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USACE / NAVFAC / AFCESA / NASA **UFGS-23 70 03.00 10 (January 2008)**

Preparing Activity: USACE **Superseding UFGS-23 70.03 00 10 (October 2007)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated March 2008
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

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HEATING AND UTILITIES SYSTEMS, CENTRAL STEAM

01/08

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SECTION 23 70 03.00 10

HEATING AND UTILITIES SYSTEMS, CENTRAL STEAM
01/08

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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.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

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

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

This guide specification includes tailoring options for radiators & convectors, unit heaters, and heating and ventilating units. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.
****

PART 1 GENERAL

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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: Steam heating systems shall operate at a pressure of approximately 35 kPa (5 psig). The steam shall be supplied from a central steam plant and shall be reduced to the specified gauge pressure.

(1) Vacuum-return system: Condensate from the heating system shall be returned by vacuum to the vacuum pumping unit which will pump the condensate back to the central steam plant.

(2) Gravity-return system: Condensate from the heating system shall be returned 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 shall 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). The steam shall be supplied to steam-using equipment without further reduction in pressure and the condensate shall return through medium-pressure traps, flash tanks, and a condensate pumping unit to the central system.

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1.1 REFERENCES

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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 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.

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

AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 850 (2004) Standard for Performance Rating of Commercial and Industrial Air Filter

Equipment

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2006) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2004; Errata 2004) Specification for Filler Metals for Brazing and Braze Welding
AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2005) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.15	(2006) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(2001; R 2005) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.3	(2006) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(1998; R 2006) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(2006) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	(2003) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B19.3	(1991; Addenda A 1994; Addenda B 1995) Safety Standard for Compressors for Process Industries
ASME B31.1	(2007) Power Piping
ASME B40.100	(2006) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2007) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

ASME BPVC SEC VIII D1	(2007) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME PTC 19.3	(1974; R 2004) Temperature Measurement Instruments and Apparatus

ASTM INTERNATIONAL (ASTM)

ASTM A 106/A 106M	(2006a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 181/A 181M	(2006) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A 183	(2003) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 504/A 504M	(2007) Standard Specification for Wrought Carbon Steel Wheels
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 2004) Standard Specification for Ductile Iron Castings
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 659/A 659M	(2006) Standard Specification for Commercial Steel (CS), Sheet and Strip, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled
ASTM A 733	(2003) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B 251	(2002e1) General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
ASTM B 251M	(1997; R 2003) General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Metric)
ASTM B 32	(2004) Standard Specification for Solder Metal
ASTM B 88	(2003) Standard Specification for Seamless Copper Water Tube
ASTM B 88M	(2005) Standard Specification for Seamless Copper Water Tube (Metric)

ASTM C 700	(2007a) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D 1248	(2005) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D 1693	(2007a) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 2000	(2006ae1) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 3308	(2006) PTFE Resin Skived Tape
ASTM D 635	(2006) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2003) EJMA Standards

HYDRONICS INSTITUTE DIVISION OF GAMA (HYI)

HYI-005	(2004) 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	(1998) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-70	(2006) Standard for Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2005) Standard for Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2002) Standard for Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2007) Standard for Motors and Generators

PLUMBING-HEATING-COOLING CONTRACTORS NATIONAL ASSOCIATION (PHCC)

NAPHCC NSPC	(2003) National Standard Plumbing Code

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996; Rev thru Jun 2006) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

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

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

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

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings
Installation

Detail drawings consisting of schedules, performance charts, brochures, diagrams, drawings, and instructions necessary for installation of the systems as specified. 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.

Pipe Anchors

Detailed drawings of pipe anchors, before installation.

SD-03 Product Data

Welding
System Equipment

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

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 supplies, with current unit prices and supply sources.

Framed Instructions

Proposed diagrams, instructions, and other sheets, before posting.

SD-06 Test Reports

Adjusting, Balancing, Testing and Inspecting

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.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

[Six] [_____] 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. [Six] [_____] 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.

1.3 QUALITY ASSURANCE

1.3.1 Welding

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NOTE: If need exists for more stringent requirements for weldments, delete the first bracketed statement and the welding submittal.
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[Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall 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 shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05 05 23 WELDING, STRUCTURAL.] [Welding and nondestructive testing procedures are specified in Section 43 02 00 WELDING PRESSURE 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. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

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

2.1.3 Prevention of Rust

Unless otherwise specified, surfaces of ferrous metal subject to corrosion shall 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

shall 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

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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. High temperature equipment and piping exposed to contact by personnel or where a fire hazard will be created shall be properly guarded or covered 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 05 50 00 METAL: MISCELLANEOUS AND FABRICATIONS.

2.2 MATERIALS

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

Materials shall conform to the following:

2.2.1 Filters

ARI 850.

2.2.2 Iron and Steel Sheets

2.2.2.1 Galvanized Iron and Steel

ASTM A 659/A 659M, ASTM A 653/A 653M with general requirements conforming to ASTM A 504/A 504M. 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

Adapters for copper tubing shall be brass or bronze 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 C 700, Class 1, Type I, Style a.

