

SECTION 33 63 00**STEAM ENERGY DISTRIBUTION****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies materials and procedures for construction of underground steam distribution and condensate return piping system, including manholes, outside the buildings. System shall be: pre-engineered direct-buried drainable-dryable-testable (DDT).

1.2 RELATED WORK

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. Painting exposed steel and other surfaces: Section 09 91 00, PAINTING.
- D. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- E. Erosion and Sediment Controls: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 DEFINITIONS

- A. System: The complete underground steam and condensate distribution system including all components such as carrier piping, pipe supports, insulation, protective enclosures, anchors, corrosion protection and accessories.
- B. Pre-Engineered Direct-Buried System: The factory-fabricated system.
- C. Drainable-Dryable-Testable (DDT) Pre-Engineered Direct-Buried System: A factory-fabricated system.
- D. Carrier Pipe (also called Service Pipe): Pipe carrying the steam or condensate.
- E. Encasement Pipe (also called Casing or Conduit): Outer protective pipe on any main line pipe. Carrier pipe and insulation are within the casing.
- F. HP Systems: High-pressure piping operating at more than 15 psi (104 kPa) as required by ASME B31.1.
- G. LP Systems: Low-pressure piping operating at 15 psi (104 kPa) or less as required by ASME B31.9.

1.4 ABBREVIATIONS

- A. HDPE: high-density polyethylene
- B. WOG: water, oil and gas

1.5 DELIVERY, STORAGE AND HANDLING

- A. The Contractor is solely responsible for the protection of equipment and material against damage. Protect piping systems against the entry of water, mud or other foreign substances by installing watertight covers on open ends at all times. Protect direct-buried system coatings from ultraviolet light (sunlight). Existing equipment worked on by the Contractor or in the Contractor's working area shall be considered to be in the custody and responsibility of the Contractor.
- B. All insulated piping systems exposed to water must be replaced prior to installation.

1.6 COORDINATION

- A. Coordinate exterior steam lines and connections to building services up to the actual extent of building wall.

1.7 QUALITY ASSURANCE:

- A. Products Criteria:
1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Contractor shall restore damaged items to as-new operating condition or replace damaged items as directed by the Contracting Officer's Representative, at no additional cost to the Government.
- C. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with provisions in ASME B31.9, Building Services Piping.
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. ASME Compliance: Comply with ASME B31.9, Building Services Piping, for materials, products, and installation.
- E. ASME Compliance: Safety valves and pressure vessels shall bear appropriate ASME labels.

1.8 SUBMITTALS

A. Manufacturers' Literature and Data shall be submitted, as one package, for pipes, fittings and appurtenances, including jointing materials, insulation, hangers and other miscellaneous items.

1.9 APPLICABLE PUBLICATIONS

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

B. Federal Specifications (Fed. Spec.):

A-A-60005 NOT 1.....Frames, Covers, Grating, Steps, Sump and Catch Basin, Manhole

L-S-125.....Screening, Insect, Nonmetallic

C. Military Specifications (Mil. Spec.):

MIL-S-901.....Shock Tests H.I. (High Impact) Shipboard Machinery, Equipment and Systems

D. American Society for Testing and Materials (ASTM):

A36/A36M-08.....Carbon Structural Steel

A47/A47M-99(2009).....Ferritic Malleable Iron Castings

A53/A53M-10.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A105/A105M-10a.....Carbon Steel Forgings for Piping Applications

A106/A106M-10.....Seamless Carbon Steel Pipe for High-Temperature Service

A126-04(2009).....Gray Iron Castings for Valves, Flanges, and Pipe Fittings

A139/A139M-04(2010).....Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

A167-99(2009).....Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

A193/A193M-10a.....Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

A194/A194M-10a.....Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A197/A197M-00(2006)Cupola Malleable Iron

A234/A234M-10b.....Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

A240/A240M-10b.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A307-10.....Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

A666-10.....Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

A733-03(2009).....Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

B61-08.....Steam or Valve Bronze Castings

C177-10.....Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C411-05.....Hot-Surface Performance of High-Temperature Thermal Insulation

C449-07.....Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

C450-08.....Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging

C533-09.....Calcium Silicate Block and Pipe Thermal Insulation

C547-07.....Mineral Fiber Pipe Insulation

C552-07.....Cellular Glass Thermal Insulation

C585-10.....Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing

C591-09.....Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation

C655-09.....Reinforced Concrete D-Load Culvert, Storm
Drain, and Sewer Pipe

C920-10.....Elastomeric Joint Sealants

C1126-10a.....Faced or Unfaced Rigid Cellular Phenolic
Thermal Insulation

C1136-10.....Flexible, Low Permeance Vapor Retarders for
Thermal Insulation

D2996-01(2007).....Filament-Wound Fiberglass (Glass-Fiber-
Reinforced Thermosetting-Resin) Pipe

D4024-05.....Machine Made Fiberglass (Glass-Fiber-Reinforced
Thermosetting Resin) Flanges

E84-10b.....Surface Burning Characteristics of Building
Materials

E. American Society of Mechanical Engineers (ASME):

B1.20.1-2006.....Pipe Threads, General Purpose (Inch)

B16.3-2006.....Malleable Iron Threaded Fittings: Classes 150
and 300

B16.4-2006.....Gray Iron Threaded Fittings: (Classes 125 and
250)

B16-5-2009.....Pipe Flanges and Flanged Fittings: NPS 1/2
through NPS 24 Metric/Inch Standard

B16.9-2007.....Factory-Made Wrought Buttwelding Fittings

B16.11-2009.....Forged Fittings, Socket-Welding and Threaded

B16.21-2005.....Nonmetallic Flat Gaskets for Pipe Flanges

B18.2.1-2010.....Square, Hex, Heavy Hex, and Askew Head Bolts
and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch
Series)

B31.1-2010.....Power Piping

B31.9-2008.....Building Services Piping

B40.1000-2009.....Pressure Gauges and Gauge Attachments

F. American Welding Society (AWS):

B2.1-B2.1M-BMG-2009.....Base Metal Grouping for Welding Procedures and Performance Qualification

D10.12/D10.12M-2000.....Guide for welding Mild Steel Pipe

G. American Association of State Highway and Transportation Officials (AASHTO):

M300-03.....Inorganic Zinc-Rich Primer

H. Manufacturer's Standardization Society (MSS):

MSS SP 58.....Pipe Hangers and Supports-Materials, Design, Manufacture, Selection, Application and Installation

1.10 WARRANTY

A. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting there from within a period of two years from final acceptance. Further, the Contractor will provide all manufacturer's and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 STEEL PIPES AND FITTINGS

A. Steel Pipe: ASTM A53, Type E, Grade A, wall thickness as indicated in "Piping Application" Article; black with plain ends.

