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USACE / NAVFAC / AFCEC **UFGS-33 60 02 (August 2024)**

Preparing Activity: USACE **Superseding**
UFGS-33 60 02 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2024
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DIVISION 33 - UTILITIES

SECTION 33 60 02

ABOVEGROUND HEAT DISTRIBUTION SYSTEM

08/24

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SECTION 33 60 02

ABOVEGROUND HEAT DISTRIBUTION SYSTEM
08/24

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NOTE: This guide specification covers the requirements for insulated aboveground heat distribution systems as covered in UFC 3-430-09 "Mechanical Utility Distribution" (hot water systems to 216 degrees C 420 degrees F and steam systems to 1.72 MPa 250 psig).

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).

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PART 1 GENERAL

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NOTE: Aboveground heat distribution system should be considered for use in lieu of underground heat distribution systems due generally to longer life and lower maintenance and should be utilized wherever operations and local conditions permit.

Due to the similarity of a high temperature hot water system and a steam system, no attempt was made to enclose in brackets all information which may differentiate one system from the other. In the event that only one type of distribution system is

required this guide specification must be edited to ensure that all information not applicable to the design is deleted. This may require that some paragraphs be deleted and others renumbered.

The Contract drawings will provide the following information on the aboveground heat distribution system as applicable: (1) dimensions on all runs of pipe; (2) elevation of the pipe along the systems path; (3) sizes of pipes; (4) system operating temperature and pressure; (5)types of check valves used; (6) cold set dimensions of expansion loops and Z-and L-bends; (7) how changes in pipe direction are to be made; (8) any changes in pipe pitch from the usual 20 mm per 10 m 1 inch per 40 feet; (9) aboveground heat distribution system support and pipe support spacing, locations and details; (10) vent and drain locations and details; and (11) other pertinent information and details required to clearly show the intent of the aboveground heat distribution system. Also indicate any obstructions and interferences in the path of the aboveground heat distribution system the Contractor may have to work around.

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1.1 SUMMARY

This specification covers the furnishing of materials for and the installation of an insulated aboveground heat distribution system. The contract drawings show the arrangement of piping, supports and the routing of the heat distribution system. Other details, such as sizes of piping, location of expansion loops, location of valves and items of equipment, are also shown on the contract drawings. This specification covers the installation of the system 150 mm 6 inches into the building which it serves.

1.2 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 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.

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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.

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 B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B31.1	(2022) Power Piping
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

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2023) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A234/A234M	(2024) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240/A240M	(2024) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A475	(2022) Standard Specification for Metallic-Coated Steel Wire Strand

ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B650	(1995; R 2023) Standard Specification for Electrodeposited Engineering Chromium Coatings on Ferrous Substrates
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C449	(2007; R 2013) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F1139	(1988; R 2019) Steam Traps and Drains

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

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

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

MSS SP-45	(2020) Bypass and Drain Connections
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-83	(2014) Class 3000 Steel Pipe Unions Socket Welding and Threaded

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of

1.3 SUBMITTALS

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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 and Air Force 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.

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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. Submittals not having a "G" or "S" classification are 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

Materials and Equipment

SD-03 Product Data

Materials and Equipment; G, [_____]

Procedures and Welders

Piping

Fittings

Valves

Steam Traps

Insulation

SD-04 Samples

Insulation Systems

SD-10 Operation and Maintenance Data

Distribution System; G, [_____]

1.4 QUALITY ASSURANCE

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NOTE: If the need exists for more stringent welding requirements, such as nondestructive testing, delete the sentences within the first set of brackets.

If the referenced specification sections are not to be included in the project specifications, applicable paragraphs from the referenced sections must be incorporated into this specification.

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[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with ASME BPVC SEC IX. Submit [6][_____] copies of qualified procedures and lists of names and identification symbols of qualified welders and welding operators, prior to welding operations. 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 to be performed at the work site, if possible. The welder or welding operator must apply the personally assigned symbol near each weld made 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.]

1.5 DELIVERY, STORAGE, AND HANDLING

After delivery to the jobsite, protect materials and equipment from anything which could cause damage to the material or equipment. Seal pipe at each end to keep the interior clean and free of dirt and debris. Keep fittings together with their interior surfaces clean at all times. Keep all stored insulation dry and clean.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of manufacturers regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening. Submit complete fabrication and assembly drawings for all parts of the work in sufficient detail to check conformity with the requirements of the contract documents. Show the

proposed layout for the aboveground heat distribution system, including provisions for pipe expansion, pipe anchors and guides, and supports in plan views and pipe profile elevations. Include data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope, details and calculations, with expansion stress calculations, required to demonstrate that the system has been coordinated and will properly function as a unit. Ensure equipment is supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2 PIPING

2.2.1 General

Unless otherwise specified, provide steel pipe, fittings, valves, and piping accessories conforming to the requirements of ASME B31.1, and suitable for the indicated pressure and temperature requirements. Weld joints for ferrous piping, except that joints 19 mm 3/4 inches and smaller may be threaded. Seal weld high temperature hot water system threaded joints. Provide seamless or electric resistance welded pipe conforming to ASTM A53/A53M or ASTM A106/A106M, Grade B. Provide seamless steel pipe 40 mm 1-1/2 inches in diameter and smaller conforming to ASTM A106/A106M, Grade B.