2.2.3.4 Copper Tubing

ASTM B 88, ASTM B 88M, Type K or L. For compressed air tubing, ASTM B 251M ASTM B 251.

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. Bronze threaded fittings shall conform to the applicable requirements of ASME B16.15. Cast copper alloy solder joint pressure fittings shall conform to ASME B16.18. Fittings on Type L tubing shall be brazed-joint type of cast or wrought bronze or wrought copper. Fittings on Type K tubing shall be 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. Grooved mechanical joints and fittings shall be designed for not less than 862 kPa 125 psig service and shall be the product of the same manufacturer. Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A 536. Gaskets for use in grooved joints shall be molded synthetic polymer of pressure responsive design and shall conform to ASTM D 2000 for circulating medium up to 110 degrees C 230 degrees F. Grooved joints shall conform to AWWA C606. Coupling nuts and bolts for use in grooved joints shall be steel and shall conform to ASTM A 183.

2.2.3.7 Malleable Iron Pipe Fittings

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

2.2.3.8 Nipples

ASTM A 733, standard weight.

2.2.3.9 Pipe

ASTM A 53/A 53M or ASTM A 106/A 106M, Grade A or B, black steel. Pipe shall be standard weight 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 A 181/A 181M and ASME B16.5. Convoluted flanges shall mate with ASME B16.5, Class 150 flanges. Flanges and fittings shall have the manufacturer's trademark affixed 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 and MSS SP-69.

2.2.3.13 Pipe Threads

ASME B1.20.1.

2.2.3.14 Solder, Silver

AWS A5.8/A5.8M, or the solder metal shall conform to ASTM B 32 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 D 1248, 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. Valves shall be provided with union radiator connections, spring-retained packing, and composition mushroom handles.

2.2.6 Electrical Motors

Motors shall be 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. Electrical equipment and wiring shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics shall be as specified or indicated. Integral size motors shall be the premium efficiency type 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 shall 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 required for controls and devices but not shown, shall be provided.

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	Pump capacity, liters per sec.	Capacity receiving Tank liters
93	0.10	75
186	0.19	75
372	0.38	114
557	0.57	170
744	0.76	227
929	0.95	284
1394	1.4	435
1858	1.9	568
2323	2.4	719

Minimum capacity for condensate pumps and receivers:

EDR sq m	Pump capacity, liters per sec.	Capacity receiving Tank liters
2787	2.8	852
3716	3.8	1136
4645	4.7	1420
6968	7.1	2158

Minimum capacity for condensate pumps and receivers:

EDR sq.ft.	**Pump capacity, gpm**	**Capacity receiving Tank gallons**
1,000	**1.5**	**20**
2,000	**3.0**	**20**
4,000	**6.0**	**30**
6,000	**9.0**	**45**
8,000	**12.0**	**60**
10,000	**15.0**	**75**
15,000	**22.5**	**115**
20,000	**30.0**	**150**
25,000	**37.5**	**190**
30,000	**45.0**	**225**
40,000	**60.0**	**300**
50,000	**75.0**	**375**
75,000	**112.5**	**570**

****

Each pump shall have a minimum capacity of [_____] L/second gpm when discharging against the specified pressure. Minimum capacity of the tank shall be [_____] liters gallons. Condensate pumping unit shall be of the [single] [duplex], [horizontal-shaft] [vertical-shaft] type. Unit shall consist of [one pump] [two pumps] [one electric motor] [two electric motors] and a single receiver. Pump shall be centrifugal or turbine type, bronze-fitted throughout, with impellers of bronze or other corrosion-resistant metal. Pumps shall be free from air-binding when handling condensate up to 95 degrees C 200 degrees F. Pumps shall be connected directly to drip-proof enclosed motors. Receiver shall be cast iron and shall be provided with condensate return, vent, overflow, and pump suction connections, water level indicator and automatic air vent. Strainer shall be provided in the inlet line to tank. Vent pipe shall be galvanized steel, and the fittings shall be galvanized malleable iron. Vent pipe shall be installed as indicated. Vent piping shall be flashed as specified. Pump, motor, and receiving tank may be mounted on a single base with the receiver pipe to the pump suction. A gate valve and check valve shall be provided in the discharge connection from each pump. Enclosed float switches complete with float mechanism shall be installed in the head of the receiver. Each condensate pump shall be controlled 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. Motors shall be provided with magnetic across-the-line starters equipped with general purpose enclosure and "Automatic-Manual-Off" selector switch in the cover. Automatic alternator shall be provided 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.
****