B. Cast-Iron, Threaded Fittings: ASME B16.4, Class 125 and Class 250, standard pattern.

C. Malleable-Iron, Threaded Fittings: ASME B16.3, Class 150 and Class 300.

D. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

- 1. Material Group: 1.1.
- 2. End Connections: Butt welding.
- 3. Facings: Raised face.

E. Steel Welding Fittings: ASME B16.9, seamless or welded.

- 1. Welding Filler Metals shall comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Nipples: ASTM A733, Standard Weight, seamless, carbon-steel pipe.

G. Pipe-Flange Gasket Materials: ASME B16.21, suitable for chemical and thermal conditions of piping system contents, nonmetallic, flat, asbestos free, 1/8 inch (3.2 mm) maximum thickness unless thickness or specific material is indicated.

1. For flat-face, Class 125, cast-iron and cast-bronze flanges.
2. For raised-face, Class 250, cast-iron and steel flanges.

H. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.2 PRE-ENGINEERED, FACTORY-FABRICATED, DIRECT-BURIED, DRAINABLE-DRYABLE-TESTABLE (DDT) SYSTEMS

A. Complete steam and condensate piping system with carrier pipe, carrier pipe insulation with banding, air space, steel casing, fiberglass casing cladding, and accessories. Do not locate condensate pipes in casings (conduits) that contain steam pipes.

B. All components of system shall be suitable for carrier pipe pressures and temperatures as follows:

1. Steam System: 150 psi (1000 kPa); 366 deg F (185 deg C).
2. Condensate System: 50 psi (345 kPa); 310 deg F (154 deg C).

C. Steam Carrier Pipes and Condensate Carrier Pipes:

1. No piping joints are allowed in factory-fabricated straight sections of pre-engineered direct-buried systems.
2. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected.

D. Carrier Pipe Insulation shall:

1. Conform to minimum thickness and type of insulation listed in Tables 1 and 2 below as required for service temperature in carrier pipe as listed below.
2. All Sections: Steam temperature is 340 deg F (171 deg C), steam pressure is 100 psi (690 kPa). Pumped condensate temperature is 300 deg F (93 deg C). Drip return temperature is 212 deg F (100 deg C).
3. Allowable Carrier Pipe Insulation Type and Minimum Insulation Thickness:

TABLE 1 Minimum Pipe Insulation Thickness mm (inches) For Steam 16 to 408 psi (110 to 2800 kPa) gage			
Nominal Pipe Diameter Inches (mm)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp

1 (25)	2 (50)	2-1/2 (65)	4 (100)
1-1/2 (40)	2 (50)	2-1/2 (65)	4 (100)
2 (50)	2-1/2 (65)	3-1/2 (85)	4-1/2 (110)
2-1/2 (65)	2-1/2 (65)	3-1/2 (85))	4-1/2 (110)
3 (80)	3 (75)	4 (100)	5 (125)
4 (100)	3 (75)	4 (100)	5 (125)
5 (125)	3 (75)	4 (100)	5 (125)
6 (150)	3-1/2 (85)	4-1/2 (110)	5-1/2 (135)
8 (200)	3-1/2 (85)	4-1/2 (110)	5-1/2 (135)
10 (250)	4 (100)	5 (125)	6 (150)
12 (300)	4 (100)	5 (125)	6 (150)
14 (350)	4 (100)	5 (125)	6 (150)
16 (400)	4 (100)	5 (125)	6 (150)
18 (450)	4 (100)	5 (125)	6 (150)

Notes: Insulation listed has passed the 96-hour boiling water test.

Pipes smaller than 1 inch (25 mm) shall have same insulation thickness as 1 inch (25 mm) pipe.

TABLE 2 Minimum Pipe Insulation Thickness inches (mm) For Steam Less than 16 psi (110) gage, Condensate Return			
Nominal Pipe Diameter inches (mm)	Nominal Pipe Diameter inches (mm)	Nominal Pipe Diameter inches (mm)	Nominal Pipe Diameter inches (mm)
1 (25)	1-1/2 (40)	2 (50)	3 (75)
1-1/2 (40)	1-1/2 (40)	2 (50)	3 (75)
2 (50)	1-1/2 (40)	2 (50)	3 (75)
2-1/2 (65)	1-1/2 (40)	2 (50)	3 (75)
3 (80)	2 (50)	2-1/2 (65)	3-1/2 (85)
4 (100)	2 (50)	2-1/2 (65)	3-1/2 (85)
5 (125)	2 (50)	2-1/2 (65)	3-1/2 (85)
6 (150)	2-1/2 (65)	3 (80)	4-1/2 (110)
8 (200)	2-1/2 (65)	3 (80)	4-1/2 (110)
10 (250)	3 (80)	4 (100)	5 (125)
12 (300)	3 (80)	4 (100)	5 (125)
14 (350)	3 (80)	4 (100)	5 (125)
16 (400)	3 (80)	4 (100)	5 (125)
18 (450)	3 (80)	4 (100)	5 (125)

Notes: Insulation listed has passed the 96-hour boiling water test

which indicates that satisfactory performance in underground service can be expected. Pipes smaller than 1 inch (25 mm) shall have the same insulation thickness as required for 1 inch (25 mm) pipe.

E. Insulation Banding: ASTM A167, 304 stainless steel bands and clips, at least 0.5 inches (13 mm) wide, maximum spacing 18 inches (460 mm). A minimum of two bands is required for each 4 foot (1300 mm) section of insulation.

F. Casing: ASTM A139, smooth-wall steel, electric resistance welded, minimum thickness of 10 gauge (3.42 mm). Plastic casings are not permitted. Use

eccentric connectors as necessary between casing sections to provide continuous gravity drainage in bottom of casing between manholes and between manholes and buildings.

- G. Casing End Seal Plates with Vents and Drains: ASTM A36, steel, minimum thickness 0.375 inches (9.5 mm) for casings up thru 12 inches (300 mm) diameter and 0.5 inches (13 mm) for casings over 12 inches (300 mm) diameter. Provide 1 inch (25 mm) drain at the bottom and vent at the top. Construct with threaded steel half couplings. Install threaded brass plugs in drains.
- H. Vent Riser Pipes: ASTM A53, Schedule 40, galvanized, extending through top of manhole and terminate 12 inches (300 mm) above grade with 180-degree bend.
- I. Gland Seals are not permitted because of the possibility of water entering the system through the gland seal from a flooded manhole.
- J. Provide continuous 1 inch (25 mm) minimum air space between carrier pipe insulation and casing.
- K. Casing Cladding: Filament wound fiberglass reinforced plastic, minimum 100 mil (2.5 mm) thickness, designed to withstand 35,000 volt dielectric testing. Factory-inspect for holidays and make repairs as necessary.
- L. Coating of end plates and casing (conduit) sections extending in manholes shall be zinc-rich coating that conforms to AASHTO M300, Type IA except that volatile organic compounds shall not exceed 2.8 pounds per gallon (0.34 kg per liter). The zinc rich coating shall be applied in accordance with the recommendations of the coating manufacturer including surface preparation. No additional top coat shall be applied.
- M. Carrier pipe guides and supports shall be maximum spacing 10 feet (3000 mm) on centers, no more than 5 feet (1500 mm) from pipe ends, minimum of three guides per elbow section. Designed to permit thermal expansion without damage, provide proper pipe guiding and support, and to allow horizontal movement in two directions as necessary at expansion loops and bends. Design of guides and supports must permit continuous drainage of water in bottom of casing. Pipe insulation shall extend through the pipe guides and supports and be protected by steel sleeves. Design of guides and supports shall be such that no metal-to-metal contact exists between the casing and the carrier pipe. Insulation or non-metallic material used to ensure no metal to metal contact shall be

designed to not be compressed by the weight of the carrier pipe when full of water.

