

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 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. General piping, protection of Materials and Equipment, and quality assurance: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- D. 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: Pipe carrying the steam or condensate.
- E. Encasement Pipe: 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. RTRP: reinforced thermosetting resin plastic
- B. RTRF: reinforced thermosetting resin fittings

C. 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 COR, at no additional cost to the Government.

C. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

D. 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 ASME B31.1, Power Piping.

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. ASME Compliance: Comply with ASME B31.9, Building Services Piping, ASME B31.1, Power Piping, for materials, products, and installation.

F. 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, hangars 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
- I. NACE International (NACE):
- SP0169-2007.....Control of External Corrosion on Underground or
Submerged Metallic Piping Systems
- J. National Fire Protection Agency (NFPA):
- 255-2006 Ed.....Test Burning Characteristics of Building
Materials

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. Steam Pipe: Schedule 40, ASTM A106 Grade B seamless carbon steel, conforming to ANSI B31.1 with wall thickness as indicated in "Piping Application" Article; black with plain ends.
- B. Condensate Pipe: Schedule 80, ASTM A106 Grade B seamless carbon steel, conforming to ANSI B31.1
- C. Steam Outer Conduit:
1. The steel conduit casing shall be smooth wall, 10 gauge, welded steel conduit. Changes in casing size, as required at oversized casing to allow for carrier pipe expansion, shall be accomplished by eccentric and/or concentric fittings and shall provide for continuous drainage.
 2. All casing welds, including elbows, anchors, tees and end seals shall be factory air tested at 5 psig to assure conduit tightness prior to insulating. Air test records will be verified by the QA Department and Air test reports shall be included in the Quality Assurance Bill of Lading upon shipment and shall be turned over to the COR by the Contractor or Factory Service Technician
 3. The exterior steel conduit surface shall be abrasive blast - cleaned to a minimum of a near white surface, SSPC-SP10-63T. Profile must be a minimum of 1.5 mil peak to valley range. Any areas of rust bloom or oil shall be wiped and re-blasted.
 4. After blasting, the steel conduit shall be coated with (Zinc). The zinc coating shall be a high solids inorganic coating that protects the steel galvanically, thus eliminating sub-film corrosion. The zinc coating shall be a two part spray coating consisting of a liquid base portion and a dry powdered metal. The two components when mixed

together can be spray applied. The dry film thickness shall be in a range of 2 to 4 mil.

- D. Steam pipe and fittings shall be standard weight. Condensate pipe and fittings shall be Schedule 80, ASTM A106 Grade B seamless carbon steel.
- E. Pipe shall be plain end for sizes 2" and smaller, beveled for sizes 2 ½" and larger.
- F. Fittings shall be socket-welded for sizes 2" and smaller, butt-welded for sizes 2 ½" and larger.
- G. Where possible, straight sections shall be supplied in 40 foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.
- H. All elbows shall be long radius.
- I. Piping shall be preinsulated and fabricated at the factory. All fittings shall have factory fabricated straight legs extending on all sides. Straight legs shall be a minimum of thirty (30) inches long. Factory service pipe (benders) may be utilized for the service pipe.
- J. All steam pipe conduit fittings shall require a factory air test of the conduit after construction. Air test reports shall be included in the Quality Assurance Bill of Lading upon shipment and shall be turned over to the COR by the Contractor.
- K. All fittings shall be coated, insulated and FRP jacketed in accordance with the Coating, Insulation and Jacketing section of these specifications.

2.2 FIBERGLASS PIPE AND FITTINGS

- A. RTRP: ASTM D2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.
- B. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.
- C. Fiberglass Pipe Adhesive: Furnished or as recommended by the pipe manufacturer.
- D. Flanges: ASTM D4024, full-face gaskets suitable for the service, minimum 1/8 inch (3.2 mm) thick, 60-70 durometer. ASTM A307, Grade B, hex-head bolts with washers.

2.3 CONDUIT PIPING SYSTEM

- A. Conduit Piping System: Factory-fabricated and assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe

supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.