Vacuum pumping unit shall consist of a [single pump, motor, and receiving tank, [pumps, motors, and other functioning parts in duplicate, and a single receiving tank, as indicated]]. Unit shall be arranged for automatic operation. Each pump shall be suitable for the number of square feet of equivalent direct radiation (EDR) and the discharge pressure indicated. Receiver shall be a two-compartment type, constructed of close-grained cast iron with multijet vacuum producers. Pumping unit shall be close coupled vertical design, bronze-fitted with stainless steel shafts, enclosed bronze impeller, renewable bronze case ring, and mechanical shaft seal. Equipment, including pumps, motors, and receiver shall preferably be mounted on a single base. Accessories shall 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. Pump discharge line shall be provided 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 (Meters)

A	B	C	D
2,500	3.8	1.3	1.3
5,000	7.5	2.5	2.5
10,000	15.0	5.0	4.0
15,000	22.5	7.5	5.4
20,000	30.0	10.0	6.8
25,000	37.5	12.5	8.3
30,000	45.0	15.0	9.7
40,000	60.0	20.0	12.6
65,000	97.5	32.5	19.8
100,000	150.0	50.0	30.0

Vacuum Pump Sizing Guide (Inch-Pound)

A	B	C	D
232	0.24	0.08	0.04
465	0.47	0.16	0.07
929	0.95	0.32	0.11
1394	1.4	0.47	0.15
1858	1.9	0.63	0.19

Vacuum Pump Sizing Guide
(Inch-Pound)

A	B	C	D
2323	2.4	0.79	0.24
2787	2.8	0.95	0.27
3716	3.8	1.3	0.36
6039	6.2	2.1	0.56
9290	9.5	3.2	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 139.7 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 139.7 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 139.7 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 shall 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 shall 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. Condensate receiver shall have a capacity, between float-switch start and stop, of not less than [_____] liters gallons.

2.4.2.2 Motor and Controls

Each pump shall be driven by a sleeve- or ball-bearing motor of such size that the brake horsepower required by the pumping unit under the specified rated capacities shall not exceed the nameplate rating of motor. Motor shall be drip-proof type, and shall conform to the requirement specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Fully automatic controls shall be provided 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.
****

Space temperature control system shall be pneumatic, electric, or electronic. Control wiring and tubing required to complete the space temperature control system shall be included.

2.4.3.1 Air Compressor

Where pneumatic controls are furnished, an air compressor of the standard piston type shall be provided complete with air tanks, air dryer, and other appurtenances. Compressor and installation shall comply with ASME B19.3. Compressor shall be of sufficient capacity to provide continuous control air when operating on a 1/3-on 2/3-off cycle and shall be provided with a visible oil-level sight glass and oil filter. Air dryers shall be of the silicagel type with reactivation, or of the refrigerated type, and shall 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). Air dryer shall be located at the outlet of the tank. A standby compressor of capacity equal to the basic compressor shall be provided with interlocked control system to provide automatic changeover upon the malfunction or failure of basic compressor. A manual selector switch shall be provided to index the lead compressor including the automatic changeover.

2.4.3.2 Air Lines

Air lines for pneumatic controls shall be seamless copper tubing or nonmetallic tubing. Piping shall be concealed except in mechanical rooms or areas where other piping is exposed. Copper tubing shall be hard-drawn in exposed areas and either hard-drawn or annealed in concealed intervals and shall run parallel to the lines of the building. Only tool-made bends will be acceptable. Fittings for copper tubing shall be brass or copper solder joint-type except at connections to apparatus, where fittings shall be brass compression-type. Nonmetallic tubing shall be polyethylene, meeting the stress crack test of ASTM D 1693. Individual tube polyethylene or multitube instrument tubing bundle shall be classified as flame retardant under UL 94 and the polyethylene material shall be rated as self-extinguishing when tested in accordance with ASTM D 635. Nonmetallic tubing shall be run 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 shall be hard-drawn copper tubing or nonmetallic tubing run in conduit. Terminal single lines shall be hard-drawn copper tubing, except if the run is less than 300 mm 12 inches, flexible polyethylene may be used. Nonmetallic tubing shall not be used 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. Tubing shall be periodically tested for leaks during installation and all tubing shall be free of installation impurities and moisture before connecting to the control instrument. Fittings for polyethylene tubing shall be for instrument service and may be brass or acetal homopolymer of the compression or barb push-on type. Tubing shall 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

Thermostats shall be standard commercial type 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

Thermostat shall be of the adjustable type set for a design temperature of [_____] degrees C degrees F with a heating supply water temperature of [_____] degrees C degrees F. A suitable ventilated weather shelter shall be provided for the outside sensing element. Unit shall be mounted indoors with its sensing element located in the outside air. Unit shall proportionally reset the control point of a remote sensing temperature controller.

2.4.3.5 Seven-Day Program Timer

Timer shall be provided with the proper switching action so that one timer will switch all zones. Timer schedule for each zone shall raise and lower the temperature twice during each 24-hour period throughout the week. During the weekend, there shall 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

Valve shall be adjustable; shall have an operating range of approximately 38 to 95 degrees C 100 to 200 degrees F and shall be furnished with a thermostatic element, steam valve, connecting capillary tubing, and all required accessories. Thermostatic element shall be inserted in a separable socket in the hot-water supply main. Parts subject to wear shall be constructed of noncorrodible metal and shall be easily replaceable.