- N. Anchor plates shall be ASTM A36 steel, welded to carrier pipe and casing, 0.5 inches (13 mm) minimum thickness, passages for air flow and water drainage through the annular air space in the system. Coated with same cladding material as the casing. Locate 3 to 5 feet (900 to 1500 mm) from piping entrance to manhole or building wall. Walls of manholes and buildings cannot be utilized as anchor points.
- O. Field connection of casing sections shall be steel section conforming to casing specification, welded to casing sections, coated on all surfaces with system manufacturer's cladding field repair compound, and covered with a 0.05 inch (1.3 mm) minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 176 deg F (80 deg C).
- P. Manhole and building wall penetrations shall provide steel leak plates welded to wall sleeves or to casings. Where a wall sleeve is utilized, allow sufficient annular space between the sleeve and the casing and install a watertight seal, rated for 250 deg F (121 deg C) minimum. Manhole and building walls cannot be used as anchor points.
- Q. Provide embossed brass or stainless steel tag hung by a brass or stainless steel chain at each end of each conduit or insulated piping in the manholes and buildings. The tag shall identify system manufacturer's name, date of installation, government contract, and manufacturer's project number.
- R. All branch piping connections must be located in manholes.

2.3 MANHOLES

- A. Reinforced concrete manholes: Not less than 8 inches (200 mm) thick. Pour monolithically where possible. Place waterproof membrane between mud slab and bottom concrete slab, and continue up sides to top of sidewalls. Joints between manhole walls and conduit casings or concrete trench sections shall be watertight. Steel manholes or prefabricated concrete manholes are not permitted.
- B. Accessories for Manholes: Cast iron manhole frames and solid covers, not less than 28 inch (700 mm) clear openings. Unless otherwise shown on the drawings, frames and covers shall be as follows:
 - 1. For non traffic applications:
 - a. Fed Spec. A-A-60005 NOT1, Frame Type IV, Size 28

- b. Fed Spec. A-A-60005 NOT1, Cover Type E, Size 28, cast identification "STEAM".
- 2. For traffic applications:
 - a. Fed Spec. A-A-60005 NOT1, Frame Type I, Style A, Size 27A
 - b. Fed Spec. A-A-60005 NOT1, Cover Type A, Size 27A, cast identification "STEAM".
- 3. Manhole steps shall be standard, cast iron.
- C. Drainage as shown on drawings. Provide a 24 inch (610 mm) square by 24 inch (610 mm) deep sump pit in each manhole where indicated on drawings. Provide larger sump pit if necessary to accommodate required electric sump pumps.
- D. Electric Sump Pumps with Automatic Controls and High Water Alarm:
 - 1. Type: High temperature submersible duplex pumps and automatic controls.
 - 2. Service: Continuous operation at required flows and pressures while completely submerged at 200 deg F (93 deg C). All pumps and pump controls shall have demonstrated 200,000 cycles of operation at 200 deg F (93 deg C) and 100% relative humidity while totally submerged in water.
 - 3. Capacity and pressure: Pumps shall be capable of passing 0.375 inch (10 mm) spheres. Pumps and motors shall be capable of operating continuously without damage when not submerged.
 - 4. Pumps: Epoxy-coated cast iron casing, cast iron impeller, stainless steel shaft, carbon/ceramic shaft seal, stainless steel hardware, permanently lubricated bearings, screened inlets. Schedule 80 discharge pipe protected from corrosion.
 - 5. Motors: Non-overloading at all points on the pump performance curve. Include overload protection.
 - 6. Controls: Automatic alternating lead-lag, with damp-proof electrical service.
 - 7. High water alarm switch: Set at level below lowest steam or condensate pipe in the manhole. Provide contacts and connect to engineering control center.

2.4 STEAM CARRIER PIPING

- A. Pipe: ASTM A53, steel, seamless or ERW, Grade B or ASTM A106, Grade B, seamless, Schedule 40. Standard weight permitted for pipe sizes 12 inches (300 mm) and above. Grade F, furnace butt-welded pipe, is not permitted.

B. Joints:

1. In trenches and direct-buried systems: Butt-weld; socket weld for pipe sizes 2 inches (DN 50) and below. No joints are allowed in factory-fabricated straight sections of pre-engineered direct-buried systems. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected. All radiographs shall be reviewed and interpreted by an American Society for Non-Destructive Testing (ASNT) Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. Dye penetrant testing may be utilized for pipe sizes 2 inches (50 mm) and below.
2. In manholes and open areas: Butt weld pipe sizes 2-1/2 inches (65 mm) and above; thread or socket weld pipe sized 2 inches (50 mm) and below.

C. Fittings:

1. Butt welded joints: ASTM A234 or ASME B16.9, steel, Grade B, same schedule as adjoining pipe. All elbows shall be long radius unless otherwise indicated. Tees shall be full size or reducing as required, having interior surfaces smoothly contoured.
2. Threaded joints: ASTM A47 or ASTM A197 or ASME B16.3, malleable iron, 300 pound (2050 kPa) class.
3. Socket welded joints: ASME B16.11, forged steel, 2000 psi (13,800 kPa) class.

D. Flanges and bolts: // ASME B16.5, weld neck, forged steel // or // ASTM A105, pressure class 150 psi (1025 kPa) // . Bolts shall be high strength ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

E. Unions: Pipe 2 inches (50 mm) and smaller shall be threaded, malleable iron or steel, 300 psi (2050 kPa) class.

2.5 STEAM CONDENSATE CARRIER PIPING

A. Pipe: ASTM A53, seamless or ERW, Grade B or ASTM A106, Grade B, seamless; Schedule 80. Grade F, furnace butt-welded, pipe is not permitted.

