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USACE / NAVFAC / AFCEC / NASA **UFGS-33 60 02 (April 2008)**

Preparing Activity: USACE **Superseding**
UFGS-33 60 02 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 33 60 02

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04/08

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SECTION 33 60 02

ABOVEGROUND HEAT DISTRIBUTION SYSTEM
04/08

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NOTE: This guide specification covers the requirements for insulated aboveground heat distribution system (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).

****

PART 1 GENERAL

****

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; and (10) other pertinent information and details required to clearly show the intent of the aboveground heat distribution system. Also indicate any obstructions in the path of the aboveground heat distribution system the Contractor may have to work around.

****

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

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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

the basic designation only.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS ANSI O5.1	(2017) Wood Poles -- Specifications & Dimensions

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	(2017) 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	(2016) Forged Fittings, Socket-Welding and Threaded
ASME B16.34	(2017) Valves - Flanged, Threaded and Welding End
ASME B31.1	(2020) 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

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA P5	(2015) Standard for Waterborne Preservatives
AWPA U1	(2020) Use Category System: User Specification for Treated Wood

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105/A105M	(2018) 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 A167	(2011) Standard Specification for Stainless and Heat-Resisting

	Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A234/A234M	(2019) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A475	(2003; R 2020) Standard Specification for Zinc-Coated Steel Wire Strand
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B650	(1995; R 2018) 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) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C547	(2019) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2017; E 2018) Standard Specification for Cellular Glass Thermal Insulation
ASTM E84	(2020) 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	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 723	(2018) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials

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, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials and Equipment

SD-03 Product Data

Materials and Equipment; G[, [_____]]

Procedures and Welders

SD-04 Samples

Insulation Systems

SD-10 Operation and Maintenance Data

Distribution System; G[, [_____]]

1.4 QUALITY ASSURANCE

****

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.

****

[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 [_____] 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 shall 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. The proposed layout for the aboveground heat distribution system, including provisions for pipe expansion, pipe anchors and guides, and supports shall be shown 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. Equipment shall be 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, steel pipe, fittings, valves, and piping accessories shall conform to the requirements of ASME B31.1, and shall be suitable for [the indicated pressure and temperature requirements] [_____]. Joints for ferrous piping shall be welded, except that joints 19 mm 3/4 inches and smaller may be threaded. High temperature hot water system threaded joints shall be seal welded. Pipe shall be seamless or electric resistance welded conforming to ASTM A53/A53M or ASTM A106/A106M, Grade B. Steel pipe 40 mm 1-1/2 inches in diameter and smaller shall be seamless conforming to ASTM A106/A106M, Grade B.

2.2.2 Supply Pipe

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

2.2.3 Condensate Return Pipes

Condensate return pipes shall be black steel, Schedule 80 with plain end beveled.

2.2.4 Drip, Vent, Relief, and Gauge Pipe

Drip, vent, relief, and gauge connecting pipe and threaded pipe shall be black steel, Schedule 80.

2.3 FITTINGS

2.3.1 Threaded Fittings

Threaded fittings shall conform to the requirements of ASME B16.11, Pressure Class 3000.

2.3.2 Unions

Unions shall conform to the requirements of MSS SP-83.

2.3.3 Welding Fittings

Welding fittings shall conform to the requirements of ASTM A105/A105M/ or ASTM A234/A234M. Welding fittings shall also conform to ASME B16.9 for buttweld fittings and ASME B16.11 for socket-weld fittings. Long radius buttwelding elbows conforming to ASME B16.9 shall be used whenever space permits.

2.3.4 Pipe Threads

Pipe threads shall conform to ASME B1.20.2MASME B1.20.1. Pipe to be threaded shall be Schedule 80.

2.4 VALVES

2.4.1 General

****

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.

****

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

2.4.2 Bronze Valves

2.4.2.1 Globe, Gate and Angle Valves

Globe, gate and angle valves shall conform to the requirements of MSS SP-80.

2.4.2.2 Check Valves

Check valves shall conform to the requirements of MSS SP-80.