2.4.4.2 Pressure-Reducing Valves

Valves designed for a working pressure of not less than 860 kPa 125 psig shall be provided where indicated or otherwise required. Each reducing valve shall be adjusted to maintain the desired terminal pressure within 20 kPa 3 psi, regardless of fluctuations in the initial pressure. Valves

shall be quiet in operation. Reducing valves provided in lines for space heating only shall be of the double disk and seat type or sliding gate and plate type. Reducing valves for dead-end service shall be single-seated or sliding gate and plate type. Parts subject to wear shall be constructed of noncorrodible metal and shall be easily replaceable.

2.4.4.3 General Purpose Control Valves and Controllers

Control valves and controllers shall as specified in Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS.

2.4.5 Flash Tank

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

Tank shall be sized and installed as indicated and shall be of welded construction utilizing black steel sheets not less than [_____] mm inches thick. Tank shall be provided with a handhole and with tapping for the condensate returns, drip lines, vent line, and condensate discharge line. Discharge line shall be equipped with a float trap. Vent pipe shall be of galvanized steel and fittings shall be of galvanized malleable iron. Vent pipe shall be installed as indicated. Vent piping shall be flashed as specified.

2.4.6 Steam Traps

2.4.6.1 Float Traps

****
NOTE: Drawings shall indicate steam trap capacities, working pressures, and differential pressures.
****

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

2.4.6.2 Float-and-Thermostatic Traps

Traps shall be designed for a steam working pressure of approximately 105 kPa 15 psig, but shall operate with a supply pressure of approximately 35 kPa 5 psig. Capacity of the traps shall be as indicated. Trap capacity shall be based on a pressure differential of 2 kPa 1/4 psig. Each float-and-thermostatic trap shall be provided 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 shall have a cast-iron strainer, either an integral part of the trap or a separate item of equipment.

2.4.6.3 Bucket Traps

Traps shall be inverted or vertical bucket type with automatic air discharge. Traps shall be designed for a working pressure of 1.03 MPa 150 psig, but shall operate under a steam supply pressure of approximately 275 to 690 kPa 40 to 100 psig. Each trap shall have a heavy body and cap of fine-grained, gray cast iron. Bucket shall be made of brass; the mechanism

of hard bronze; the valve and seat of stainless or monel; or each of equivalent material. Traps shall be tested hydrostatically under a pressure of 1.5 MPa 200 psig. Traps shall have capacities as indicated when operating under the specified working conditions. Strainer shall be provided 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. Thermostatic traps shall be equipped with valves and seats of stainless steel, or monel metal, and shall have capacities based on a pressure differential not in excess of the following:

Steam Working Pressure kPa psig	Differential kPa psig
170-345 kPa 25-50 psig	140 kPa 20 psig
620-690 kPa 90-100 kPa	550 psig 80 kPa

2.4.6.4 Thermostatic Traps

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

2.5 SPACE HEATING EQUIPMENT

2.5.1 Radiators and Convectors

****
NOTE: References to types of radiation not required for the project shall be deleted. Indicate test pressures desired. Drawings shall indicate types and sizes of radiators and convectors.
****

Radiators and convectors shall be the types and sizes indicated. Each radiator and convector shall be provided with a top supply and a bottom return connection at opposite ends. Supply connection to each radiator and convector shall contain the radiator control valve, and the return connection shall contain the thermostatic trap. Radiators and nonferrous convectors shall be tested hydrostatically at the factory under a pressure of [_____]kPa psig. Cast iron convectors, after assembly, shall be tested pneumatically under water at a pressure of not less than [_____] kPa psig.

2.5.1.1 Cast-Iron Radiators

Cast-iron radiators shall be gray cast iron, free from sandholes and other defects. Sections shall be connected with malleable iron nipples not less than 2.3 mm 0.09 inch thick at any point. Cast-iron radiators shall be the legless type, wall mounted by means of hangers as specified. Adjustable

radiator hangers shall be secured to the wall and shall 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. Not less than two bolts shall 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 shall be provided.

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.
****

Radiators shall 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 shall have capacities not less than those indicated, determined in accordance with HYI-005. Radiators shall 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 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 wall with brackets.]

2.5.1.3 Convectors

Convectors shall be constructed of cast iron or of nonferrous alloys, and shall be installed where indicated. Capacity of convectors shall be as indicated. Overall space requirements for convectors shall not be greater than the space provided. Convectors shall be complete with heating units and enclosing cabinets having bottom recirculating opening, manual control damper and top supply grille. Convector cabinets shall be constructed of sheet steel not 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 SIASHRAE FUN IP, as follows: 50 for fair; 44 for very good; and 38 for perfect speech intelligibility.