2.2.2 Supply Pipe

[Steam] [Hot water] [Hot water return] [Steam and hot water] pipes must be black steel Schedule 40 with plain end beveled. Nominal pipe sizes 25 mm 1 inch and below must be Schedule 80.

2.2.3 Condensate Return Pipes

Provide condensate return pipes consisting of black steel, Schedule 80 with plain end beveled.

2.2.4 Drip, Vent, Relief, and Gauge Pipe

Provide drip, vent, relief, and gauge connecting pipe and threaded pipe consisting of black steel, Schedule 80.

2.3 FITTINGS

2.3.1 Threaded Fittings

Provide threaded fittings conforming to the requirements of ASME B16.11, Pressure Class 3000.

2.3.2 Unions

Provide unions conforming to the requirements of MSS SP-83.

2.3.3 Welding Fittings

Provide welding fittings conforming to the requirements of ASTM A105/A105M / or ASTM A234/A234M. Also conform to ASME B16.9 for buttweld fittings and ASME B16.11 for socket-weld fittings. Use long radius buttwelding elbows conforming to ASME B16.9 whenever space permits.

2.3.4 Pipe Threads

Provide pipe threads conforming to ASME B1.20.2M ASME B1.20.1. Ensure pipe to be threaded is Schedule 80.

2.4 VALVES

2.4.1 General

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NOTE: Select the appropriate valves for the operating temperatures and pressures of all systems in the project. Delete valve types not included in project.

Use not less than Class 150 for up to 862 kPa 125 psig steam and not less than Class 300 for 863 kPa 126 psig steam and higher. For isolation and shutoff, use gate valves only. Steam pressure reducing valves are not normally part of the system. If needed, the designer should refer to Section 23 52 30.01 10 CENTRAL COAL-FIRED STEAM-GENERATING SYSTEM.

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Unless otherwise specified, provide ferrous and nonferrous valves meeting the material, fabrication and operating requirements of ASME B31.1. Provide valves that are suitable for the temperature and pressure requirements of the system on which they are to be installed. Provide valves for [steam] [hot water] conforming to ASME B31.1 Class [150] [and] [or] [300] as suitable for the application. [Provide valves for condensate services conforming to ASME B31.1 Class 150.] Provide valves 150 mm 6 inches and larger with a 25 mm 1 inch minimum gate or globe [integral] bypass valve sized in conformance with MSS SP-45. Valves must have the manufacturer's trademark.

2.4.2 Bronze Valves

2.4.2.1 Globe, Gate and Angle Valves

Provide globe, gate and angle valves conforming to the requirements of MSS SP-80.

2.4.2.2 Check Valves

Provide check valves conforming to the requirements of MSS SP-80.

2.4.3 Steel Valves

Provide steel globe, gate, angle and check valves conforming to the requirements of ASME B16.34 and ASME B31.1 for the temperature and pressure requirements of the system.

2.4.4 Packing

Packing used with valves must not contain asbestos. Use die-formed, ring type valve stem packing specifically designated as suitable for the temperature and pressure of the service and compatible with the fluid in the system. Packing rings must be polytetrafluoroethylene with minimum 50

percent graphite filament top and bottom rings. Provide valves 40 mm 1-1/2 inches and smaller with 4 or 5 packing rings, and valves 50 mm 2 inches and larger with at least 6 packing rings. Spiral or continuous packing will not be acceptable. Provide a metal insert having proper clearance around the valve stem at the bottom of the stuffing box and acting as a base for the packing material. Furnish packing glands with a liner of noncorrosive material and consisting of 1 piece construction with provisions for no less than 2 bolts for packing adjustment.

2.5 STEAM TRAPS

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NOTE: The following paragraphs are applicable to steam systems only. Only these two types of steam traps will be used. A schedule of steam trap selections will be shown on the drawings.

Trap capacity (kilograms per hour (pounds per hour during normal operation), pressure drop kPa psi, and pressure rating kPa psi of each trap will be included in schedule on the drawings. Additionally, show on the drawings a vent valve or test valve connection downstream of the traps for test of trap operation, a strainer ahead of the trap, a check valve in the outlet piping, unions and shut-off valves on both sides of the trap for trap changeout. Provide a means of bypassing the trap for system warm-up.

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2.5.1 General

Class of trap bodies must be suitable for a working pressure of no less than 1.5 times the steam supply pressure, but no less than 1.38 MPa 200 psi, and traps must be capable of operation under a steam-supply pressure as indicated. Ensure traps have capacities as shown when operating under the specified working conditions. Traps must fail open.

