every 100-filter section or fraction thereof. Each washing and charging unit must accommodate [_____] filters.]]

2.5.3.5 Duct Connections

Provide outside air intake with aluminum, copper, or galvanized steel rain louvers with [13 mm 1/2 inch mesh, 18 gauge galvanized wire screen] [and] [16 by 18 mesh] [copper] [aluminum] [insect screen]. Construct intake box of no less than 0.91 mm (20 gauge) 20 gauge galvanized steel. Separate dissimilar metal from galvanized steel by plastic membrane. Provide discharge ductwork, diffusers, registers, and grilles as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.3.6 Dampers

Provide galvanized steel, opposed-blade type dampers with ball bearings. Provide mixing dampers for outside and return air as one assembly in a mixing box.

2.6 SYSTEM ACCESSORIES

2.6.1 Foundations and Anchorage

Provide foundations and anchorage for pumping units and for other heating equipment in accordance with the manufacturer's requirements.

2.6.2 Pressure Gauges and Thermometers

Provide gauges for piping as indicated. Provide gauges that comply with ASME B40.100 and thermometers that comply with ASME PTC 19.3 TW. Provide a thermometer and pressure gauge on the steam supply and return mains. Provide separable socket type thermometers.

2.6.3 Vacuum Relief Valve

Install an approved vacuum relief valve where indicated. On shutoff of steam supply and condensing of steam, the vacuum relief valve must automatically admit air to the system.

2.6.4 Safety Valves

Provide pop safety valves on the low side of each pressure reducing valve. Set valves to open automatically and to relieve steam at 35 kPa 5 psi in excess of the setting of the reducing valve, or as indicated. Provide safety valves conforming to the requirements of ASME BPVC SEC VIII D1 and install as indicated.

2.6.5 Drains

Install a drain connection with 25 mm 1 inch gate valve or 19 mm 3/4 inch hose bib at the lowest point in the return main. In addition, install threaded drain connections with threaded cap or plug wherever required for thorough draining of the steam system.

2.7 PIPING AND ACCESSORIES

2.7.1 Pipe and Fittings

2.7.1.1 Steam Piping and Fittings

Provide black steel piping conforming to ASTM A53/A53M, Grade A. Provide black, malleable iron or steel fittings. For fittings adjacent to valves, use fittings that suit valves specified. Use reducing fittings for changes in pipe sizes. In horizontal steam lines, use the eccentric type reducing fittings to maintain the bottom of the lines at the same level.

2.7.1.2 Condensate Return Piping and Fittings

Provide black steel, extra strong weight piping conforming to ASTM A53/A53M, Grade A. Provide cast iron or malleable iron, extra heavy fittings.

2.7.1.3 Vent Piping and Fittings

Provide black steel piping, conforming to ASTM A53/A53M, Grade A. Use black malleable iron fittings to suit piping. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases.

2.7.1.4 Gauge Piping

Provide copper tubing, Type K or L, piping for steam and condensate 170 kPa 25 psig and less and steel for greater than 170 kPa 25 psig.

2.7.2 Joints

Except as otherwise specified, use fittings on steel pipe that is threaded for fittings 25 mm 1 inch and smaller; threaded or welded for fittings 32 mm 1-1/4 inches up through 65 mm 2-1/2 inches; and flanged or welded for fittings 80 mm 3 inches and larger. Use flared or sweated joints between sections of copper tubing or pipe. Weld pipe and fittings 32 mm 1-1/4 inches and larger and installed in inaccessible conduits or trenches beneath concrete floor slabs. Unless otherwise specified, make connections to equipment 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 more, in diameter.

2.7.2.1 Bellows-Type Joints

Provide flexible, guided type joints. Provide stainless steel. Provide joints in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.7.2.2 Flexible Ball Joints

Construct joints of stainless steel, malleable iron, ductile iron, carbon steel, bronze, or other alloys as appropriate for the service intended.

2.7.2.3 Dielectric Waterways and Flanges

Provide dielectric waterways conforming to the tensile strength and dimensional requirements specified in ASME B16.39. Provide waterways with metal connections on both ends suited to match adjacent piping. Line dielectric waterways internally with an insulator specifically designed to

prevent current flow between dissimilar metals. Provide dielectric waterways with pressure and temperature rating equal to or greater than that specified for the connecting piping. Use dielectric flanges meeting the performance requirements described herein for dielectric waterways.