****

Heaters shall have a heating capacity not in excess of 125 percent of the capacity indicated. [Noise level of each unit heater for areas noted shall not exceed the criteria indicated.]

2.5.2.1 Propeller Fan (Type I) Heaters

Heaters shall be designed for suspension and arranged for [horizontal] [vertical] discharge of air. Casings shall be not less than 0.91 mm (20 gauge) 20 gauge black steel and finished with lacquer or enamel. Suitable stationary or rotating air deflectors shall be provided to ensure 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 shall operate 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. Horizontal discharge type unit heaters shall have discharge or face velocities not in excess of the following:

Unit capacity, liters per second	Face velocity, meters per second
Up to 472	4.1
473-1400	4.6
1401 and over	5.1

Unit capacity, cfm	Face velocity, fpm
Up to 1,000	800
1,001 to 3,000	900
3,001 and over	1,000

2.5.2.2 Centrifugal Fan (Type II) Heaters

Heaters shall be arranged for floor or ceiling mounting. Heating elements and fans shall be housed in steel cabinets of sectionalized steel plates or reinforced with angle-iron frames. Cabinets shall be constructed of not lighter than 1.214 mm (18 gauge) 18 gauge black steel. Each unit heater shall be provided with a means of diffusing and distributing the air. Fans shall be mounted on a common shaft, with one fan to each air outlet. Fan shaft shall be equipped 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 shall be the same size.

2.5.2.3 Heating Elements

Heating coils and radiating fins shall be of nonferrous alloy. Heating elements shall be free to expand or contract and shall be pitched for drainage. Elements shall be tested under a hydrostatic pressure of 1.4 MPa 200 psig.

2.5.2.4 Motors

Motors shall be provided with manual selection switches for [On-Off-Automatic] [On-Off] [High/Low-Off] operation and shall be equipped with thermal overload protection.

2.5.3 Heating and Ventilating Units

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

Units shall be ceiling- or floor-mounted type, self-contained, 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. Each unit shall be provided with latched, removable access panels located so that any equipment within the housing can be removed for cleaning or maintenance. Fan section of the housing shall be internally insulated with not less than 40 mm 1-1/2 inches of fibrous glass insulation of not 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

Coil shall be of nonferrous alloy, free to expand and contract, and shall be pitched for drainage. Coil shall be tested hydrostatically after assembly of the unit and provided tight under a gauge pressure of 1.4 MPa 200 psig.

2.5.3.2 Fans and Drive

Fans shall be the multiblade centrifugal type, one to each air outlet, mounted on a common shaft. Fans within any one unit shall be of the same size. Fan units shall be installed on vibration isolators and shall be completely isolated from the building structure. Bearings shall be ball, roller, or taper type and shall be provided with lubrication fittings, externally accessible at the drive side of the unit. Fans shall be directly connected or indirectly connected to the driving motors through V-belt drive. V-belt drive shall be rated for 150 percent of motor capacity. Adjustable sheaves shall be provided to produce at least 20 percent fan speed adjustment. Sheaves shall be selected to produce specified fan capacity at the midpoint of the adjustment.

2.5.3.3 Motor

Motor shall be provided with general purpose type enclosure. Direct-connected motors shall operate at a speed not in excess of 1,200 rpm, and motors using V-belt drives shall operate at 1,750 rpm. Adjustable base rails shall be provided 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.
****

Filters and filter racks of the V- or flat-type arrangement shall be provided. Filters shall be removable from one accessible side of the unit. Filters shall be [[25 mm 1 inch] [50 mm 2 inches] thick replaceable throw-away type, in accordance with ARI 850] [of cleanable type, in accordance with ARI 850, 25 mm 1 inch thick, or the size required to suit the application. Viscous adhesive shall be furnished in 19 L 5 gallon containers in sufficient quantity for 12 cleaning operations; not less than one quart shall be provided for each filter section. [One washing and charging tank shall be provided for every 100-filter section or fraction thereof. Each washing and charging unit shall accommodate [_____] filters.]]

2.5.3.5 Duct Connections

Outside air intake shall be provided 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]. Intake box shall be constructed of not less than 0.91 mm (20 gauge) 20 gauge galvanized steel. Dissimilar metal shall be separated from galvanized steel by plastic membrane. Discharge ductwork, diffusers, registers, and grilles shall be as specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.5.3.6 Dampers

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

2.6 SYSTEM ACCESSORIES

2.6.1 Foundations and Anchorage

Foundations and anchorage for pumping units and for other heating equipment shall be in accordance with the manufacturer's requirements.

2.6.2 Pressure Gauges and Thermometers

Gauges shall be provided for piping as indicated. Gauges shall comply with ASME B40.100 and thermometers shall comply with ASME PTC 19.3. A thermometer and pressure gauge shall be provided on the steam supply and return mains. Thermometers shall be separable socket type.