2.4.3 Steel Valves

Steel globe, gate, angle and check valves shall conform 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 shall not contain asbestos. Valve stem packing shall be die-formed, ring type specifically designated as suitable for the temperature and pressure of the service and compatible with the fluid in the system. Packing rings shall be polytetrafluoroethylene with minimum 50 percent graphite filament top and bottom rings. Valves 40 mm 1-1/2 inches and smaller shall have 4 or 5 packing rings, and valves 50 mm 2 inches and larger shall have at least 6 packing rings. Spiral or continuous packing will not be acceptable. A metal insert shall be provided having proper clearance around the valve stem at the bottom of the stuffing box and acting as a base for the packing material. Packing glands shall be furnished with a liner of noncorrosive material and shall be of 1 piece construction with provisions for not less than 2 bolts for packing adjustment.

2.5 STEAM TRAPS

****
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. A means of bypassing the trap shall be provided for system warm-up.
****

2.5.1 General

Class of trap bodies shall be suitable for a working pressure of not less than 1.5 times the steam supply pressure, but not less than 1.38 MPa 200 psi, and traps shall be capable of operation under a steam-supply pressure as indicated. Traps shall have capacities as shown when operating under the specified working conditions. Traps shall fail open.

2.5.2 Bucket Traps

Bucket traps shall be 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.
****

Traps shall be thermostatic type, bimetallic element with automatic air

discharge conforming to ASTM F1139.

2.6 STRAINERS

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NOTE: Delete for high temperature water systems.
****

Basket or Y-type strainer body connections shall be the same size as the pipelines in which the strainers are installed. The strainer bodies for steam systems shall be heavy and durable, of cast steel, with bottoms drilled and plugged. The strainers shall be suitable for the temperature and pressure requirements of the system on which they are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with nipple and gate valve for blowdown. The basket for steam systems shall be not 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 shall be into the basket and out through the perforations. For high temperature hot water systems, only cast steel bodies and stainless or Monel baskets shall be used.

2.7 ABOVEGROUND PIPE SUPPORTS

****
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.
****

2.7.1 Concrete

Concrete used in the formation of poles or foundation for the supports shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.7.2 Steel

****
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.
****

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

2.7.3 Wood Poles and Lumber

Wood poles shall conform to the requirements of ATIS ANSI O5.1, Class 3, treated southern pine, machine trimmed to a smooth surface, free of crooks or sweeps exceeding 10 mm per 1.0 m 1 inch per 10 feet of pole length, and bored, gained and roofed before treatment. Wood poles shall be pressure treated with nonleaching water-borne preservative, ACA or CCA conforming to AWPA P5. Treatment shall be in accordance with AWPA U1. Poles shall be furnished with pole caps. Lumber shall be No. 1 dense stress grade southern pine, pressure treated with nonleaching water-borne preservative, ACA or CCA conforming to AWPA P5. Treatment shall be in accordance with AWPA U1.

2.7.4 Accessories

The following accessories shall be furnished as needed to support the poles and/or to maintain the alignment of the aboveground structure. Materials shall have a hot-dipped galvanized finish.

2.7.4.1 Guy Wires

Guy wires shall conform to the requirements of ASTM A475, extra high strength grade, extra galvanized, stranded with 7 or 19 wires in each strand. Thimbles shall be provided at each end of guy wires.

2.7.4.2 Anchor Rods

Anchor rods shall be 32 mm 1-1/4 inch diameter threaded rod with oval eye.

2.7.4.3 Screw Anchors

Screw anchors shall be 250 mm 10 inch diameter.

2.7.4.4 Turnbuckles

Turnbuckles shall be the open type, forged body, with jaw and jaw end pulls, 10 mm 3/8 inch size and hot-dipped galvanized.

2.7.4.5 Clamps

Clamps shall be forged high carbon steel fitted with galvanized heat treated bolts of best commercial grade. Clamps shall be capable of developing full strength of the guy wire. Two clamps at each connection of the guy wire shall be provided.

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

Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Insulation for piping, fittings, and valves shall be 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. The thickness of insulation used on aboveground piping shall be 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
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
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

Nonmetallic jacketing shall consist 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 shall 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. Nonmetallic jackets shall be used with molded mineral fiber insulation.