B. Carrier Pipe Insulation:

1. Polyurethane Foam Pipe Insulation: Un-faced, preformed, rigid cellular polyurethane material intended for use as thermal insulation.

a. Comply with ASTM C591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.

b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E84.

c. Fabricated shapes: ASTM C450 and ASTM C585.

d. Shall be spray applied polyurethane foam, having a nominal 2 lb/ft³ density for all straight lengths and fittings. The insulation thickness shall be 1 inch maximum. Quality assurance procedures for the insulation shall include either a visual check prior to jacketing, an infrared inspection or an x-ray inspection of the entire length to insure there are no insulation voids. The urethane foam shall have the minimum characteristics of 0.16 K-factor, density of 2 lb/ft³, closed cell content of 90 to 95% and compression strength of 40 psi.

e. The polyurethane foam insulation shall be tested by the manufacturer for mechanical and thermal properties to assure compliance with the above values. All test samples will be taken from production material, identified, tagged and tested in accordance with the table below. Test reports showing results will be furnished to the engineer for approval. Data supplied by the polyurethane foam chemical supplier is not acceptable.

C. Minimum Clearance:

1. Between Carrier Pipe Insulation and Conduit: 1 inch (25 mm)
2. Between Insulation of Multiple Carrier Pipes: 3/16 inch (4.75 mm)
3. Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch (25 mm)
4. Between Bottom of Bare, Carrier Pipe and Casing: 1-3/8 inches (35 mm)

D. Conduit shall be spiral wound, steel.

1. Finish: Two coats of fusion-bonded epoxy, minimum 20 mils (0.50 mm) thick.
2. Cover: The outer jacket shall be fiberglass (FRP) and shall be applied directly onto the urethane foam insulation. Approved FRP jackets shall be filament wound and chop spray up directly applied fiberglass reinforced plastic. No PVC or HDPE (polyethylene jackets) shall be allowed. All straights and fittings shall be (FRP) factory jacketed.
3. Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet (3 m). These supports shall be designed to allow for continuous airflow and drainage of the conduit in place. The straight supports shall be designed to occupy not more than 10% of the annular air space. Supports shall be of the type where insulation thermally isolates the carrier pipe from the outer conduit. The surface of the insulation shall be protected at the support by a sleeve not less than 12 inches long, fitted with traverse and, where required, rotational arresters.
4. Fittings: Factory-fabricated and insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with the carrier pipe.
5. Expansion Offsets and Loops: Size casing to contain piping expansion.
6. Accessories include the following:
 - a. Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches (75 mm) deep and 2 inches (50 mm) larger than casing; terminate casing 20 inches (500 mm) above the floor level.
 - b. Guides and Anchors: Steel plate welded to carrier pipes and to casing, complete with vent and drainage openings inside casing.
 - c. End Seals: Steel plate welded to carrier pipes and to casing, complete with drain and vent openings on vertical centerline.
 - d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of casing, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.

e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.

E. Source Quality Control: Factory test the conduit to 15 psi (105 kPa) for a minimum of two minutes with no change in pressure. Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

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

A. Complete steam and condensate piping system with carrier pipes, carrier pipe insulation with jackets and banding, air space, 0.25 inch (6.35 mm) thick steel casing, fusion-bonded epoxy casing coatings, cathodic protection, 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. Steam temperature is 307 deg F, steam pressure is 60 psi. Pumped condensate temperature is 300 deg F (93 deg C). Drip return temperature is 212 deg F (100 deg C).

E. Service pipe insulation may be one of two types: Pyrogel XT or Cellular Glas. Insulation shall be held in place by stainless steel bands installed not more than 18 inches apart. The insulation shall be applied to a thickness determined by Heat Transfer Calculations, conduit temperatures of 200°F or less and FRP jacket temperatures of 100° F or less.

1. Insulation Thermal Conductivity C 518 Once per shift < 0.16 Btu-in/hr/ft²/°F
 2. Insulation test reports shall be included in the Quality Assurance Bill of Lading upon shipment and shall be turned over to the COR by the Contractor or Factory Service Technician.
- F. Insulation Banding and Jacket: ASTM A167, stainless steel bands and clips, at least 0.5 inches (13 mm) wide, (304 stainless steel), maximum spacing 18 inches (460 mm). A minimum of two bands is required for each 4 foot (1300 mm) section of insulation.
- G. Vinyl-coated fiberglass scrim jacket: Fed. Spec. L-S-125, Type II, Class 2, with 18 x 16 mesh (number of filaments per inch) and made of 0.013 inches (0.335 mm) diameter vinyl-coated fibrous glass yarn. Install bands over the jacket to secure the insulation to the carrier pipe.
- H. Casing: ASTM A139, smooth-wall steel, electric resistance welded. 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.