2.6.3 Vacuum Relief Valve

An approved vacuum relief valve shall be installed where indicated. On shutoff of steam supply and condensing of steam, the vacuum relief valve shall automatically admit air to the system.

2.6.4 Safety Valves

Pop safety valves shall be provided on the low side of each pressure reducing valve. The valves shall be set to open automatically and to relieve steam at 35 kPa 5 psi in excess of the setting of the reducing valve, or as indicated. Safety valves shall conform to the requirements of ASME BPVC SEC VIII D1 and shall be installed as indicated.

2.6.5 Drains

A drain connection with 25 mm 1 inch gate valve or 19 mm 3/4 inch hose bib shall be installed at the lowest point in the return main. In addition, threaded drain connections with threaded cap or plug shall be installed 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

Piping shall be black steel, conforming to ASTM A 53/A 53M, Grade A. Fittings shall be black, malleable iron or steel. Fittings adjacent to valves shall suit valves specified. Reducing fittings shall be used for changes in pipe sizes. In horizontal steam lines, reducing fittings shall be the eccentric type to maintain the bottom of the lines at the same level.

2.7.1.2 Condensate Return Piping and Fittings

Piping shall be black steel, extra strong weight, conforming to ASTM A 53/A 53M, Grade A. Fittings shall be cast iron or malleable iron, extra heavy.

2.7.1.3 Vent Piping and Fittings

Piping shall be black steel, conforming to ASTM A 53/A 53M, Grade A. Fittings shall be black malleable iron 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

Piping shall be copper tubing, Type K or L, 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, fittings used on steel pipe shall be 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. Joints between sections of copper tubing or pipe shall be flared or sweated. Pipe and fittings 32 mm 1-1/4 inches and larger and installed in inaccessible conduits or trenches beneath concrete floor slabs shall be welded. Unless otherwise specified, connections to equipment shall 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 more, in diameter.

2.7.2.1 Bellows-Type Joints

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

2.7.2.2 Flexible Ball Joints

Joints shall be constructed 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

Dielectric waterways shall conform to the tensile strength and dimensional requirements specified in ASME B16.39. Waterways shall have metal connections on both ends suited to match adjacent piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric waterways shall have pressure and temperature rating equal to or greater than that specified for the connecting piping. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways.

2.7.3 Strainers

Basket or Y-type strainers shall be the same size as the pipelines in which they are installed. The strainer bodies shall be cast-iron rated for Class 125 125 pound service, with bottoms drilled and plugged. Bodies shall have arrows cast on the sides to indicate the direction of flow. Each strainer shall be equipped with a removable cover and sediment basket. Basket shall not be less than 0.76 mm (22 gauge) 22 gauge and shall 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 shall be as specified in Section 23 09 23 DIRECT DIGITAL CONTROL FOR HVAC AND OTHER LOCAL BUILDING SYSTEMS.

2.9 FACTORY COATING

Radiator and convector enclosures shall be coated with the manufacturer's standard rust inhibiting primer. Other equipment and component items, when fabricated from ferrous metal, shall 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) shall 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 shall detail anchors and pipe guide and indicate location.

****

All work shall be installed as indicated and in accordance with the manufacturer's diagrams and recommendations.

3.2.1 Piping

Unless otherwise specified, pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite and worked 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. Piping or tubing shall be cut square, shall have burrs removed by reaming, and shall be so installed as to permit free expansion and contraction without causing damage to building structure, pipe, joints, or hangers. Filings, dust, or dirt shall be wiped from interior of the pipe or tubing before connections are made. Changes in direction shall be made 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 shall not be less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattenings, or other malformations will not be accepted. Vent pipes shall be installed through the roof as directed and shall be flashed as specified. Horizontal supply mains shall pitch up or down in the direction of flow as indicated. The grade shall be not less than 25 mm in 12 m 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Open ends of pipelines and equipment shall be capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated. Unions for copper pipe or tubing shall be brass or bronze. Connections between ferrous piping and copper piping shall be electrically isolated from each other with dielectric waterways.

3.2.1.1 Threaded Joints

Threaded joints shall be made with tapered threads properly cut, and shall be made tight with polytetrafluoroethylene (PTFE) tape complying with ASTM D 3308, 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 shall be fusion-welded unless otherwise required. Changes in direction of piping shall be made with welding fittings only. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.2.1.3 Flanges and Unions

Flanges and unions shall be faced true, and made square and tight. Gaskets shall 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. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Union or flange joints shall be provided 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

Flared and sweated pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Installation shall be made 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. Joints for soldered fittings shall be made with silver solder. Joints for flared-type fittings shall be provided 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. Joint shall 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, dimpled depth stops shall be provided. The branch tube shall be notched for proper penetration into fitting to ensure a free flow joint. Joints shall be brazed in accordance with the NAPHCC NSPC. Soldered joints will not be permitted.