2.7.3 Strainers

Provide basket or Y-type strainers that are the same size as the pipelines in which they are installed. Provide cast-iron strainer bodies rated for Class 125 125 pound service, with bottoms drilled and plugged. Cast arrows cast on the sides of bodies to indicate the direction of flow. Equip each strainer with a removable cover and sediment basket. Basket must not be less than 0.76 mm (22 gauge) 22 gauge and have perforations to provide a net free area through the basket of at least four times that of the entering pipe.

2.8 SEQUENCE OF AUTOMATIC CONTROLS

Sequence of automatic controls must be as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.9 FACTORY COATING

Coat radiator and convector enclosures with the manufacturer's standard rust inhibiting primer. Other equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish.

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 any work.

3.2 INSTALLATION

****

NOTE: Mechanical and electrical layout drawings and specifications for ceiling suspensions should contain notes indicating that hanger loads between panel points in excess of 222 Newtons 50 pounds must have the excess hanger loads suspended from panel points.

All pertinent piping and related equipment supports should be designed and indicated in accordance with paragraph Pipe Supports and Structural Bracing, Seismic Requirements below. The reference to the ICC IBC will allow for deviations from the design drawings where required to match equipment actually supplied. Drawings must detail anchors and pipe guide and indicate location.

****

Install all work as indicated and in accordance with the manufacturer's diagrams and recommendations. Submit detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and

instructions necessary for installation of the systems as specified. Submit detail drawings for pumping units and appurtenances, including controls. Indicate in the Drawings clearances required for maintenance and operation and complete wiring and schematic diagrams, equipment layout and anchorage, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

3.2.1 Piping

Unless otherwise specified, install pipe and fittings conforming to the requirements of ASME B31.1. Cut pipe accurately to measurements established at the jobsite and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Cut piping or tubing square, remove burrs by reaming, and install to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Wipe filings, dust, or dirt from interior of the pipe or tubing before connections are made. Make changes in direction with fittings, except that bending of pipe up to 100 mm 4 inches size 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, flattenings, or other malformations will not be accepted. Install vent pipes through the roof as directed and flash as specified. Pitch horizontal supply mains up or down in the direction of flow as indicated. The grade must be no less than 25 mm in 12 m 1 inch in 40 feet. Use reducing fittings for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the systems. Provide uncoated pipe not otherwise specified. Use brass or bronze unions for copper pipe or tubing. Isolate connections between ferrous piping and copper piping electrically from each other with dielectric waterways.

3.2.1.1 Threaded Joints

Make threaded joints with tapered threads properly cut, and make tight with polytetrafluoroethylene (PTFE) tape complying with ASTM D3308, or equivalent joint compound applied to the male threads only, and in no case to the fittings.

3.2.1.2 Welded Joints

Welded joints must be fusion-welded unless otherwise required. Make changes in direction of piping with welding fittings only. Branch connection may be made with either welding tees or forged branch outlet fittings. Provide forged, flared branch outlet fittings for improvement of flow where attached to the run, and reinforce against external strains. Beveling, alignment, heat treatment, and inspection of weld must conform to ASME B31.1. Remove weld defects and make repairs to the weld, or remove the weld joints entirely and reweld at no additional cost to the Government. Store and dry electrodes in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Do not use electrodes that have been wetted or that have lost any of their coating.

3.2.1.3 Flanges and Unions

Flanges and unions must be faced true, and made square and tight. Provide gaskets consisting of nonasbestos compressed material in accordance with ASME B16.21, 1.6 mm 1/16 inch thickness, full face or self-centering flat

ring type. The gaskets must contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). Use NBR binder for hydrocarbon service. Provide union or flange joints in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

3.2.1.4 Flared and Sweated Pipe and Tubing

Cut flared and sweated pipe and tubing square and remove burrs. Clean both inside of fittings and outside of tubing with an abrasive before sweating. Take care to prevent annealing of fittings and hard drawn tubing when making connection. Install in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Make joints for soldered fittings with silver solder. Provide joints for flared-type fittings on all branch connections, mains, and risers to provide for expansion and contraction of the pipe without stress to fittings, pipe, or tubing.

3.2.1.5 Copper Tube Extracted Joint

An extracted mechanical tee joint may be used in copper tube. Produce joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch branch tube for proper penetration into fitting to ensure a free flow joint. Braze joints in accordance with the NAPHCC NSPC. Soldered joints will not be permitted.

3.2.1.6 Grooved Mechanical Joints

Prepare grooves according to the coupling manufacturer's instructions. Use grooved fittings, couplings, and grooving tools that are products of the same manufacturer. Pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field 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. Measure and record groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations.

3.2.2 Connections to Equipment

Provide supply and return connections by the Contractor unless otherwise indicated. Install valves and traps in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment must not be smaller than the equipment connections. Make steam and return connections, unless otherwise indicated, 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.