Casing Diameter in. (mm)	Minimum Thickness in. (mm)
6 - 46 (150 - 1170)	0.250 (6.35)

- I. 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.
- J. 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.
- K. Gland Seals are not permitted because of the possibility of water entering the system thru the gland seal from a flooded manhole.
- L. Provide continuous 1 inch (25 mm) minimum air space between carrier pipe insulation and casing.
- M. Casing coating shall be dual layers of fusion-bonded epoxy, inner green-colored layer minimum thickness 0.020 inches (0.5 mm), outer black-colored layer minimum thickness 0.010 inches (0.25 mm). Rated by coating

manufacturer for continuous service for at least 25 years at minimum temperature of 230 deg F (110 deg C) and having a coefficient of expansion similar to that of steel. Coating shall be applied in accordance to recommendations of coating manufacturer including surface preparation. Factory-inspect for holidays and make repairs as necessary.

- N. 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.
- O. 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 thru 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.
- P. 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 thru the annular air space in the system. Coated with same coating 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.
- Q. 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 coating 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).
- R. 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. Building walls cannot be used as anchor points.

- S. 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.

2.5 STEAM CARRIER PIPING

- A. Pipe: Schedule 40, ASTM A106 Grade B seamless carbon steel, conforming to ANSI B31.1. Standard weight permitted for pipe sizes 12 inches (300 mm) and above. Grade F, furnace butt-welded pipe, is not permitted.

B. Joints:

1. Direct-buried systems: 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 a 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.

C. Fittings:

1. Piping shall be preinsulated and fabricated at the factory. All fittings shall have factory fabricated straight legs extending on all sides. Straight legs shall be a minimum of thirty (30) inches long. Factory service pipe (benders) may be utilized for the service pipe.
2. All steam pipe conduit fittings shall require a factory air test of the conduit after construction. Air test reports shall be included in the Quality Assurance Bill of Lading upon shipment and shall be turned over to the COR by the Contractor.
3. All fittings shall be coated, insulated and FRP jacketed in accordance with the Coating, Insulation and Jacketing section of these specifications.

2.6 SERVICE (STEAM) PIPE COATING

- A. The exterior steel pipe surface shall be abrasive blast - cleaned to a minimum of a near white surface, SSPC-SP10-63T. Profile must be a minimum of 1.5 mil peak to valley range. Any areas of rust bloom or oil shall be wiped and re-blasted.
- B. After blasting, the steel service pipe shall be coated with (Zinc). The Zinc coating shall be a high solids inorganic coating that protects the steel galvanically, thus eliminating sub-film corrosion. The zinc coating shall be a two part spray coating consisting of a liquid base portion and a dry powdered metal. The two components when mixed together can be spray applied.
- C. The dry film thickness shall be a range of 2 to 4 mil.

2.7 STEAM CONDENSATE CARRIER PIPING

- A. Pipe: Condensate Pipe: Schedule 80, ASTM A106 Grade B seamless carbon steel, conforms to ANSI B31.1. Grade F, furnace butt-welded, pipe is not permitted.
- B. Joints:
 - 1. Direct-buried systems: 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.
- C. Fittings:
 - 1. Piping shall be preinsulated and fabricated at the factory. All fittings shall have factory fabricated straight legs extending on all sides. Straight legs shall be a minimum of thirty (30) inches long. Factory service pipe (benders) may be utilized for the service pipe.
 - 2. All steam pipe conduit fittings shall require a factory air test of the conduit after construction. Air test reports shall be included in the Quality Assurance Bill of Lading upon shipment and shall be turned over to the COR by the Contractor.

3. All fittings shall be coated, insulated and FRP jacketed in accordance with the Coating, Insulation and Jacketing section of these specifications.

2.8 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.
- B. Low pressure steam systems 15 psi (100 kPa) and less: ASME B31.9, base calculations for steam and condensate on 15 psi (100 kPa) and 250 deg F (121 deg C).

2.9 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 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.
- E. Label each trap at the factory with an identification number keyed to the contract drawings. Label shall be a metal tag permanently attached to the trap.

2.10 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. The supply steam will be 60 PSIG and 307°F.
- 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 tunnels.