B. Joints:

1. In Trenches and direct-buried systems: Butt weld joints. Socket weld is required for pipe sizes 2 inches (50 mm) and below. No joints are allowed in factory-fabricated straight sections of pre-engineered direct-buried systems. Factory-fabricated direct-buried piping systems that are a portion of expansion loops or bends shall have all welded joints 100% radiograph inspected. All radiographs shall

be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. Dye penetrant testing may be utilized for pipe sizes 2 inches (50 mm) and below.

2. In manholes and open areas: Butt weld pipe sizes 2-1/2 inches (65 mm) and above; thread or socket weld pipe sizes 2 inches (50 mm) and below.

C. Fittings:

1. Welded joints: ASTM A234, steel, Grade B, or ASME B16.9, same schedule as adjoining pipe.
2. Threaded joints: ASTM A47 or A197, malleable iron, or ASME B16.3, 300 psi (2050 kPa) class.
3. Socket welded joints: ASME B16.11, forged steel, 2000 psi (13,800 kPa) class.

D. Unions (Except in Trenches) are allowed on piping 2 inches (50 mm) and under, 300 psi (2050 kPa) malleable iron or steel.

E. Flanges: Weld neck ASME B16.5 or ASTM A105, forged steel, 150 psi (1025 kPa).

2.6 EXPANSION LOOPS AND BENDS

A. Stresses: Less than the maximum allowable stress in the Power Piping Code (ASME B31.1). Submit shop drawings and stress and anchor force calculations for all loops and bends. Show locations of all anchors, guides and supports. Base calculations on 150 psi (1000 kPa) and 366 deg F (185 deg C) for steam line loops and bends and 50 psi (345 kPa) and 310 deg F (154 deg C) for condensate return line loops and bends. Base calculations on actual pressures and temperatures if they are higher than those listed above.

2.7 VALVES

A. Gate Valves (ASTM A126):

1. Type 101 shall have:
 - a. Cast steel body, rated 150 psi (1025 kPa) at 500 deg F (260 deg C), 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 150 psi (1025 kPa) flanged ends, OS&Y, rising stem, bolted bonnet.
 - b. Factory installed globe valved bypass on all steam valves larger than 3 inches (80 mm).
 - c. Drill and tap bosses for connection of drains where shown.
2. Type 102 is not used.

3. Type 103 shall have:

- a. Cast iron body, Class B, rated for 125 psi (850 kPa) saturated steam, 200 psi (1375 kPa) WOG, bronze or bronze faced wedge and seats, 125 psi (850 kPa) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

4. Type 104 shall have:

- a. Bronze body, rated for 200 psi (1375 kPa) saturated steam, 400 psi (2750 kPa) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.

5. Type 105 is not used.

6. Type 106 shall have:

- a. Forged steel body, rated for 300 psi (2050 kPa) at 420 deg F (216 deg C) minimum Class 600 psi (4130 kPa) or Class 800 psi (5500 kPa), hardened stainless steel or satellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.

B. Globe Valves (ASTM A126):

1. Type 201 shall have:

- a. Cast steel body, rated 150 psi (1025 kPa) at 500 deg F (260 deg C), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 150 psi (1025 kPa) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains.

2. Type 202 is not used.

3. Type 203:

- a. Cast iron body, rated for 125 psi (850 kPa) saturated steam, 200 psi (1375 kPa) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 125 psi (850 kPa) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

4. Type 204:

- a. ASTM B61, bronze body, rated for 200 psi (1375 kPa) saturated steam, 400 psi (2750 kPa) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.

C. Check valves (ASTM A126):

1. Type 401 shall have:

- a. Cast steel body, swing-type, rated for 150 psi (1025 kPa) at 500 deg F (260 deg C), stainless steel or stainless steel - faced

disc and seat, 150 psi (1025 kPa) ASME flanged ends, bolted cover, renewable disc.

2. Type 402 is not used.

3. Type 403 shall have:

a. Cast iron body, Class B, swing-type, rated for 125 psi (850 kPa) saturated steam, 200 psi (1375 kPa) WOG, bronze or bronze-faced disc and seat, 125 psi (850 kPa) ASME flanged ends, bolted cover, renewable disc and seat.

4. Type 404 shall have:

a. Bronze body, swing-type, rated for 200 psi (1375 kPa) saturated steam, 400 psi (2750 kPa) WOG, bronze disc, threaded ends, regrinding disc.

D. Ball valves (ASTM A126):

1. Type 501 is not used.

2. Type 502 shall have:

a. Bronze body, rated for 150 psi (1025 kPa) at 365 deg F (185 deg C), 250 psi (1725 kPa) at 250 deg F (121 deg C); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, one-fourth turn to open.

3. Type 503 is not used.

4. Type 504 shall have:

a. Carbon steel or ductile iron body, saturated steam service, rated for 150 psi (1030 kPa), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, 150 psi (1025 kPa) ASME flanged ends. Manufacturer: American, Worcester, or equal.

E. Butterfly valves (ASTM A126):

1. Type 601 shall have:

a. Ductile iron body, wafer style, rated for 125 psi (850 kPa), 212 deg F (100 deg C), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, geared handwheel operator for valves 4 inch (100 mm) pipe size and larger, ratchet handle operator for smaller pipe sizes.

2. Type 602:

a. Triple-offset, lug or flanged type, carbon steel body, steam service, rated for 150 psi (1025 kPa) at 500 deg F (260 deg C), stainless steel nitrided disc, stellite seat, stainless steel shaft, stainless steel/graphite-laminated seal ring, neck

extending beyond pipe insulation, geared handwheel operator for valves 4 inch (100 mm) pipe size and larger, ratchet handle operator for smaller pipe size valves.

F. Valve Applications (Steam Lines):

1. Gate valves, 2 inches (50 mm) and under: Type 106.
2. Gate valves, 2-1/2 inches (65 mm) and above: Type 101.
3. Globe valves, 2 inches (50 mm) and under: Type 204.
4. Globe valves, 2-1/2 inches (65 mm) and above: Type 201.
5. Check valves, 2 inches (50 mm) and under: Type 404.
6. Check valves, 2-1/2 inches (65 mm) and above: Type 401.
7. Ball valves, 2 inches (50 mm) and under: Type 502
8. Ball valves, 2-1/2 inches (65 mm) and above: Type 504.
9. Butterfly valves, all sizes: Type 602.

G. Valve Applications (Condensate Lines):

1. Gate valves, 2 inches (50 mm) and under: Type 104.
2. Gate valves, 2-1/2 inches (65 mm) and above: Type 103.
3. Globe valves, 2 inches (50 mm) and under: Type 204.
4. Globe valves, 2-1/2 inches (65 mm) and above:
5. Type 203. Check valves, 2 inches (50 mm) and under: Type 404.
6. Check valves, 2-1/2 inches (65 mm) and above: Type 403.
7. Ball valves, 2 inches (50 mm) and under: Type 502.
8. Ball valves, 2-1/2 inches (65 mm) and above: Type 504.
9. Butterfly valves, all sizes: Type 601.