3.2.1.6 Grooved Mechanical Joints

Grooves shall be prepared according to the coupling manufacturer's instructions. Grooved fittings, couplings, and grooving tools shall be products of the same manufacturer. Pipe and groove dimensions shall comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field shall 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 shall be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Grooved joints shall not be used in concealed locations.

3.2.2 Connections to Equipment

Supply and return connections shall be provided by the Contractor unless otherwise indicated. Valves and traps shall 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 shall not be smaller than the equipment connections. Steam and return connections, unless otherwise indicated, shall 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.

3.2.3 Branch Connections

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

Branches shall pitch up or down as indicated, unless otherwise specified. Connection shall be made to ensure unrestricted circulation; eliminate air pockets; and permit drainage of the system. Steam supply and condensate branches taken from mains shall pitch with a grade of not 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 shall be as approved. Steam supply downfeed risers shall terminate in a dirt pocket and shall be drip trapped to the return.

3.2.5 Supports

3.2.5.1 General

Hangers used to support piping 50 mm 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall 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, shall be supported by variable spring hangers and supports or by constant support hangers. Pipe hanger loads suspended from steel joist between panel points shall not exceed 222 Newtons 50 pounds. Loads exceeding 222 Newtons 50 pounds shall be suspended 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 3-310-04 and Sections 13 48 00 and 13 48 00.00 10, properly edited, must be included in the contract documents.
****

Piping and attached valves shall be supported and braced to resist seismic loads as specified in UFC 3-310-04 SEISMIC DESIGN FOR BUILDINGS and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as shown]. Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided in this section. Material used for supports shall be as specified in Section 05 12 00 STRUCTURAL STEEL.

3.2.5.3 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall 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.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. The C-clamp body shall not be constructed from bent plate.

e. Type 20 attachments used on angles and channels shall be furnished 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, the type 39 saddle welded to the pipe, shall be used on all pipe 100 mm 4 inches and larger when the temperature of the medium is 16 degrees C 60 degrees F or higher. Type 40 shields shall be used 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. A high density insulation insert of a density 130 kg/cubic meter 8 pcf or greater shall be used under the type 40 shield for piping 50 mm 2 inches and larger.

h. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 300 mm 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 1.5 m 5 feet apart at valves. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any of the individual pipes in the multiple pipe run. The clips or clamps shall be rigidly connected to the common base member. A clearance of 3 mm 1/8 inch shall be provided between the pipe and clip or clamp for all piping which may be subjected to thermal expansion.

i. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 4.5 m 15 feet, not more than 2.4 m 8 feet from end of risers, and at vent terminations.

j. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be 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. A high density insulation insert of density 130 kg/cubic meter 8 pcf or greater shall be used 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 shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 100 mm 4 inches, or by an amount adequate for the insulation, whichever is greater.

k. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

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

l. Piping in trenches shall be supported as indicated.

3.2.6 Pipe Sleeves

****
NOTE: Typical details of pipe sleeves through walls, floors, and roofs are shown in UFC 3-190-01FA JOINT SEALING FOR BUILDINGS. The applicable detail plates will be completed and included in the contract drawings. Sleeve thickness and square- and rectangular- opening detail will be determined and indicated.

Fire walls and fire partitions shall be designated on the drawings.
****

Pipe passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall not be installed in structural members except where indicated or approved. Rectangular and square openings shall be as detailed on the drawings. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Unless otherwise indicated, sleeves shall be 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. Sleeves in bearing walls, waterproofing membrane floors, and wet areas shall 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 shall be sealed as indicated and specified in Section 07 92 00 JOINT SEALANTS and in fire-rated walls and floors shall be as indicated and specified in Section 07 84 00

FIRESTOPPING. Pipes passing through wall waterproofing membrane shall be sleeved as described above. In addition, a waterproofing clamping flange shall be installed 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.
****

Pipes shall be installed 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 shall be suitably formed. The skirt or flange shall extend 200 mm 8 inches or more from the pipe and shall be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall 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 floor or roof, whichever is greater. The annular space between the flashing sleeve and the bare pipe or insulation surface shall be sealed 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. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

3.2.6.2 Optional Sealing of Uninsulated Pipes

A modular mechanical type sealing assembly may be installed. The seals shall 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 shall 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 bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Each seal assembly shall 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 shall 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

Escutcheons shall be provided at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves visible. Where sleeves project slightly from floors, special

deep-type escutcheons shall be used. Escutcheons shall be chromium-plated iron or brass, either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.2.6.5 Clay Sewer Pipe

Pipe shall be installed where indicated for housing steam-supply and condensate-return lines. The sewer pipe shall be installed on properly graded and well-tamped earth or gravel base. Joints shall be packed 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.
****

Anchors shall be provided where necessary or indicated to localize expansion or prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed using turnbuckles where required. Supports, anchors, or stays shall be 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 shall 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. Expansion joints, when used, shall be installed in readily accessible locations. Drawings shall detail anchors, pipe guide offsets, and expansion joints. Drawings shall also indicate location.
****

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

3.2.8.1 Expansion Loops

Expansion loops shall provide adequate expansion of the main straight runs of the system within the stress limits specified in ASME B31.1. Loops shall be cold-sprung and installed where indicated. Pipe guides shall be provided as indicated.