2.5.2 Bucket Traps

Provide bucket traps consisting of an inverted-bucket type with automatic air discharge conforming to the requirements of ASTM F1139.

2.5.3 Thermostatic Traps

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NOTE: Specify thermostatic traps where the trap location is subject to freezing.

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Provide thermostatic type, bimetallic element traps with automatic air discharge conforming to ASTM F1139.

2.6 STRAINERS

Basket or Y-type strainer body connections must be the same size as the pipelines in which the strainers are installed. The strainer bodies for steam systems must be heavy and durable, of cast steel, with bottoms drilled and plugged. Provide strainers that are suitable for the

temperature and pressure requirements of the system on which they are installed. Clearly cast arrows on the sides of the bodies to indicate the direction of flow. Equip each strainer with an easily removable cover and sediment basket. Equip the body or bottom opening with nipple and gate valve for blowdown. Provide basket for steam systems that is no less than 0.6350 mm 0.025 inch thick stainless steel, Monel or sheet brass, with small perforations of sufficient number to provide a net free area through the basket of at least 2.5 times that of the entering pipe. The flow must be into the basket and out through the perforations. For high temperature hot water systems, use only cast steel bodies and stainless or Monel baskets.

2.7 ABOVEGROUND PIPE SUPPORTS

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NOTE: If the referenced specification sections are not to be included in the project specifications, applicable paragraphs from the referenced sections must be incorporated into this specification.
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2.7.1 Concrete

Use concrete in the formation of poles or foundation for the supports conforming to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.7.2 Steel

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NOTE: Steel pipe supports must be protected from corrosion. Corrosion-resistant steel, such as stainless or hot-dipped galvanized should be used in the construction of the pipe supports. If paint is to be used to prevent corrosion of the steel pipe supports, then additional consideration should be given to the manpower needed, the future costs, and the time involved in maintaining the painted system. Specifications should be modified to indicate how corrosion protection is to be accomplished.
****

Use steel as support members or as part of the pipe support structure conforming to the requirements of Section 05 12 00 STRUCTURAL STEEL. To the maximum extent possible, the pipe supports must be hot-dipped galvanized after they have been fabricated.

2.7.3 Accessories

Furnish the following accessories as needed to maintain the alignment of the aboveground structure. Provide materials with a hot-dipped galvanized finish.

2.7.3.1 Guy Wires

Provide guy wires conforming to the requirements of ASTM A475, extra high strength grade, extra galvanized, stranded with 7 or 19 wires in each strand. Provide thimbles at each end of guy wires.

2.7.3.2 Anchor Rods

Provide anchor rods that are 32 mm 1-1/4 inch diameter threaded rod with oval eye.

2.7.3.3 Screw Anchors

Provide screw anchors with 250 mm 10 inch diameter.

2.7.3.4 Turnbuckles

Provide open type, forged body, turnbuckles with jaw and jaw end pulls, 10 mm 3/8 inch size and hot-dipped galvanized.

2.7.3.5 Clamps

Provide forged high carbon steel clamps fitted with galvanized heat treated bolts of best commercial grade. Ensure clamps are capable of developing full strength of the guy wire. Provide two clamps at each connection of the guy wire.

2.8 INSULATION SYSTEMS

Display sample sections for insulation of pipe, elbow, tee, valve, support point, and terminating points. After approval of materials and prior to insulation of piping, prepare a display of insulated sections showing compliance with specifications, including fastening, sealing, jacketing, straps, waterproofing, supports, hangers, anchors, and saddles. Keep approved display sample sections on display at the jobsite during the construction period until no longer needed by Contracting Officer, then remove.

2.8.1 Insulation

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NOTE: If ASHRAE 90.1 is more stringent for insulation thickness, the Table 1 and 2 will be updated to match ASHRAE 90.1 requirements.
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Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Ensure insulation for piping, fittings, and valves is molded mineral fiber insulation conforming to the requirements of ASTM C547, Class 2, asbestos free, molded calcium silicate conforming to the requirements of ASTM C533, Type I, asbestos free or cellular glass insulation conforming to ASTM C552. Provide insulation thickness used on aboveground piping as shown in Tables 1 and 2.

TABLE 1
Minimum Pipe Insulation Thickness (mm) (inches)

For steam up to 1.72 MPa 250 psig and high temperature hot water supply and return piping up to 232 degrees C 450 degrees F			
Nominal Pipe Diameter (mm) (inches)	Insulation Thermal Conductivity (k)		
	k less than 0.29	k from 0.29 to 0.40	k greater than 0.40
25 1.0	50 2.0	63 2.5	100 4.0

TABLE 1
Minimum Pipe Insulation Thickness (mm) (inches)

For steam up to 1.72 MPa 250 psig and high temperature hot water supply and return piping up to 232 degrees C 450 degrees F

40 1.5	50 2.0	63 2.5	100 4.0
50 2.0	63 2.5	85 3.5	110 4.5
65 2.5	63 2.5	85 3.5	110 4.5
80 3.0	75 3.0	100 4.0	125 5.0
100 4.0	75 3.0	100 4.0	125 5.0
125 5.0	75 3.0	100 4.0	125 5.0
150 6.0	85 3.5	110 4.5	135 5.5
200 8.0	85 3.5	110 4.5	135 5.5
250 10.0	100 4.0	125 5.0	150 6.0
300 12.0	100 4.0	125 5.0	150 6.0
350 14.0	100 4.0	125 5.0	150 6.0
400 16.0	100 4.0	125 5.0	150 6.0
450 18.0	100 4.0	125 5.0	150 6.0

NOTE: Insulation thermal conductivity (k-value) is in units of watt per meter-degree K at 93 degrees C Btu-inches/hour-square-feet-degrees F at 200 degrees F mean temperature.