2.8 STEAM TRAPS

- A. Apply at steam line drip points.
- B. Construct inverted bucket type with thermostatic vent in bucket, except closed-float-thermostatic on discharge side of pressure reducing stations. Each type furnished by a single manufacturer. Select the traps for pressures and capacities as shown or required. Fixed orifice or venturi type traps are not permitted.
- C. Traps: Cast iron or stainless steel bodies. Construction shall permit ease of removal and servicing working parts without disturbing connecting piping. Include stainless steel floats, hardened chrome steel valves, stainless steel mechanisms and bi-metallic air vent on inverted bucket traps.
- D. All traps shall include ports for future installation of monitoring devices. To facilitate future removal of plugs, remove plugs, install Teflon tape on the threads, and reinstall the plugs.

2.9 STRAINERS, Y TYPE

- A. Provide as shown on steam and condensate piping systems.
- B. Include open end removable cylindrical screen and threaded blow off connection.
- C. For steam service up to 150 psi (1025 kPa) and at drip traps, strainer shall be rated for minimum 150 psi (1025 kPa) saturated steam; rated for 150 psi (1025 kPa), flanged ends, cast steel, for pipe sizes above 2 inches (50 mm). Use cast iron or bronze, rated for 250 psi (1725 kPa) saturated steam, threaded ends, for pipe sizes 2 inches (50 mm) and under.
- D. For condensate service, strainer shall be rated for 125 psi (850 kPa) saturated steam, 175 psi (1200 kPa) WOG. Provide 125 psi (850 kPa), flanged ends, cast iron, for pipe sizes above 2 inches (50 mm). Provide cast iron or bronze, threaded ends, for pipe sizes 2 inches (50 mm) and under.
- E. Strainer screen shall be stainless steel, with a free area not less than 2 1/2 times flow area of pipe. Diameter of openings shall be 0.05 inch (1.3 mm) or less on steam service and 0.06 inch (1.5 mm) or less on water service.
- F. Include drain valve on all blowoff connections.

2.10 PIPE HANGERS AND SUPPORTS

- A. Requirements: MSS SP 58 and ASME B31.1.
- B. Applies to all piping not in factory-fabricated direct-buried system. All systems shall be completely supported. Arrange supports so that all loads due to weight, thermal expansion, and pressure are transferred from the support system to the structure. The design and location of supports shall at all times prevent excessive forces, moments, and stresses from being imposed on the equipment, structure, supported system, and supports. Heated systems generally require resilient or roller/slide supports.
- C. Manufacturer Certification: Factory built products of a manufacturer whose principle business is pipe supports for 10 years. All components must have published load ratings. For concrete trenches, non-factory built products that comply with details may be utilized.
- D. Drawings:
 - 1. Types, sizes, locations, and spacing of all hangers and supports.
 - 2. Roller or slider supports for all horizontal steam and condensate piping.

3. Special supports including anchors, guides and braces.
 4. If equipment and piping arrangement differs from that shown on the drawings, support locations and types shall be revised at no cost to the government.
 5. Supports to permit removal of valves and strainers from pipelines without disturbing supports.
 6. Roller hangers and sliding supports on all systems subject to horizontal movement.
 7. If vertical angle of hanger rod exceeds four degrees, rollers or sliders are required.
 8. Loads for all supports. On systems utilizing variable spring supports; show the loads at each support by calculating the forces and moments throughout the system.
 9. Vertical deflection: Shall not exceed 0.1 inch (2.5 mm) between supports when system is filled with fluid normally carried.
 10. Individual drawing for each hanger assembly showing all components, sizes, calculated loadings. Provide identification tags, on each hanger part, keyed to the layout drawings.
- E. Components:
1. Roller supports: MSS SP 58, Type 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
- F. Clevis supports: MSS SP 58, Type 1.
- G. Wall brackets: MSS SP 58, Type 31, 32, or 33.
- H. Pipe stands: MSS SP 58, Type 38.
- I. Riser clamp: MSS SP 58, Type 42.
- J. Alignment guides: Welded steel as shown to restrain movement perpendicular to the long axis of the piping. If not welded, provide steel spider clamped to pipe, enclosed within steel sleeve that is bolted or welded to structural support. Must provide lateral force equal to minimum of 15 percent of anchor loading.
- K. Trapeze supports: MSS SP 58, may be used where pipes are close together and parallel, structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with "U" bolts.
- L. Pipe covering protection saddles: MSS SP 58, Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamp is provided.

- M. Sliding supports: MSS SP 58, Type 35. Welded steel attachments to pipe and structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.
- N. Pipe racks and miscellaneous supports: ASTM A36, structural steel shapes. Manufactured strut systems are acceptable if they have the required load carrying ability.
- O. Supports, including all structural steel, in trenches and manholes: Hot-dip galvanized.

2.11 INSULATION

- A. Calcium Silicate Insulation:
 - 1. Preformed piping insulation: ASTM C533, Type I.
 - 2. Blocks: ASTM C533, Type I.
 - 3. Fitting Insulation: Same as for straight pipe, segmented, gored, and mitered to completely cover fitting, and giving a smooth and neat finished appearance.
- B. Rigid closed cell phenolic foam: ASTM C1126, Type III, Grade 1, 250 deg F (121 deg C).
- C. Cellular glass insulation: ASTM C552.
- D. Insulating and finishing cements: ASTM C449, as recommended by the manufacturer for the type of insulation system and service conditions.
- E. Insulation bands: ASTM A167, minimum of 1/2 inch (12 mm) wide by 0.015 inch (0.4 mm) thick stainless steel.
- F. Aluminum jackets: Minimum of 0.016 inch (0.4 mm) thick aluminum, 3003 alloy, H-14 temper, with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory fabricated to match material and construction of the straight run jackets. Factory fabricated stainless steel bands shall be furnished and installed on all circumferential joints. Bands shall be 0.75 inch (20 mm) wide on 18 inch (450 mm) centers. Bands shall be applied with manufacturers recommended sealant. Entire system shall be watertight.
- G. Pipe covering protection saddles: MSS SP 58, Type 39 at all hanger points except where Type 3 pipe clamps are provided.

2.12 BURIED UTILITY WARNING TAPE

- A. Tape: 0.004 inch (0.1 mm) thick, 6 inches (150 mm) wide, yellow polyethylene with a ferrous metallic core, acid and alkali-resistant and shall have a minimum strength of 1750 psi (12,000 kPa) lengthwise and 1500 psi (10,300 kPa) crosswise with an elongation factor of 350

percent. Provide bold black letters on the tape identifying the type of system. Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material.