3.2.3 Branch Connections

****

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

Pitch branches up or down as indicated, unless otherwise specified. Make connection to ensure unrestricted circulation; eliminate air pockets; and permit drainage of the system. Pitch steam supply and condensate branches taken from mains with a grade of no less than 25 mm in 3 m 1 inch in 10 feet, unless otherwise indicated.

3.2.4 Risers

The location of risers is approximate. Exact locations of the risers must be as approved. Terminate steam supply downfeed risers in a dirt pocket and drip trap to the return.

3.2.5 Supports

3.2.5.1 General

Fabricate hangers used to support piping 50 mm 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Install pipe guides and anchors to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Support all piping subjected to vertical movement when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers. Pipe hanger loads suspended from steel joist between panel points must not exceed 222 Newtons 50 pounds. Supend loads exceeding 222 Newtons 50 pounds from panel points.

3.2.5.2 Pipe Supports and Structural Bracing, Seismic Requirements

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

Supported and brace piping and attached valves to resist seismic loads as specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC [as indicated]. Provide structural steel required for reinforcement to properly support piping, headers, and equipment but not shown,as specified in this section. Use material for supports as specified in Section 05 12 00 STRUCTURAL STEEL.

3.2.5.3 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts and supports conforming to MSS SP-58, except as modified herein.

a. Do not use Types 5, 12, and 26.

b. Do not use Type 3 on insulated pipe.

c. Secure Type 18 inserts 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.

d. Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Do not construct C-clamp body from bent plate.

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

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

g. Where type 39 saddle or type 40 shield are permitted for a particular pipe attachment application, use the type 39 saddle welded to the pipe, on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Use Type 40 shields on all piping less than 100 mm 4 inches and all piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F. Use a high density insulation insert of a density 130 kg/cubic meter 8 pcf or greater under the type 40 shield for piping 50 mm 2 inches and larger.

h. Space horizontal pipe supports as specified in MSS SP-58 and do not install a support 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. In the support of multiple pipe runs on a common base member, use a clip or clamp 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 of the individual pipes in the multiple pipe run. Connect clips or clamps rigidly to the common base member. Provide a clearance of 3 mm 1/8 inch between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

i. Support vertical pipe at each floor, except at slab-on-grade, and at intervals of no more than 4.5 m 15 feet, no more than 2.4 m 8 feet from end of risers, and at vent terminations.

j. Provide Type 35 guides using steel, reinforced PTFE or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

(1) Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 100 mm 4 inches and larger carrying medium 16 degrees C 60 degrees F or higher, a type 39 saddle may be welded to the pipe and freely rest on the steel plate. On piping under 100 mm 4 inches and piping 100 mm 4 inches and larger carrying medium less than 16 degrees C 60 degrees F a type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel plate. Use a high density insulation insert of density 130 kg/cubic meter 8 pcf or greater under all shields on piping 50 mm 2 inches and larger.

(2) 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. Separate the pipe from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

k. Use pipe hangers on horizontal insulated pipe that are the size of the outside diameter of the insulation. Make insulation continuous through the hanger on all pipe sizes and applications.

****

NOTE: Detail the methods of supporting pipe in trenches.

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l. Support piping in trenches as indicated.

3.2.6 Pipe Sleeves

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

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Provide pipe passing through concrete or masonry walls or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Do not install sleeves in structural members except where indicated or approved. Make rectangular and square openings as detailed on the drawings. Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Unless otherwise indicated, provide sleeves of such size as to provide a minimum of 6 mm 1/4 inch all around clearance between sleeve and bare pipe or insulation surface. Use steel pipe or cast-iron pipe sleeves in bearing walls, waterproofing membrane floors, and wet areas. 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, seal the annular space between pipe and sleeve or between jacket over insulation and sleeve in nonfire-rated walls and floors as indicated and specified in Section 07 92 00 JOINT SEALANTS and in fire-rated walls and floors must be as indicated and specified in Section 07 84 00 FIRESTOPPING. Pipes passing through wall waterproofing membrane must be sleeved as described above. In addition, install a waterproofing clamping flange as indicated.

3.2.6.1 Roof or Floor Penetrations of Waterproofing Membrane

****

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

****

Install pipes through a 1.8 kg 4 pound lead-flashing sleeve, a 453 g 16 ounce copper sleeve, or a 0.081 mm 0.032 inch thick aluminum sleeve, each having an integral skirt or flange. Flashing sleeve must be suitably formed. Extend the skirt or flange 200 mm 8 inches or more from the pipe and set over the roof or floor membrane in a troweled coating of

bituminous cement. Extend the flashing sleeve 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 floor or roof, whichever is greater. Seal the annular space between the flashing sleeve and the bare pipe or insulation surface as indicated. 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. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.6.2 Optional Sealing of Uninsulated Pipes

A modular mechanical type sealing assembly may be installed. Provide seals consisting 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. Assemble links loosely 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, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly 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.