TABLE 2
Minimum Pipe Insulation Thickness (mm) (inches)

For Low Pressure Steam (less than 110 kPa (gage) 16 psig), Condensate Return and Low Temperature Hot Water (less than 120 degrees C 250 degrees F) supply and return piping.

Nominal Pipe Diameter (mm) (inches)	Insulation Thermal Conductivity (k)		
	k less than 0.29	k from 0.29 to 0.40	k greater than 0.40
25 1.0	35 1.5	50 2.0	75 3.0
40 1.5	35 1.5	50 2.0	75 3.0
50 2.0	35 1.5	50 2.0	75 3.0

TABLE 2 Minimum Pipe Insulation Thickness (mm) (inches)			
For Low Pressure Steam (less than 110 kPa (gage) 16 psig), Condensate Return and Low Temperature Hot Water (less than 120 degrees C 250 degrees F) supply and return piping.			
65 2.5	35 1.5	50 2.0	75 3.0
80 3.0	50 2.0	63 2.5	85 3.5
100 4.0	50 2.0	63 2.5	85 3.5
125 5.0	50 2.0	63 2.5	85 3.5
150 6.0	63 2.5	75 3.0	110 4.5
200 8.0	63 2.5	75 3.0	110 4.5
250 10.0	75 3.0	100 4.0	125 5.0
300 12.0	75 3.0	100 4.0	125 5.0
350 14.0	75 3.0	100 4.0	125 5.0
400 16.0	75 3.0	100 4.0	125 5.0
450 18.0	75 3.0	100 4.0	125 5.0
NOTE: Insulation thermal conductivity (k-value) is in units of watt per meter-degree K at 93 degrees C Btu-inches/hour-square-feet-degrees F at 200 degrees F mean temperature.			

2.8.2 Insulation Jackets

2.8.2.1 Nonmetallic Jackets

Provide nonmetallic jacketing consisting of a 200 grams per square meter 6 ounces per square yard fiberglass fabric impregnated with chlorosulfonated polyethylene (Hypalon) and a 0.038 mm 1.5 mil polyvinyl fluoride film (Tedlar) bonded to it. Overall thickness of the composite must be 0.254 mm 0.010 inch and weigh approximately 356 grams per square meter 10.5 ounces per square yard. Jackets may be either field or factory applied to the insulation. Use nonmetallic jackets with molded mineral fiber insulation.

2.8.2.2 Aluminum Jackets

Provide smooth sheet aluminum jackets meeting the requirements of ASTM B209/B209M, Alloys 3003, 3105 or 5005. Provide aluminum jackets that are no less than 0.406 mm 0.016 inch thick and secure with aluminum or Type 304 annealed stainless steel securing bands. Use securing bands that are at least 13 mm 1/2 inch wide for jackets with less than a 500 mm 20 inch circumference and 19 mm 3/4 inch wide for jacket circumferences 500 mm 20 inches and greater. The jacket may, at the option of the Contractor, be provided with a factory fabricated "Pittsburgh" or "Z" type longitudinal joint. When the "Z" joint is used, design the

circumferential joints by the manufacturer to seal the joints and hold the jacket in place. Supply jacket with a factory installed moisture barrier. This moisture barrier must consist of at least 18 kg 40 pound kraft paper coated on 1 side with a 0.025 mm 1 mil polyethylene film. Adhere the moisture barrier to the aluminum jacket over 100 percent of the aluminum jacket surface. Jacket may be either field or factory applied to the insulation. Use aluminum jackets with calcium silicate insulation.

2.8.3 Finishing Materials

2.8.3.1 Wire

Use wire to secure the insulation prior to the installation of the jacket consisting of [soft annealed Type 302, 304 or 316 stainless steel, 1.56 or 1.25 mm 16 or 18 gauge] [soft annealed galvanized, 1.56 mm 16 gauge].

2.8.3.2 Staples

Provide outward clinching type staples [made of monel] [conforming to the requirements of ASTM A240/A240M, Type 304 or 316].

2.8.3.3 Insulating and Finishing Cement

Mineral fiber hydraulic-setting thermal insulating and finishing cement must conform to the requirements of ASTM C449.