PART 3 - EXECUTION

3.1 GENERAL

- A. Connect new work to existing work in a neat and workmanlike manner. Where an existing structure must be cut or existing utilities interfere, such obstruction shall be bypassed, removed, replaced or relocated, patched and repaired. Piping connections shall be made only in manholes or buildings.
- B. Coordinate the location of all items of equipment and work of all trades. Maintain operability and maintainability of the equipment and systems. The contractor at his cost shall perform any relocation of equipment or systems to comply with the requirement of operability and maintainability.
- C. Unless otherwise shown on drawings, steam lines shall be graded downward not less than 2 inches in 40 feet (50 mm in 12 meters) in direction of the flow. Provide eccentric reducing fittings on steam mains and branches, (except on vertical piping). Install said fittings to maintain continuity of grade in bottom of pipeline. Provide risers with drip pockets and steam traps on steam lines where space restrictions prevent continuous grading. All steam traps must be located in manholes or buildings.

3.2 DEMOLITION

- A. Perform work in accordance with requirements for phasing and the Drawings.
- B. Completely remove all pipe, valves, fittings, insulation, and all hangers including the connection to the structure and any fastenings.
- C. Seal all openings in manhole or building walls after removal of piping.
- D. All material and equipment removed shall become the property of the Contractor and shall be removed from Government property and shall not be stored in operating areas.
- E. All flame cutting shall be performed with adequate fire protection facilities available as required by safety codes and Contracting Officer's Representative.

3.3 PIPING APPLICATION

- A. HP Steam Piping (including carrier pipe in pre-engineered, direct-bury, DDT system):
 - 1. NPS 2 (DN 50) and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
 - 2. NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40 , Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- B. Condensate Piping (including carrier pipe in pre-engineered, direct-bury, DDT system):
 - 1. NPS 2 (DN 50) and smaller: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
 - 2. NPS 2-1/2 (DN 65) and larger: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.4 PIPING INSTALLATION

- A. Drawings indicate general location and arrangement of piping systems.
Install piping insulation as indicated.
- B. Standing water in the bottom of trench: Remove all water.
- C. Pipe Bedding: Minimum 6 inch (150 mm) layer of sand.
- D. Clearance: Minimum 6 inch (150 mm) clearance between the pipes.
- E. Testing: Do not insulate piping or backfill piping trench until field quality-control testing has been completed and results approved.
- F. Grade:
 - 1. Install condensate piping at uniform grade of 0.4 percent downward in direction of flow.
 - 2. Install steam piping at uniform grade of 0.2 percent downward in direction of flow or as indicated on the Drawings.
- G. Drain Valves and Air Vents: In conduits, install at low points and air vents at high points.
- H. Install components with pressure rating equal to or greater than system operating pressure.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Secure anchors with concrete thrust blocks.
- L. Connect to steam and condensate piping where it passes through the building wall.

3.5 DRAIN VALVES AND VENT VALVES

- A. Provide 1-1/2 inch (40 mm) minimum pipe size drain valves on condensate return carrier pipes at all low points in manholes. Provide 1 inch (25 mm) minimum air vent valves in manholes at all high points in condensate return carrier piping.

3.6 PIPE SUPPORT INSTALLATION (IN TRENCHES AND MANHOLES)

- A. Coordinate support locations prior to erection of piping. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site during construction.
- B. Upper Attachments to Structure:
1. New reinforced concrete construction shall have concrete inserts.
 2. For existing reinforced concrete construction, upper attachment shall be welded or clamped to steel clip angles (or other construction shown on the drawings) that are expansion bolted to the concrete. Expansion bolting shall be located so that loads place bolts in shear.
 3. For steel deck and structural framing, upper attachments shall be welded or clamped to structural steel members.
- C. In existing concrete construction, expansion fasteners may be used for hanger loads up to one third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.
- D. Special Supports:
1. Secure horizontal pipes where necessary to prevent vibration or excess sway.
 2. Where hangers cannot be adequately secured as specified, make special provisions for hanging and supporting pipe as approved by the Contracting Officer's Representative.
 3. Do not attach pipe supports, hangers, clamps or anchors to equipment unless specified for that equipment or unless the Contracting Officer's Representative gives written permission.
- G. Minimum Clearances in Trenches and Manholes:
1. Floor to bottom of pipe support beam: 2 inches (50 mm)
 2. Floor to bottom of pipe insulation jacket: 6 inches (150 mm)
 3. Wall to side of pipe insulation jacket: 3 inches (75 mm)

4. Ceiling to top of pipe insulation jacket: 1 inch (25 mm)

3.7 PAINTING EXPOSED STEEL SURFACES IN MANHOLES

- A. Provide surface cleaning and preparation, apply primer and finish coat of zinc-rich paint.

3.8 DIRECT-BURIED SYSTEM INSTALLATION

- A. The Contractor shall oversee the delivery, storage, installation and testing of the system as per manufacturer's recommendations. All work shall be in strict accordance with the requirements specified by the manufacturer. Printed instructions must be available on site prior to delivery of system components. Any changes required to the design and layout of the system due to site conditions must be approved in writing by the Contracting Officer's Representative. All branch piping connections, valves and drip traps must be located within manholes.
- B. Excavation, Trenching, and Backfilling: Perform all excavation, trenching, and backfilling as required by the system manufacturer's design. Beach sand or any sand with large amounts of chlorides is not permitted. Place system on a 6 inch (150 mm) thick sand bed and backfill on all sides with 6 inch (150 mm) thick sand as measured from outside the carrier pipe/insulation. Foundation for system must be firm and stable. Foundation and backfill must be free from rocks. Concrete anchor and thrust blocks must be installed in undisturbed earth. Backfilling must not commence until elevations have been surveyed and accepted and system has been satisfactorily pressure tested including hydrostatic testing of carrier pipes and air testing of casings.
- C. Maintain constant slope of carrier pipes as shown or specified. Prior to backfilling over the top of the casing, but after removal of temporary supports, Contractor shall measure and record elevations of top of casing in the trench. Elevations shall be taken at every field joint, 1/3 points along each pipe section, and at tops of elbows. These measurements shall be checked against contract drawings and shall confirm that the conduit system has been installed to the elevations shown on the contract drawings unless approved by the Contracting Officer's Representative. Slope shall be uniform within 0.1 percent. Measurements shall be recorded by the Contractor, included in the direct buried system manufacturer representative's daily report, and given to the Contracting Officer's Representative prior to covering the top of the casing with backfill.