3.2.8.2 Slip-Tube Type Expansion Joints

Slip-tube type expansion joints shall be used for steam and condensate systems only and shall be installed where indicated. Joints shall 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 shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1, Type I or III. End connections shall be flanged. Anchor bases or support bases shall be provided as indicated or required. Initial setting shall be made in accordance with the manufacturer's recommendations to allow for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer, but shall be not more than 1.5 m 5 feet from expansion joint, except in lines 100 mm 4 inches or smaller where guides shall be installed not more than 600 mm 2 feet from the joint.

3.2.8.3 Bellows-Type Joint

Bellows-type joint design and installation shall comply with EJMA Stds. The joints shall be designed for the working temperature and pressure suitable for the application and shall be not 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 shall 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. Flanges shall conform to the diameter and drilling of ASME B16.5. Molded gaskets furnished shall be suitable for the service intended.

3.2.9 Valves and Equipment

Valves shall be installed at the locations shown, where specified, and where required for the proper functioning of the system as directed. Gate valves shall be used unless otherwise shown, specified, or directed. Valves shall be installed with their stems horizontal or above. Valves used with ferrous piping shall have threaded or flanged ends for ferrous piping and sweat-type connections for copper tubing.

3.2.9.1 Thermometer Socket

A thermometer well shall be provided in each return line circuit in multicircuit systems.

3.2.9.2 Radiator Valves

An automatic or manual control valve and a 6 mm 1/8 inch air valve shall be installed on each radiator and convector. Control valve shall be the same size as supply connection. Ten keys for air valves shall be delivered 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 shall be indicated on the drawings.
****

Vents shall be installed where indicated. Discharge pipes from the vent shall be run to a point as indicated. Vent shall be a quick-acting valve that continuously removes air. Valve shall be constructed of corrosion-resisting metal, shall be designed to withstand the maximum piping system pressure, and shall automatically close tight to prevent escape of steam and condensate. Vent shall be provided with a manual isolation valve.

3.2.9.4 Pressure Reducing Valves

Valves designed for a working pressure of not less than 860 kPa 125 psig shall be provided wherever indicated or required. Each valve shall be installed 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.
****

Float traps shall be installed [in the condensate-discharge line from the flash tank and elsewhere as] [where] indicated. All other steam traps shall be installed where indicated.

3.2.11 Unit Heaters

Unit heaters shall be installed as indicated and in accordance with the manufacturer's recommendation.

3.2.12 Insulation

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

3.3 FRAMED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. 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 shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

3.4 ADJUSTING, BALANCING, TESTING AND INSPECTING

****
NOTE: Before occupancy of a facility the boilers shall be inspected 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.
****

3.4.1 Field Tests

Notify the Contracting Officer [_____] days before the performance and acceptance tests are to be conducted. The tests shall be performed 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, the entire heating system, including all heating units, valves and fittings, shall be hydrostatically tested at 1-1/2 times the design operating pressure for a minimum of 4 hours.

3.4.2 Cleaning and Adjusting

After hydrostatic tests have been made and prior to the operating tests, piping shall be thoroughly cleaned 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. The water shall be heated to approximately 65 degrees C 150 degrees F, and the solution circulated in the system for a period of 48 hours, then drained and thoroughly flushed out with fresh water. Equipment shall be wiped 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. Bearings shall be lubricated as recommended by the manufacturer. Belts shall be adjusted with correct tension, and other miscellaneous equipment shall be adjusted to setting indicated or as recommended by the respective manufacturers.

3.4.3 System Operation

Upon completion and prior to acceptance of the project, the installation shall be subjected to such operating tests as may be required to demonstrate that the steam heating system will operate as specified or indicated. Tests shall be conducted by a qualified test engineer at such times as directed. Provide instruments, facilities, and labor required to conduct the tests. Indicating instruments shall be read at 1/2-hour intervals, unless otherwise directed. Tests shall cover a period of 3 or more hours for each system tested, and test reports shall include the

following applicable specific information together with conclusions as to the adequacy of the system:

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.

3.4.4 Balancing

Systems shall be completely balanced by a qualified engineer. A complete balancing procedure shall be submitted for approval. All required piping, valves, and connections required to balance the systems shall be provided.

Balancing of air systems shall be as specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.4.5 Retesting

Any deficiencies revealed during testing shall be corrected and tests shall be reconducted.

3.5 FIELD PAINTING

****
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.

3.6 MANUFACURERS' FIELD SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise installing, adjusting, and testing the equipment.

3.7 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. The training period of [_____] hours normal working time shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the approved Operating and Maintenance Instructions as well as demonstrations of routine maintenance operations. Contracting Office shall be given at least 2 weeks advance notice of such training.

-- End of Section --