2.8.3.4 Glass Tape

Provide glass tape meeting the requirements of UL 723 and ASTM E84. There must be no distortion of the tape when a sample 610 mm 24 inches in length is spread across a flat horizontal surface and observed for evidence of distortion (such as tendency to curl rather than lie flat). The width tolerance is plus or minus 3.175 mm 1/8 inch.

2.8.3.4.1 Plain Weave, Untreated

Properly interlock the ends with the picks to ensure that there is no raveling of the tape edges. It must have an average weight of 196.7 grams per square meter, plus or minus 10 percent 5.8 ounces per square yard, plus or minus 10 percent. An average thickness of 0.1778 mm plus or minus 0.0254 mm 0.007 inches plus or minus 0.001 inches, warp ends/wales of 17 plus or minus 1 per centimeter 42 plus or minus 2 per inch or filling picks/courses of 13 plus or minus 1 per centimeter 32 plus or minus 2 per inch, a minimum breaking strength of 2679 grams per mm 150 pounds per inch of width, and after heating to 482 degrees C 900 degrees F for 2 hours, a minimum breaking strength of 714 grams per mm 40 pounds per inch of width.

2.8.3.4.2 Knitted, Untreated

Properly interlock the wales with the courses to ensure that there is no raveling of the tape edges. It must have an average weight of 153 grams per square meter 4.5 ounces per square yard, plus or minus 10 percent. An average thickness of 0.1778 mm plus or minus 0.0254 mm 0.007 inches plus or minus 0.001 inches, warp ends/wales of 6 plus or minus 1 per centimeter 16 plus or minus 2 per inch. A minimum breaking strength of 714 grams per mm 40 pounds per inch of width, and after heating to 482 degrees C 900 degrees F for 2 hours, a minimum breaking strength of 375 grams per mm 21 pounds per inch of width.

2.8.3.4.3 Open-Weave Type

Use open-weave type tape with an average weight of [1.08][_____] kg per square meter [2][_____] ounce per square yard for embedding between coats of adhesive or coating materials.

2.8.3.5 Glass Cloth

Provide an untreated light weight satin weave glass cloth, woven with an 8-harness satin weave and fabricated from fibrous glass yarn. Make the yarn from low twist continuous filament glass fiber. The maximum average diameter of the glass fibers used for the yarns must not exceed 0.00761 mm 0.000299 inch. Provide cloth meeting the requirements of UL 723 and the following properties:

a. Average weight 302 grams/square meter 8.9 ounces/square yard.

b. Fabric count-warp 56 yarns/25 mm 57 yarns/inch ends.

c. Filling picks 53 yarns/25 mm 54 yarns/inch.

d. Minimum breaking strength:

(1) Warp 3572 grams/mm 200 lb/inch.
(2) Filling 3214 grams/mm 180 lb/inch.

e. After heating to 482 degrees C 900 degrees F for 2 hours:

(1) Warp 1071 grams/mm 60 lb/inch.
(2) Filling 1071 grams/mm 60 lb/inch.

f. Cloth must meet the following tolerances:

(1) Up to and including 1016 mm, tolerance of plus or minus 13 mm 40 inches, tolerance of plus or minus 1/2 inch.

(2) Over 1016 mm and up to 1524 mm, tolerance of plus or minus 19 mm 40 inches and less than 60 inches, tolerance of plus or minus 3/4 inch.

(3) Over 1524 mm, tolerance of plus or minus 25 mm 60 inches, tolerance of plus or minus 1 inch.

g. Furnish the cloth in 45.72 meter, plus or minus 4.572 meter 50 yard, plus or minus 5 yard rolls. The minimum length in a spliced roll must be 3.658 meters 4 yards, and a spliced roll must contain no more than 3 pieces for each 45.72 meter 50 yard length. Open-weave type of [1.08][_____] kilogram per square meter [2][_____] ounce per square yard may be used for embedding between coats of adhesive or coating materials.

2.8.4 Adhesives

2.8.4.1 Mineral Fiber Insulation Cement

Provide cement in accordance with ASTM C195.

2.8.4.2 Contact Adhesive

Contact adhesive may be dispersed in a non-halogenated organic solvent with a low flash point (flash point less than minus 3.9 degrees C 25 degrees F) or, dispersed in a nonflammable organic solvent which must not have a fire point below 93.3 degrees C 200 degrees F. Ensure adhesive does not adversely affect, initially or in service, the insulation to which it is applied, nor cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive must have no objectionable odor and must not contain any benzene or carbon tetrachloride. The dried adhesive must not emit nauseous, irritating, or toxic volatile matter or aerosols when the adhesive is heated to any temperature up to 100 degrees C 212 degrees F. Provide nonflammable, fire resistant adhesive conforming to ASTM E84.

2.8.4.3 Lagging Adhesive

Provide nonflammable, fire-resistant lagging adhesives in accordance with NFPA 90A, UL 723, and ASTM E84. Provide either the Class 1 or Class 2 type adhesives. Use Class 1 adhesives which are pigmented [white] [red] and suitable for: bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; bonding cotton batiste cloth to faced and unfaced fibrous glass insulation board; sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; or bonding lagging cloth to thermal insulation. Use pigmented white Class 2 adhesive suitable for attaching fibrous glass insulation to metal surfaces. Apply lagging adhesives in accordance with the manufacturer's recommendations.