- D. Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, or fittings.
- E. Sections of system that have been fully or partially submerged in water must be replaced. Moisture content of insulation during installation shall not exceed five percent by weight.
- F. At each casing termination (end plate) in buildings and manholes, plug the casing drain openings with brass plugs and extend 1 inch pipe size galvanized vent pipes (ASTM A53) from the casing vents through the tops of the manholes or 1 foot (300 mm) above the conduit in buildings. Terminate the outside vents in 180-degree bends.
- G. Provide reports to the Contracting Officer's Representative that include:
1. Daily written report: Prepared daily and signed by the Contractor. Submit the original report to the Contracting Officer's Representative on the same day it is prepared. Provide one set of field pictures of work daily.
 2. Report Contents: State whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the manufacturer's recommendations, changes to drawings and specifications, any corrective action that was taken of the system, identify any conditions that could result in an unsatisfactory installation.
 3. Report Certification: Daily reports are to be reviewed, signed and sealed by the Professional Engineer responsible for the system installation.
 4. Report Submittals and Stop Order: Daily reports shall be submitted with the payment requests. All work must stop if daily reports are not furnished and requests for payments shall be denied if the daily reports are not furnished.
 5. Certification of Compliance: Upon completion of the work and 30 days prior to final acceptance, deliver to Contracting Officer's Representative a notarized Certificate of Compliance signed by principal officers of Contractor, stating that the installation is satisfactory and in accordance with plans, specifications, and manufacturer's instructions.
 6. The Contractor shall retain copies of all the daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.

H. Sections of system that have been fully or partially submerged in water must be replaced. Moisture content of insulation during installation shall not exceed five percent by weight.

3.9 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded joints: ASME B1.20.1, tapered pipe threads. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Joints made with oil and graphite pipe joint compound shall have compound applied to male threads only.
 2. Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 3. Pipe threads shall be cut to give proper engagement in threaded fittings. Clean pipe and fittings before installation and ream pipe after cutting threads. Threaded pipe shall have clean-cut threads; dull or damaged pipe dies shall not be used.
- D. Construct welded joints: AWS D10.12, using qualified processes and welding operators according to "Quality Assurance" Article. Branch connections shall be made with either welding tees or welding outlet fittings. Welding outlet fittings shall be forged, integrally reinforced to provide 100 percent pipe strength, beveled for full penetration welding and funneled at inlet for full fluid flow.
- E. Flanged joints: Select gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.
- F. All pipe intersections and changes in direction shall be made with factory-built, reinforced fittings. Field-fabricated fittings and miters are not permitted.

3.10 INSTALLATION - VALVES

- A. Do not locate valve stems below the horizontal centerline of the pipe.
- B. Locate valves to permit access for operation, maintenance, and replacement.
- C. Provide 3/4 inch (19 mm) globe-valved warm-up bypasses at all steam gate and butterfly valves 3 inch (80 mm) pipe size and larger.
- D. Provide 3/4 inch (19 mm) gate or ball-valved drains at each side of steam gate and butterfly valves where condensate could collect, due to the slope of the pipeline, when the main valve is shut.

3.11 THERMAL INSULATION

- A. Steam, condensate and drip return piping, other than in pre-engineered direct buried systems, shall be insulated as follows:
1. Piping in concrete trenches and manholes: Insulated with calcium silicate, fiberglass, or cellular glass pipe insulation, and aluminum jacket.
 2. Minimum Insulation Thickness: Insulation thicknesses given in Table 5 and 6 are minimum nominal thickness.

TABLE 5				
Minimum Pipe Insulation Thickness inches (mm)				
For Steam 16 to 250 psi (110 to 1724 kPa) gage				
Nominal Pipe Diameter inches (mm)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp	Foamglas
1 (25)	2 (50)	2-1/2 (63)	4 (100)	4-1/2 (110)
1-1/2 (40)	2 (50)	2-1/2 (63)	4 (100)	4-1/2 (110)
2 (50)	2-1/2 (63)	3-1/2 (85)	4-1/2 (110)	5 (125)
2-1/2 (65)	2-1/2 (63)	3-1/2 (85)	4-1/2 (110)	5 (125)
3 (80)	3 (75)	4 (100)	5 (125)	6 (150)
4 (100)	3 (75)	4 (100)	5 (125)	6 (150)
5 (125)	3 (75)	4 (100)	5 (125)	6 (150)
6 (150)	3-1/2 (85)	4-1/2 (110)	5-1/2 (135)	6 (150)
8 (200)	6 (150)	3-1/2 (85)	5-1/2 (135)	6 (150)
10 (250)	4 (100)	5 (125)	6 (150)	6-1/2 (165)
12 (300)	4 (100)	5 (125)	6 (150)	6-1/2 (165)
14 (350)	4 (100)	5 (125)	6 (150)	6-1/2 (165)
16 (400)	4 (100)	5 (125)	6 (150)	6-1/2 (165)
18 (450)	4 (100)	5 (125)	6 (150)	6-1/2 (165)

TABLE 6				
Minimum Pipe Insulation Thickness inches (mm)				
For Steam less than 16 psi (110 kPa) gage, Condensate Return				
Nominal Pipe Diameter inches (mm)	MPT-PC MPT-PF	Delta	Foamglas Thermo- 12 Super Caltemp	Insul-phen
1 (25) and under	1-1/2 (35)	2 (50)	3 (75)	1 (25)
1-1/2 (40)	1-1/2 (35)	2 (50)	3 (75)	1 (25)
2 (50)	1-1/2 (35)	2 (50)	3 (75)	1 (25)
2-1/2 (65)	1-1/2 (35)	2 (50)	3 (75)	1 (25)
3 (80)	2 (50)	2-1/2 (63)	3-1/2 (85)	1 (25)
4 (100)	2 (50)	2-1/2 (63)	3-1/2 (85)	1-1/2 (38)
5 (125)	2 (50)	2-1/2 (63)	3-1/2 (85)	1-1/2 (38)
6 (150)	2-1/2 (63)	3 (76)	4-1/2 (110)	1-1/2 (38)
8 (200)	2-1/2 (63)	3 (76)	4-1/2 (110)	1-1/2 (38)

Parts not to be insulated are:

- a. Threaded valves
 - b. Steam traps
 - c. Check valves
 - d. Unions
 - e. Threaded strainers
 - f. Strainer basket removal cover and bolting
 - g. Dielectric flanges and unions
 - h. Flexible connectors
3. Installation of insulation:
- a. Pressure Tests: Complete all pressure tests before installing.
 - b. Insulation material: New, clean, dry and stored in a clean dry environment; jacketing materials to be clean and unmarred; store adhesives in original containers. Materials shall not have exceeded the predicted shelf life as set by manufacturer.
 - c. Identify all materials incorporated in the job on manufacturer's container by name, type and description.
 - d. Apply materials on clean, dry surfaces from which all dirt, loose scale, construction debris has been removed by wire brushing.
 - e. The installation shall be neat, thermally and structurally tight without sag, neatly finished at all hanger or other penetrations and shall provide a smooth finished surface primed as required to receive specified painting.