2.8.2.2 Aluminum Jackets

Aluminum jackets shall be smooth sheet and shall meet the requirements of ASTM B209M ASTM B209, Alloys 3003, 3105 or 5005. Aluminum jackets shall be not less than 0.406 mm 0.016 inch thick and shall be secured with aluminum or Type 304 annealed stainless steel securing bands. Securing bands shall be 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 "Pittsburg" or "Z" type longitudinal joint. When the "Z" joint is used, the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place. The jacket shall be supplied with a factory installed moisture barrier. This moisture barrier shall consist of at least 18 kg 40 pound kraft paper coated on 1 side with a 0.025 mm 1 mil polyethylene film. The moisture barrier shall be adhered to the aluminum jacket over 100 percent of the aluminum jacket surface. Jacket may be either field or factory applied to the insulation. Aluminum jackets shall be used with calcium silicate insulation.

2.8.3 Finishing Materials

2.8.3.1 Wire

Wire used to secure the insulation prior to the installation of the jacket shall be [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

Staples shall be the outward clinching type [made of monel] [conforming to the requirements of ASTM A167, Type 304 or 316].

2.8.3.3 Insulating and Finishing Cement

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

2.8.3.4 Glass Tape

Glass tape shall meet the requirements of UL 723 and ASTM E84. There shall 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

The ends shall be properly interlocked with the picks to ensure that there is no raveling of the tape edges. It shall 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

The wales shall be properly interlocked with the courses to ensure that there is no raveling of the tape edges. It shall 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

Tape shall be open-weave type and shall have an average weight of [_____] kg per square meter ounce per square yard and shall be used for embedding between coats of adhesive or coating materials.

2.8.3.5 Glass Cloth

Glass cloth shall be an untreated light weight satin weave. It shall be woven with an 8-harness satin weave and shall be fabricated from fibrous glass yarn. The yarn shall be made from low twist continuous filament glass fiber. The maximum average diameter of the glass fibers used for the yarns shall not exceed 0.00761 mm 0.000299 inch. The cloth shall meet 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. Nominal width of the cloth shall be [_____] meters feet with 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. The cloth shall be furnished 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 shall be 3.658 meters 4 yards, and a spliced roll shall contain no more than 3 pieces for each 45.72 meter 50 yard length. Open-weave type of [_____] kilogram per square meter 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

Cement shall be 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 shall not have a fire point below 93.3 degrees C 200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall 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. The adhesive shall be nonflammable, fire resistant conforming to ASTM E84.

2.8.4.3 Lagging Adhesive

Lagging adhesives shall be nonflammable, fire-resistant in accordance with NFPA 90A, UL 723, and ASTM E84. Adhesives shall be either the Class 1 or Class 2 type. Class 1 adhesives shall be pigmented [white] [red] and shall be 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. Class 2 adhesive shall be pigmented white and shall be suitable for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in accordance with the manufacturer's recommendations.

2.9 PIPE SLEEVES

Sleeves in masonry and concrete walls, floors, and roofs shall be Schedule 40 galvanized steel pipe conforming to ASTM A53/A53M. Sleeves in nonmasonry and nonconcrete walls, floors, and ceilings shall be fabricated 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 shall be flexible, guided expansion joints. Expansion element shall be of stainless steel. Bellows-type expansion joints shall be 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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Expansion joints shall provide for either single or double slip of connected pipes, as required or indicated, and for not less than the traverse indicated. Joints shall be designed for hot water working pressure not less than [_____] kPa psig and shall be in accordance with applicable requirements of EJMA Stds and ASME B31.1. Joints shall be designed for packing injection under full line pressure. End connections shall be flanged or beveled for welding as indicated. Joints shall be provided with anchor base where required or indicated. Where adjoining pipe is carbon steel, the sliding slip shall be seamless steel plated with a minimum of 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Joint components shall be fabricated from material equivalent to that of the pipeline. Initial settings shall be made in accordance with manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by joint manufacturer, but in any case shall not be more than 1.5 m 5 feet from expansion joint except for lines 100 mm 4 inches or smaller, guides shall be installed not more than 600 mm 2 feet from the joint. Service outlets shall be provided 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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Flexible ball joints shall be constructed of alloys as appropriate for the service intended. Where so indicated, the ball joint shall be designed for packing injection under full line pressure to contain leakage. Joint ends shall be threaded (to 50 mm 2 inches only), grooved, flanged or beveled for welding as indicated or required and shall be capable of absorbing a minimum of 15-degree angular flex and 360-degree rotation. Balls and sockets shall be of equivalent material as the adjoining pipeline. Exterior spherical surface of carbon steel balls shall be plated with 0.0508 mm 2 mils of hard chrome conforming to ASTM B650. Ball type joints shall be designed and constructed in accordance with ASME B31.1 and ASME BPVC SEC VIII D1, where applicable. Flanges where required shall conform to ASME B16.5. Gaskets and compression seals shall 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 shall 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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Pipes shall be supported by concrete, steel, or wood structures as indicated. Structures shall be set, plumbed and guyed as required. Guy wires shall be stressed until taut. Elevation of the structures shall be as indicated on the drawings. Painting of structural steel members shall be 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. Manuals shall be approved prior to the field performance testing. Piping shall be installed straight and true to bear evenly on supports. Changes in direction shall be made by pipe fittings. Changes in horizontal steam piping sizes shall be made using eccentric reducing fittings to keep bottom of pipe at the same level. Horizontal steam piping, unless otherwise indicated, shall be pitched with a grade of not less than 25 mm in 6 m 1 inch in 20 feet in the direction of flow. All other piping, unless otherwise indicated, shall be pitched with a grade of not less than 20 mm in 10 m 1 inch in 40 feet toward the drain points. Pipe shall be accurately cut to measurements established at the construction site and shall be worked 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. Pipe ends shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints or hangers. Open ends of pipe lines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign matter out of the system.