2.9 PIPE SLEEVES

Sleeves in masonry and concrete walls, floors, and roofs must be Schedule 40 galvanized steel pipe conforming to ASTM A53/A53M. Fabricate sleeves in nonmasonry and nonconcrete walls, floors, and ceilings of 0.47 mm 26 gauge galvanized steel.

[2.10 Bellows-Type Joints

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.

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Select bellows-type or slip-type to satisfy specific design conditions. Joints must be flexible, guided expansion joints. Expansion element must be of stainless steel. Provide bellows-type expansion joints in accordance with the applicable requirements of EJMA Stds and ASME B31.1 with internal liners.

2.11 Expansion Joints

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.

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Use expansion joints that provide for either single or double slip of connected pipes, as required or indicated, and for no less than the traverse indicated. Design joints for hot water working pressure no less than [_____] kPa[_____] psig and in accordance with applicable requirements of EJMA Stds and ASME B31.1. Design joints for packing injection under full line pressure. End connections must be flanged or beveled for welding as indicated. Provide joints with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip must be seamless steel plated with a minimum of 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Fabricate joint components from material equivalent to that of the pipeline. Make initial settings in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Install pipe alignment guides as recommended by joint manufacturer, but in any case no more than 1.5 m 5 feet from expansion joint except for lines 100 mm 4 inches or smaller, install guides no more than 600 mm 2 feet from the joint. Provide service outlets where indicated.

2.12 Flexible Ball Joints

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.

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Construct flexible ball joints of alloys as appropriate for the service intended. Where so indicated, design the ball joint for packing injection under full line pressure to contain leakage. Ensure joint ends are threaded (to 50 mm 2 inches only), grooved, flanged or beveled for welding as indicated or required and capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation. Provide balls and sockets of equivalent material as the adjoining pipeline. Ensure exterior spherical

surface of carbon steel balls is plated with 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Design and construct ball type joints in accordance with ASME B31.1 and ASME BPVC SEC VIII D1, where applicable. Provide flanges where required conforming to ASME B16.5. Gaskets and compression seals must be compatible with the service intended.

]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

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

3.2.1 Support Structures

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NOTE: If the referenced specification sections are not to be included in the project specifications, applicable paragraphs from the referenced sections must be incorporated into this specification.
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Support pipes by concrete or steel structures as indicated. Set, plumb and guy structures as required. Stress guy wires until taut. Elevation of the structures must be as indicated on the drawings. Paint structural steel members as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2.2 Piping and Valves

3.2.2.1 Piping

Install the heat distribution system in accordance with ASME B31.1, unless otherwise specified or indicated. Submit [6][_____] copies of operation and [6][_____] copies of maintenance manuals for the equipment furnished; one complete set prior to performance testing and the remainder furnished upon acceptance. Detail in the operation manuals the step-by-step procedures required for equipment startup, operation, and shutdown. Include in the operation manuals the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. List in the maintenance manuals routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include in the maintenance manuals piping and equipment layout and simplified wiring and control diagrams of the equipment as installed. Obtain approval of manuals prior to the field performance testing. Install piping straight and true to bear evenly on supports. Make changes in direction by pipe fittings. Make changes in horizontal steam piping sizes using eccentric reducing fittings to keep bottom of pipe at the same level. Pitch horizontal steam piping, unless otherwise indicated, with a grade of no less than 25 mm in 6 m 1 inch in 20 feet in the direction of flow. Pitch all other piping, unless otherwise indicated, with a grade of no less than 20 mm in 10 m 1 inch in 40 feet toward the drain points. Accurately cut pipe to measurements established at the construction site

and work into place without springing or forcing, properly clearing all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation will not be permitted. Remove burrs from pipe ends by reaming and install to permit free expansion and contraction without damage to joints or hangers. Properly cap or plug open ends of pipe lines and equipment during installation to keep dirt or other foreign matter out of the system.

3.2.2.2 Valves

Install valves with stems horizontal or above. Weld valves, except sizes smaller than 19 mm 3/4 inch may have threaded end connections with a union on one side of the valve.

3.2.3 Joints

3.2.3.1 Welded Joints

Weld joints between sections of pipe and between pipe and fittings, except where threaded fittings are allowed and used. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitations. Where branch outlet fittings are used, they must be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Seal weld threaded joints in high temperature water systems.

3.2.3.2 Threaded Joints

Make threaded joints tight with polytetrafluoroethylene tape applied to the male pipe threads only. Seal weld threaded joints in high temperature water systems.

3.2.4 Branch Connections

Install branch connections from supply and return mains as indicated or as approved. Make connections carefully to ensure unrestricted circulation, eliminate air pockets, and permit the complete drainage of the system.