- f. Do not use scrap insulation. Repair any work damaged by welding, burning, compressing due to concentrated construction loads.
- g. Apply pipe covering protection saddles, MSS SP 58, Type 39, at all hanger points. Fill space between saddle and piping with high density insulation, thoroughly packed. Terminate jacket clear of saddle bearing area.
- h. Insulation and jacket shall terminate hard and tight at all anchor points.
- i. Insulation termination at piping facilities not to be insulated shall stop short, and be finished with 45 degree chamfered section of insulating and finishing cement, and covered with jacket.
- j. Flanged fittings and valves shall be insulated with sections of pipe insulation cut, fitted and arranged neatly, and firmly wired in place. Insulating cement shall fill all cracks, voids and outer surface. Insulation of valve bonnet shall terminate on valve side of bonnet flange to permit valve repair.
- k. On calcium silicate, cellular glass and rigid cellular phenolic insulated piping systems, fittings shall be insulated with field or factory-shaped sections of insulation, finished with specified insulating and finishing cements and covered with jacket. On sizes 2 inches (50 mm) and smaller it is permissible to apply insulating and finishing cements, and cover with jacket.

3.12 WELDING (ASME B31.1 AND AWA B2.1-B)

- A. The Contractor is entirely responsible for the quality of the welding and shall:
 - 1. Conduct tests of the welding procedures used on the project, verify the suitability of the procedures used, verify that the welds made will meet the required tests, and also verify that the welding operators have the ability to make sound welds under standard conditions.
 - 2. Perform all welding operations required for construction and installation of the distribution system.
- B. Welder Qualifications: All welders shall be qualified as per ASME B31.1 and AWS B2.1-B2.1M-BMG.
- C. Field bevels and shop bevels: Done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be

thoroughly cleaned of scale and oxidation just prior to welding.
Conform to specified standards.

- D. Utilize split welding rings or approved alternate method for field joints on all carrier pipes above 2 inches (50 mm) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe. Make field joints 2 inches (50 mm) and smaller with welding sockets.
- E. Piping shall not be split, bent, flattened, or otherwise damaged either before, during, or after installation. Where the pipe temperature falls to 32 deg F (0 deg C) or lower, the pipe shall be heated to approximately 100 deg F (38 deg C) for a distance of 1 foot (300 mm) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 32 deg F (0 deg C).
- F. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be requalified.
- G. Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.
- H. An approved independent testing firm regularly engaged in radiographic testing shall perform radiographic examination of all field welds in the carrier piping of the systems, in manholes, in accordance with ASME B31.1. Furnish a set of films or pictures showing each weld inspected, a report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project, prior to installing conduit field joints, trench covers, backfilling and hydrostatic testing. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. The Contracting Officer's Representative reserves the right to review all inspection records, and if any welds inspected are found unacceptable they shall be removed, rewelded, and radiographically reexamined at no cost to the Government.

3.13 CLEANING OF PIPING:

- A. Clean pipe and fittings inside and outside before and after assembly. Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, equipment or fittings.

3.14 IDENTIFICATION

- A. Install continuous plastic underground warning tapes during back filling of trenches for underground steam and condensate distribution piping. Locate tapes 12 inches (300 mm) below finished grade, directly over piping.

3.15 IDENTIFICATION SIGNS

- A. Valves: Provide laminated plastic signs, with engraved lettering not less than 3/16 inch (5 mm) high, on all isolating valves on steam and condensate return system, identifying building or area served. Attach to the valves with corrosion-resistant chains.
- B. Pipes: Label service of all pipes in manholes.

3.16 FIELD QUALITY CONTROL

- A. Demonstrate leak-tightness of all piping systems by performing hydrostatic and operational tests. All labor, material and test instruments must be furnished by the Contractor. All instruments must be approved by the Contracting Officer's Representative.
- B. Pressure test direct-buried systems in conformance with requirements stated in this specification and in printed instructions for the system supplied. Tests must include carrier piping and casing.
- C. Holiday testing of direct-buried system steel casings: Test entire surface of casings for faults in cladding after installation in trench prior to backfilling. Use test method and voltage recommended by cladding manufacturer. Repair any holidays found and retest. System shall not be backfilled until all holidays are eliminated.
- D. Before conducting steam system operating test, remove steam trap elements or use bypass connections around traps; then flush lines with high pressure water until discharge shows no foreign matter to the satisfaction of Contracting Officer's Representative.
- E. Steam and condensate carrier piping shall be tested hydrostatically before insulation is applied at field joints and shall be proved tight at a pressure 1 1/2 times distribution supply pressure for a period not less than 2 hours with no pressure decay.
 - 1. Test piping located in concrete trenches prior to installing trench covers. Test direct-buried systems prior to backfilling.
 - 2. Remove or isolate any elements of the system such as expansion joints, which are not designed for the test pressure.
 - 3. Prior to acceptance of installation, Contractor shall subject system to operating tests as may be required by Contracting Officer's

Representative to demonstrate satisfactory functional and operating efficiency. These operating tests shall cover a period of not less than six hours for each portion of system tested. Conduct tests at times as the Contracting Officer's Representative may direct.

4. Provide calibrated instruments, equipment, facilities and labor, at no additional cost to the Government. Test gage shall read in increments not exceeding 0.1 psi (1 kPa).
5. Repeat tests when failures occur.
6. After completion of satisfactory test, replace all elements that have been removed prior to testing.

F. Pneumatic Testing of DDT System Casings:

1. Perform test on all sections of the system before field-coating the field joints and before back-filling.
2. Test shall be with compressed air at 15 psi (100 kPa) for 24 hours with pressure source disconnected and with no decay in pressure. Corrections to the readings are permissible to compensate for significant ambient temperature changes during the test period.
3. Pressure shall be measured with a gage with reading increments of 0.1 psi (1 kPa).
4. Each casing field joint shall be tested for leaks by means of soap solution or equivalent.

G. Deficiencies discovered shall be corrected at the Contractor's expense, to satisfaction of Contracting Officer's Representative. Major deficiencies or failure to correct deficiencies, to the satisfaction of the Contracting Officer's Representative, may be considered cause for rejecting the entire installation.

H. Contractor will engage a qualified testing agency to perform tests and inspections.

I. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations for the system.

J. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

K. Tests and Inspections:

1. Steam and condensate piping for testing: ASME B31.1 and ASME B31.9 and as follows:

- a. Leave joints, including welds, uninsulated and exposed for examination during test.
 - b. Isolate equipment. Do not subject equipment to test pressure.
 - c. Install relief valve set at pressure no more than one-third higher than test pressure.
 - d. Fill system with temperature water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
 - e. Use vents installed at high points to release trapped air while filling system. Use drip legs installed at low points for complete removal of liquid.
2. Test steam and condensate piping as follows:
- a. Subject steam and condensate piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
 - b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
- L. Prepare test and inspection reports.

---- E N D ---