3.2 PIPING APPLICATION

- A. HP Steam Piping:
 - 1. NPS 2 (DN 50) and Smaller: Schedule 40, ASTM A106 Grade B seamless carbon steel, conforming to ANSI B31.1
 - 2. NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40, ASTM A106 Grade B seamless carbon steel, conforming to ANSI B31.1.
- B. Condensate Piping:
 - 1. NPS 2 (DN 50) 2" and smaller shall be the following: Schedule 80, ASTM A106 Grade B seamless carbon steel, conforming to ANSI B31.1.
 - a. RTRP and RTRF with adhesive or flanged joints.
- C. Steam Outer Conduit
 - 1. The exterior steel conduit surface shall be abrasive blast - cleaned to a minimum of a near white surface, SSPC-SP10-63T. Profile must be a minimum of 1.5 mil peak to valley range. Any areas of rust bloom or oil shall be wiped and re-blasted.

D. After blasting, the steel conduit shall be coated with (Zinc). The zinc coating shall be a high solids inorganic coating that protects the steel galvanically, thus eliminating sub-film corrosion. The zinc coating shall be a two part spray coating consisting of a liquid base portion and a dry powdered metal. The two components when mixed together can be spray applied. The dry film thickness shall be in a range of 2 to 4 mil.

3.3 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 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.

3.4 DIRECT-BURIED SYSTEM INSTALLATION

- A. The Contractor shall oversee the deliver, store, install and test the system as per manufacturer's recommendations. All work shall be in strict accordance with the requirements specified by the manufacturer. The preinsulated pipe spools shall be installed in accordance with the stenciled piece numbers shown on the manufacturer's layout drawings. 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 COR. 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 COR. 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 COR prior to covering the top of the casing with backfill.
- D. The contractor shall provide the pipe fitters sufficient room to weld and insulate the conduit piping. Bell-Holes or sandbags may be utilized for installation purposes. Double joining of pipe spools is permissible if performed in accordance with factory technician's recommendations. Shipping bars shall be removed from all pipe spools in accordance with factory technician's instructions.
- E. 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.

- F. The contractor shall use the manufacturer's supplied test caps or approved alternate to seal all pipe line ends at the end of each day. In the event the contractor fails the final hydrostatic test required between vault or building runs the contractor shall be solely responsible for locating and repairing any leak(s).
- G. Sections of system that have been fully or partially submerged in water must be replaced. The contractor will install the pipe system in a fashion that insures no water infiltration occurs inside the conduit spool pieces. The contractor shall weld and insulate the service pipe then weld the closure sleeve immediately after service pipe welding to keep the conduit system sealed. The contractor shall not leave open joints in the trench for periods longer than 24 hours. The contractor shall leave no conduit joints open should the threat of rain or severe water condition exist in the trench.
- H. Water infiltration inside conduit spool pieces shall be dealt with immediately by the contractor and in accordance with directions by the factory technician. The contractor shall implement the drying procedure immediately after installation and before system turn over. The insulation and conduit shall be checked with an approved dew point meter to monitor moisture levels. The piping system shall not be accepted until dew point readings meet the standards detailed under the steam line conduit drying part of these specifications. The technician shall notify the contractor and the COR when an acceptable level of dryness is achieved. The contractor shall be liable for all costs associated with drying including mobilization of drying equipment and technician's site visits to monitor the drying procedure.
- I. 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.
- J. Provide reports to the COR that include:
1. Daily written report: Prepared daily and signed by the Contractor. Submit the original report to the COR 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 COR 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.
- K. The service piping shall be hydrostatically tested to 150 psig or $1\frac{1}{2}$ times the operating pressure, whichever is greater, for a period of two (2) hours, no pressure drop shall be allowed.
- L. At each casing termination (end plate) in buildings and manholes, plug the casing drain openings with brass plugs and extend 1 inch pipe size ASTM A53 galvanized vent pipes from the casing vents 1 foot (300 mm) above the conduit in buildings. Terminate the outside vents in 180-degree bends.

3.5 STEAM LINE CONDUIT DRYING

- A. The contractor shall ensure the annular space between the carrier pipe and conduit is dry before system is accepted by owner. The contractor shall use a dry gas purge method to remove all moisture from the piping system.