3.2.5 Pipe Supports

Support horizontal and vertical runs of pipe securely. Support suspended pipe by adjustable pipe hangers having bolted hinged loops and turnbuckles or by other approved devices, conforming to MSS SP-58. Chain or flat steel strap hangers or single point supports will not be accepted. Provide pipe hangers, guides, brackets, supports and anchors as detailed on the drawings. Space pipe supports in accordance with MSS SP-58, Table 3, Column 1. For hangers located on the outside of the insulation, position a preformed, minimum 450 mm 18 inches long, full round, 2 mm 14 gauge, galvanized steel saddle between the hanger and the insulation. Ensure saddle is of sufficient size and thickness to limit the compressive load on the insulation to 228 kPa 33 psi.

3.2.6 Pipe Sleeves

Provide pipe sleeves where piping passes through walls or floor slabs. Secure sleeves in proper position and location during construction. Ensure sleeves are of sufficient length to pass through the entire thickness of walls or floor slabs. Extend sleeves in floor slabs 75 mm 3

inches above the finished floor. The annular space between the exterior of piping or pipe insulation and the interior of the sleeve must be no less than 8 mm 1/4 inch; and pack the space firmly with insulation and caulk both ends of the sleeve with plastic waterproof cement which will cure to a firm but pliable mass.

3.3 INSULATION

3.3.1 General

Install insulation in a manner that prevents damage by pipe expansion or contraction. Groove insulation installed over welds to assure a snug fit. Hold insulation in place with stainless steel straps or wire. Insulate all flanges, unions, valves, and fittings with premolded, prefabricated, or field fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation.

3.3.2 Installation

Except as otherwise specified, install material in accordance with the recommendations of the manufacturer. Do not apply insulation materials until tests specified are completed, foreign material such as rust, scale, or dirt has been removed, and the surfaces are clean and dry. Keep insulation clean and dry at all times.

3.3.3 Wet Insulation

3.3.3.1 Prior to Installation

Dry insulation which has become wet prior to installation thoroughly before proceeding with the installation. After drying, take a representative cross section of the insulation, as determined by the Contracting Officer, and quickly place in an airtight container for a moisture determination. Weigh the sample in the airtight container on an accurate balance or scale, after which open the container and place in an oven at 102 degrees C 215 degrees F until its weight becomes constant. Determine the percentage of water by weight from the initial and final weight of the container and the sample after appropriate corrections are made for the weight of the empty container. The average water content of the sample must not exceed 5 percent by weight. If the average water content of the insulation exceeds 5 percent by weight, replace the insulation with dry insulation.

3.3.3.2 After Installation

Dry insulation which becomes wet during or after installation thoroughly by applying heat through the carrier pipe and allowing the moisture to evaporate to the atmosphere. Check a sample of the insulation for water content in accordance with the guidance in the preceding paragraph. Dry the insulation until it is found to contain an average water content of less than 5 percent by weight. If approved by the Contracting Officer, installed insulation may be removed and dried in accordance with the guidance in the preceding paragraph and after drying, reinstalled.

3.3.4 Covering of Insulation

Cover insulation for pipe, flanges, valves, and fittings with a jacket as specified by one of the following methods.

3.3.4.1 Aluminum Jacket

Do not lap longitudinal and circumferential seams less than 75 mm 3 inches. Secure jackets with bands installed at least every 300 mm 12 inches. Install jackets on horizontal lines so that the longitudinal seams are on the bottom side of the pipe with the seam of each jacket slightly offset from the seam of the adjacent jackets. Place the seams of jackets installed on vertical lines on the off-weather side of the pipe and slightly offset as on horizontal lines. Install jackets on vertical lines and lines pitched from the horizontal from low point to high point so that the lower circumferential edge of each jacket overlaps the upper circumferential edge of the jacket below it. Seal joints with a moisture barrier. Special fitting jackets conforming to the above, with the exception of longitudinal lapping dimensions and location of seams, may be used for fittings, valves, and flanges. Properly overlap and secure jackets for fittings, valves, and flanges. Do not allow jacketing to become electrically coupled to the piping.

3.3.4.2 Nonmetallic Jacket

Match the color of the jacket to the nearest existing piping insulation nonmetallic jacket. However, if no piping exists, the jacket must be gray in color. Overlap the jacket no less than 50 mm 2 inches at longitudinal and circumferential joints, except butt factory applied jacket systems at the circumferential joint; and apply a 75 mm 3 inch matching butt strip furnished by the manufacturer. Ensure the butt strip is at least 50 mm 2 inches longer than the insulation circumference and secured by outward clinching staples (2 located at the beginning of the strip overlap and 2 at the end of the strip overlap). Close the edges of the butt strip with 50 mm 2 inches wide 0.038 mm 1.5 mil polyvinyl fluoride (TEDLAR PVF) pressure sensitive tape made from a similar material and color as the jacket. Overlap longitudinal joints down to shed water and locate at the bottom of the pipe. Staple the overlap on 50 mm 2 inch centers, working from the center toward the ends to eliminate any wrinkles. Apply matching PVF tape (50 mm 2 inches wide for 300 mm 12 inch and less diameter insulation, and 75 mm 3 inches wide for insulation diameters greater than 300 mm 12 inches) to the clean and dry overlap, covering the seam and the staples. Use matching PVF tape to weatherproof the clean and dry circumferential lap between sections. Rub down tape with a plastic squeegee.

3.3.4.3 Flanges, Unions, Valves, Fittings and Accessories

Insulate flanges, unions, valves, fittings and accessories with premolded, prefabricated, or field fabricated segments of insulation. Provide removable and reusable insulation with essentially the same thermal characteristics and thickness as the adjoining piping.

3.4 PIPE GUIDES AND SUPPORTS

Provide pipe supports and alignment guides as indicated or necessary that permit pipe expansion and contraction without damage to the insulation. Design supports, anchors, and guides to permit complete drainage of the system, with rigid steel frames of adequate strength and corrosion resistance for the service, and securely embed in concrete or securely attach to the piping supports. Equip pipe supports with steel bars and cast-iron rollers.

3.5 PIPE EXPANSION

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NOTE: Expansion joints generally will not be used in the design of the piping layout. If no other method is available to handle the expansion problem in a specific location, the design layout using an expansion joint at a specific location must be justified by a design analysis and approved in the planning phase of the piping layout, prior to including expansion joints in the specifications. If expansion joints or ball joints are required, the locations will be indicated on the drawings. Since expansion joints are high maintenance items, these must be located in a readily accessible location.

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Accommodate expansion by loops and bends as indicated on the drawings and as specified. Ensure pipe in the loops and bends accommodate expansion while maintaining required insulation clearance from other pipes; avoid crushing or breaking of insulation. Expansion loops will be designed around obstacles such as structures, or trees to avoid construction conflicts. Maintain slopes of pipe. Contractor will have the option to adjust the loop dimensions around obstacles based on final field measurements, if approved by the Contracting Officer. Submit pipe stress calculations for each revised expansion loop or bend based on the final actual measured lengths, or submit dimensions to the Contracting Officer for verification of loop and bend sizes before proceeding with that segment of work. Ensure allowable pipe stresses are in accordance with ASME B31.1. Submit final expansion loop insulation method for approval to the Contracting Officer.

3.6 TESTS

3.6.1 General

Conduct tests before, during, and after the installation of the system. Provide instruments, equipment, facilities, and labor required to properly conduct the tests. Test pressure gauges for a specific test must be approved by the Contracting Officer and must have dials indicating no less than 1.5 times nor more than 2 times the test pressure. Correct any deficiencies found and retest the system.

3.6.2 Cleaning of Piping

Prior to the hydrostatic and operating tests, clean the interior of the pipe of all foreign material by thorough flushing with clean water. Provide supplementary pumps to circulate the flushing liquid at a velocity between 2 and 3 meters per second 7 and 10 feet per second for a minimum of 4 hours. Install temporary strainers as required. After flushing, drain the flushing liquid out of the piping system and fill the piping system with clean water.

3.6.3 Field Tests

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NOTE: Compressed air will not be used in lieu of the hydrostatic tests of the service piping.

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3.6.3.1 Hydrostatic Tests of Service Piping

Test service piping hydrostatically before insulation is applied at the joints and prove tight at a pressure 1-1/2 times the working pressure or at 1.38 MPa 200 psig, whichever is greater, except do not test high temperature water lines at more than 3.48 MPa 500 psig. Hold hydrostatic test pressures for a minimum of 4 hours. If any failures occur, make such adjustments, repairs or replacements as the Contracting Officer may direct, and repeat the tests until satisfactory installation and operation are achieved.

3.6.3.2 Equipment

Check valves, traps, alarms, controls and other operable items of equipment that are a part of the aboveground heat distribution system to show proper operation. Perform these checks in the presence of the Contracting Officer or his representative.

3.6.3.3 Operational Tests

Perform operational test on the complete system or testable portions thereof. Conduct the test with full design flows and operating temperatures in all runs of piping as if in service, to demonstrate satisfactory function and operating effectiveness. The operational test must have 2 cycles. Each cycle must consist of a 6-hour period with water in the system at the maximum operating temperature and maximum flow rate; and a period of at least 6 hours with no flow rate. For dual temperature systems, the first cycle must use the heating temperature and the second cycle the cooling temperature of the designed system. Supply all items necessary to perform the test including temporary pumps, piping connections, boilers, chillers and the gauges required to circulate the water at the desired temperatures and flow rates. Circulate water through supply lines and return through the return piping to demonstrate that the pressure drop is compatible with the flow rate and size of pipe; and to show that obstructions do not exist in the piping system. Investigate any unusual indicated pressure drop and any remove obstructions. Repair leaks. After obstructions have been removed and leaks repaired, repeat the carrier piping tests.

-- End of Section --