3.2.6.3 Optional Counterflashing

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

3.2.6.4 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. Fasten escutcheons securely to pipe sleeves or to extensions of sleeves without any part of sleeves visible. Where sleeves project slightly from floors, use special deep-type escutcheons. Use chromium-plated iron or brass escutcheons, either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.2.6.5 Clay Sewer Pipe

Install pipe where indicated for housing steam-supply and condensate-return lines. Install sewer pipe on properly graded and well-tamped earth or gravel base. Pack joints with twisted-jute packing and sealed with bituminous sealing compound or portland cement mortar.

3.2.7 Pipe Anchors

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

Submit detailed drawings of pipe anchors, before installation. Provide anchors where necessary or indicated to localize expansion or prevent

undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces using turnbuckles where required. Locate supports, anchors, or stays located to prevent damage by installation operations or by the weight or expansion of the pipeline.

3.2.8 Pipe Expansion

****

NOTE: Steam piping layout should be analyzed for thermal stresses due to expansion. Spring hangers must be indicated on drawing and used to absorb vertical expansion of piping and seismic conditions.

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 will be permitted where restrictions of space prevent use of expansion loops or piping offsets. Install expansion joints, when used, in readily accessible locations. Drawings must detail anchors, pipe guide offsets, and expansion joints. Drawings must also indicate location.

****

Provide expansion of supply and return pipes for changes in the direction of the run of pipe, by expansion loops, or by expansion joints as indicated. Condensate and steam expansion joints must be one of the types specified.

3.2.8.1 Expansion Loops

Use expansion loops to provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Provide cold-sprung loops and install where indicated. Provide pipe guides as indicated.

3.2.8.2 Slip-Tube Type Expansion Joints

Use slip-tube type expansion joints for steam and condensate systems only and install where indicated. Joints must provide for either single or double slip of the connected pipes and temperature and pressure suitable for application, in no case less than [_____] kPa psig. Joints must be in accordance with applicable requirements of EJMA Stds and ASME B31.1, Type I or III. End connections must be flanged. Provide anchor bases or support bases as indicated or required. Make initial setting in accordance with the manufacturer's recommendations to allow for ambient temperature at time of installation. Install pipe alignment guides as recommended by the joint manufacturer, but no more than 1.5 m 5 feet from expansion joint, except in lines 100 mm 4 inches or smaller where guides are installed no more than 600 mm 2 feet from the joint.

3.2.8.3 Bellows-Type Joint

Bellows-type joint design and installation must comply with EJMA Stds. Design joints for the working temperature and pressure suitable for the application but no less than 1.03 MPa 150 psig in any case.

3.2.8.4 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 plans 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.

****

Flexible ball joints may be threaded, flanged, or welded end as required, and must be capable of absorbing the normal operating axial, lateral, or angular movements or combination in accordance with ASME B31.1, and ASME BPVC SEC VIII D1 where applicable. Provide flanges conforming to the diameter and drilling of ASME B16.5. Furnish molded gaskets suitable for the service intended.

3.2.9 Valves and Equipment

Install valves at the locations shown, where specified, and where required for the proper functioning of the system as directed. Use gate valves unless otherwise shown, specified, or directed. Install valves with their stems horizontal or above. Use valves with ferrous piping that have threaded or flanged ends for ferrous piping and sweat-type connections for copper tubing.

3.2.9.1 Thermometer Socket

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

3.2.9.2 Radiator Valves

Install an automatic or manual control valve and a 6 mm 1/8 inch air valve on each radiator and convector. Control valve must be the same size as supply connection. Deliver ten keys for air valves to the Contracting Officer. A fully automatic type air vent may be furnished for convectors in lieu of the manual air valves specified.

3.2.9.3 Steam Air Vents

****

NOTE: Indicate location of all air vents on the drawings. Details for vents must be indicated on the drawings.

****

Install vents where indicated. Run discharge pipes from the vent to a point as indicated. Vent must be a quick-acting valve that continuously removes air. Construct valve of corrosion-resisting metal, designed to withstand the maximum piping system pressure, and automatically closes

tight to prevent escape of steam and condensate. Provide vent with a manual isolation valve.

3.2.9.4 Pressure Reducing Valves

Provide valves designed for a working pressure of no less than 860 kPa 125 psig wherever indicated or required. Install aech valve with a strainer, a three-valve bypass, and a safety valve.