- B. The contractor shall furnish all compressors, desiccant dryers, after coolers, pressure regulators, flow meters, inlet and outlet dew point meter, piping, valves etc. as required to dry the annular air space.
- C. The contractor shall circulate dry, compressed air through the space to absorb any moisture. The compressed air shall have a maximum pressure of 5 psig, and a dew point of less than -20° F. The contractor shall provide a calibrated dew point meter for testing compressed air at inlet and outlet for the piping system annular space.
- D. The flow rate shall ensure the velocity of compressed air through the annular space is between 10 and 20 f /sec.
- E. The contractor shall circulate the compressed air for a minimum of 48 hours. After the initial dry out period, the contractor shall shut down the gas purge for a minimum of 2 hours to allow the annular space to reach equilibrium. The compressed gas system shall then be started and initial and outlet dew point measured. The dew point at the outlet shall be 20°F or less. The process all be repeated if the dew point at the outlet from the annular space exceeds 20°F.
- F. Drying the annular space using the heated carrier pipe may be used in conjunction with the dry gas purge method. Compressed ambient temperature air is not acceptable.
- G. Steam "telltale" assembly including fittings, reverse check valve and piping shall be installed at the vent outlet once drying is complete. The vent fitting should be piped to a location where the conduit can be safely vented. A ball check valve, fitting and piping shall be provided at the drain outlet once drying is complete. Vent and drain assemblies shall be required at the "low end" of the conduit piping. Vent and drain plugs shall be installed at the high end of the conduit piping. Contractor shall provide a written report to the COR detailing Dew Point Readings for Steam Line start up, drying immediately before 2 hour gas purge "equilibrium" shut down, immediately after 2 hour gas purge "equilibrium" shut down. The contractor shall coordinate all testing with the COR and shall allow the COR to witness any or all testing at owner's discretion. The report shall also state that all Vent and Drain orifices for the line being dried have been sealed with the requisite pipe, fittings, check valves, ball valves and plugs.

3.6 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 re-inspect 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 and in walk-through tunnels,

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 COR reserves the right to review all inspection records, and if any welds inspected are found unacceptable they shall be removed, re-welded, and radiographically reexamined at no cost to the Government.

3.7 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.

3.8 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.

3.9 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 and walk-thru tunnels.

3.10 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 COR.
- 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 coating after installation in trench prior to backfilling. Use test method and voltage recommended by coating 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 the COR.
- 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 the COR 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 COR 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 COR. Major deficiencies or failure to correct deficiencies, to the satisfaction of the COR, 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. 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.
 3. Test conduit as follows:
 - a. Seal vents and drains and subject conduit to 15 psi (105 kPa) for four hours with no loss of pressure. Repair leaks and retest as required.

K. Prepare test and inspection reports.

3.11 APPENDIX II - CLASSIFICATIONS FOR DIRECT BURIED SYSTEMS

A. Groundwater Conditions:

Site Classification	General Conditions for Such Classifications
A - Severe	1. The water table is expected to be frequently above the bottom of the system and surface water is expected to accumulate and remain for long periods in the soil surrounding the system, or
	2. The water table is expected to be occasionally above the bottom of the system and surface water is expected to accumulate and remain for long periods in the soil surrounding the system.
B - Bad	1. The water table is expected to be occasionally above the bottom of the system and surface water is expected to accumulate and remain for short periods (or not at all) in the soil surrounding the system, or
	2. The water table is expected never to be above the bottom of the system but surface water is expected to accumulate and remain for long periods in the soil surrounding the system.
C - Moderate	The water table is expected never to be above the bottom of the system but surface water is expected to accumulate and remain for short periods in the soil surrounding the system.
D - Mild	The water table is expected never to be above the bottom of the system and surface water is not expected to accumulate or remain in the soil surrounding the system.

1. System Temperature Classifications: High 261 to 450 deg F (127 to 232 deg C); Medium 201 to 260 deg F (94 to 126 deg C); Low 200 deg F (93 deg C) or lower.

2. Soil Conditions:

B. Soil Corrosiveness Classification:

1. The soil at the site should be classified as corrosive or noncorrosive on the basis of the following criteria:
2. Corrosive: The soil resistivity is less than 30,000 ohm-cm or stray direct currents can be detected underground.
3. Noncorrosive: The soil resistivity is 30,000 ohm-cm or greater and no stray direct currents can be detected underground.
4. The classification should be made by an experienced corrosion engineer based on a field survey of the site carried out in accordance with recognized guidelines for conducting such surveys.

C. Soil pH:

1. If there is any reason to suspect that the soil pH will be less than 5.0 anywhere along the proposed path of the system, pH measurements should be made at pipeline depth at close intervals along the proposed route, and all locations at which the pH is less than 5.0 should be indicated in the contract documents. An experienced soils engineer, preferably the same engineer responsible for other soil engineering work, should determine soil pH.
2. Type of Underground System Allowed:
 - a. Drainable-Dryable-Testable (DDT) shall be allowed for Site Classifications A, B, C, D.

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