3.2.2.2 Valves

Valves shall be installed with stems horizontal or above. Valves shall be welded, 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

Joints between sections of pipe and between pipe and fittings shall be welded, 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 shall be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength. Threaded joints in high temperature water systems shall be seal welded.

3.2.3.2 Threaded Joints

Threaded joints shall be made tight with polytetrafluoroethylene tape applied to the male pipe threads only. Threaded joints in high temperature water systems shall be seal welded.

3.2.4 Branch Connections

Branch connections from supply and return mains shall be installed as indicated or as approved. Connections shall be carefully made to ensure unrestricted circulation, eliminate air pockets, and permit the complete drainage of the system.

3.2.5 Pipe Supports

Horizontal and vertical runs of pipe shall be securely supported. Suspended pipe shall be supported 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. Pipe hangers, guides, brackets, supports and anchors shall be as detailed on the drawings. Spacing for the pipe supports shall be in accordance with MSS SP-58, Table 3, Column 1. For hangers located on the outside of the insulation, a preformed, minimum 450 mm 18 inches long, full round, 2 mm 14 gauge, galvanized steel saddle shall be positioned between the hanger and the insulation. The saddle shall be of sufficient size and thickness to limit the compressive load on the insulation to 228 kPa 33 psi.

3.2.6 Pipe Sleeves

Pipe sleeves shall be provided where piping passes through walls or floor slabs. Sleeves shall be secured in proper position and location during construction. Sleeves shall be of sufficient length to pass through the entire thickness of walls or floor slabs. Sleeves in floor slabs shall extend 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 shall be not less than 8 mm 1/4 inch; and the space shall be firmly packed with insulation and both ends of the sleeve shall be caulked 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. Insulation installed over welds shall be grooved to assure a snug fit. Insulation shall be held in place with stainless steel straps or wire. All flanges, unions, valves, and fittings shall be insulated 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, material shall be installed in accordance with the recommendations of the manufacturer. Insulation materials shall not be applied until tests specified are completed, foreign material such as rust, scale, or dirt has been removed, and the surfaces are clean and dry. Insulation shall be kept clean and dry at all times.

3.3.3 Wet Insulation

3.3.3.1 Prior to Installation

Insulation which has become wet prior to installation shall be thoroughly dried before proceeding with the installation. After drying, a representative cross section of the insulation, as determined by the Contracting Officer, shall be taken and quickly placed in an airtight container for a moisture determination. The sample shall be weighed in the airtight container on an accurate balance or scale, after which the container shall be opened and placed in an oven at 102 degrees C 215 degrees F until its weight becomes constant. The percentage of water by weight shall be determined 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 shall not exceed 5 percent by weight. If the average water content of the insulation exceeds 5 percent by weight, the insulation shall be replaced with dry insulation.

3.3.3.2 After Installation

Insulation which becomes wet during or after installation shall be thoroughly dried by applying heat through the carrier pipe and allowing the moisture to evaporate to the atmosphere. A sample of the insulation shall be checked for water content in accordance with the guidance in the preceding paragraph. The insulation shall be dried 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

Insulation for pipe, flanges, valves, and fittings shall be covered with a jacket as specified by one of the following methods.

3.3.4.1 Aluminum Jacket

The longitudinal and circumferential seams shall be lapped not less than 75 mm 3 inches. The jackets shall be secured with bands installed at least every 300 mm 12 inches. Jackets on horizontal lines shall be installed 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. The seams of jackets installed on vertical lines shall be placed on the off-weather side of the pipe and shall be slightly offset as on horizontal lines. The jackets on vertical lines and lines pitched from the horizontal shall be installed 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. Joints shall be sealed 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. Jackets for fittings, valves, and flanges shall be properly overlapped and secured. The jacketing shall not be allowed to become electrically coupled to the piping.

3.3.4.2 Nonmetallic Jacket

The color of the jacket shall match the nearest existing piping insulation nonmetallic jacket. However, if no piping exists, the jacket shall be gray in color. The jacket shall overlap not less than 50 mm 2 inches at longitudinal and circumferential joints, except that factory applied jacket systems shall be butted at the circumferential joint; and a 75 mm 3 inch matching butt strip furnished by the manufacturer shall be applied. The butt strip shall be at least 50 mm 2 inches longer than the insulation circumference and shall be secured by outward clinching staples (2 located at the beginning of the strip overlap and 2 at the end of the strip overlap). The edges of the butt strip shall be closed 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. Longitudinal joints shall be overlapped down to shed water and located at the bottom of the pipe. The overlap shall be stapled on 50 mm 2 inch centers, working

from the center toward the ends to eliminate any wrinkles. 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) shall be applied to the clean and dry overlap, covering the seam and the staples. The matching PVF tape shall be used to weatherproof the clean and dry circumferential lap between sections. Tape shall be rubbed down with a plastic squeegee.

3.3.4.3 Flanges, Unions, Valves, Fittings and Accessories

Flanges, unions, valves, fittings and accessories shall be insulated with premolded, prefabricated, or field fabricated segments of insulation. Insulation shall be removable and reusable and shall have essentially the same thermal characteristics and thickness as the adjoining piping.

3.4 PIPE GUIDES AND SUPPORTS

Pipe supports and alignment guides shall be provided as indicated or necessary and shall permit pipe expansion and contraction without damage to the insulation. The supports, anchors, and guides shall be designed to permit complete drainage of the system, shall have rigid steel frames of adequate strength and corrosion resistance for the service, and shall be securely embedded in concrete or securely attached to the piping supports. Pipe supports shall be equipped 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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Expansion shall be accommodated by loops and bends as indicated on the drawings and as specified. Pipe in the loops and bends shall accommodate expansion while maintaining required insulation clearance from other pipes; crushing or breaking of insulation shall be avoided. Expansion loops may be designed around obstacles such as structures, or trees to avoid construction conflicts. Slopes of pipe shall be maintained. 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. Allowable pipe stresses shall be in accordance with ASME B31.1. Final expansion loop insulation method shall be submitted 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 shall be approved by the Contracting Officer and shall have dials indicating not less than 1.5 times nor more than 2 times the test pressure. Any deficiencies found shall be corrected and the system retested.

3.6.2 Cleaning of Piping

Prior to the hydrostatic and operating tests, the interior of the pipe shall be cleaned of all foreign material by thorough flushing with clean water. Supplementary pumps shall be provided 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. Temporary strainers shall be installed as required. After flushing, the flushing liquid shall be drained out of the piping system and the piping system shall be filled 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

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

3.6.3.2 Equipment

Valves, traps, alarms, controls and other operable items of equipment that are a part of the aboveground heat distribution system shall be checked to show proper operation. These checks shall be performed in the presence of the Contracting Officer or his representative.

3.6.3.3 Operational Tests

Operational test shall be performed on the complete system or testable portions thereof. The test shall be conducted 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 shall have 2 cycles. Each cycle shall 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 shall 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. Water shall be circulated through supply lines and returned 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. Any unusual indicated pressure drop shall be investigated and any obstructions removed. Leaks found shall be repaired. After obstructions have been removed and leaks repaired, the carrier piping tests shall be repeated.

-- End of Section --