3.2.10 Steam Traps

****
NOTE: Indicate size of flash tanks and installation detail on drawings. If no flash tanks are required for the project, modify bracketed choices.
****

Install float traps [in the condensate-discharge line from the flash tank and elsewhere as] [where] indicated. Install all other steam traps where indicated.

3.2.11 Unit Heaters

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

3.2.12 Insulation

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

3.3 FRAMED INSTRUCTIONS

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, where directed. Submit proposed diagrams, instructions, and other sheets, before posting. Prepare 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 in typed form, frame as specified above for the wiring and control diagrams, and post beside the diagrams. Post framed instructions before acceptance testing of the system.

3.4 MANUFACURERS' FIELD SERVICES

Provide services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the specified equipment. Supervise installing, adjusting, and testing the equipment.

3.5 FIELD TRAINING

****
NOTE: The number of hours required to instruct a Government representative in operation and maintenance of the system will depend on the complexity of the system specified. Designer is to establish the number of hours of training based on equipment manufacturer recommendations, system

complexity and consultation with the installation.
****

Conduct a training course for the maintenance and operating staff. Start training period of [_____] hours normal working time after the system is functionally complete but before the final acceptance tests. Give the Contracting Officer at least 2 weeks advance notice of such training. Include all of the items contained in the approved Operating and Maintenance Instructions as well as demonstrations of routine maintenance operations. Submit [6] [_____] complete copies of operation manuals outlining the step-by-step procedures required for system startup, operation, and shutdown. Include in the manuals the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment and their basic operating features. Submit [6] [_____] complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the manuals piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed.

3.6 ADJUSTING, BALANCING, TESTING AND INSPECTING

****
NOTE: Before occupancy of a facility, inspect the boilers in accordance with the Code of Boiler and Pressure Inspectors (BPVI) and the American Society of Mechanical Engineers (ASME). Inspectors must be certified in accordance with BPVI standards.
****

Submit 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 completing and testing the system. Indicate in each test report the final position of controls.

3.6.1 Field Tests

Notify the Contracting Officer [_____] days before the performance and acceptance tests are to be conducted. Perform 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. Before thermal insulation is installed, hydrostatically test the entire heating system, including all heating units, valves and fittings, at 1-1/2 times the design operating pressure for a minimum of 4 hours.

3.6.2 Cleaning and Adjusting

After hydrostatic tests have been made and prior to the operating tests, thoroughly clean piping by filling the system with a solution of one pound of caustic soda or 1.4 kg 3 pounds of trisodium phosphate per 380 liters 100 gallons of water. Heat water to approximately 65 degrees C 150 degrees F, and circulate the solution in the system for a period of 48 hours, then drain and thoroughly flush out with fresh water. Wipe equipment clean, with all traces of oil, dust, dirt, or paint spots removed. It is the Contractor's responsibility to maintain the system in a clean condition until final acceptance. Lubricate bearings as recommended by the manufacturer. Adjust belts with correct tension, and adjust other miscellaneous equipment to setting indicated or as recommended by the respective manufacturers.

3.6.3 System Operation

Upon completion and prior to acceptance of the project, the installation must be subjected to such operating tests as may be required to demonstrate that the steam heating system will operate as specified or indicated. Conduct tests by a qualified test engineer at such times as directed. Provide instruments, facilities, and labor required to conduct the tests. Read indicating instruments at 1/2-hour intervals, unless otherwise directed. Tests must cover a period of 3 or more hours for each system tested, and include the following applicable specific information together with conclusions as to the adequacy of the system in the test reports:

a. Time, date, and duration of test.

b. Flow and pressure of steam to the inlet of the equipment.

c. Make, model, and size of each piece of equipment.

d. Dry bulb temperature entering and leaving heating and ventilating units.

e. Static discharge pressure actually obtained, total cfm handled, and voltmeter and ammeter readings for fan motor during operation.

f. Heating output for space-heating equipment.

g. Capacity and discharge pressure of each pump.

h. Automatic control sequence and operation.

3.6.4 Balancing

Systems must be completely balanced by a qualified engineer. Submit a complete balancing procedure for approval. Provide all required piping, valves, and connections required to balance the systems.

Balance air systems as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

3.6.5 Retesting

Correct any deficiencies revealed during testing and reconduct tests.

3.7 FIELD PAINTING

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NOTE: Color coding for piping identification as required by the using agency will be developed and inserted in the "Color Code Schedule" in Section 09 90 00 PAINTS AND COATINGS.

****

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, are specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --