

STEAM/CONDENSATE LINE REPLACEMENT

SECTION 33 63 00 STEAM ENERGY DISTRIBUTION

PART 1 - GENERAL:

1.1 DESCRIPTION:

Underground steam distribution and condensate return piping system, including manholes. Type of system shall be: concrete shallow trenches.

1.2 DEFINITIONS:

- A. System: A complete underground steam and condensate distribution system including all components such as carrier piping, pipe supports, insulation, protective enclosures, anchors, and accessories.
- B. Concrete Shallow Trench: System with removable concrete covers located approximately 4' below grade. Carrier pipes are located within trench. Cross-section of trench is sufficient size only for piping, insulation, supports, air space and drainage. Designed by project engineer and field erected. No equipment requiring access for operation or maintenance can be located in the trench because there is no access except by removing the heavy concrete covers. Existing concrete trench shall be re-used for this project.
- C. Carrier Pipe: Pipe carrying the steam or condensate.
- D. Casing: Outer protective pipe on pre-engineered systems. Carrier pipe and insulation are within the casing. The casing may also be referenced as the "conduit".
- E. Project Drawings: The project drawings accompanying this specification provide information on:
 - 1. The size of carrier pipes, approximate length, and site location of the system.
 - 2. Location and design of manholes and piping therein.
 - 3. The obstacles located within approximately 25 m (8 feet) of the centerline of the system, including crossing utilities that must be avoided or altered.
 - 4. Type of system required - shallow concrete trench.
 - 5. Operating pressure and temperature of systems.

6. Other pertinent general information.

J. Pressures: Pressures listed in this section are gage pressure unless otherwise noted.

1.3 RELATED WORK:

A. Phasing of work: Section 01 00 00, GENERAL REQUIREMENTS.

B. Excavation, shoring and backfill: Section 31 20 00, EARTH MOVING
Section 31 20 11,

1.4 QUALITY ASSURANCE:

A. Approval by Contracting Officer is required of products or services of proposed manufacturers, suppliers and installers.

B. For shallow concrete trench systems, expansion joints and ball joints, submit certification that:

1. Manufacturers regularly and currently manufacture the product.

2. There is a permanent service organization trained by the manufacturer that will provide the required field supervision of the installation of the system or equipment. Submit name and address of the service organization.

C. The manufacturer of shallow trench distribution system shall design the system to comply with the requirements of these specifications and is responsible for the complete product to be supplied, fabrication, witnessing installation and testing of the system.

D. Products Experience Record:

1. All Other Products: The designs shall be of current production and have been in satisfactory operation on at least three installations for approximately five years.

A. Provide a complete installation with all necessary specialties, materials and equipment fully and properly connected and coordinated. Installation shall be fully operational upon completion of work defined and as phased.

B. Apply and install systems, materials, equipment and specialties in accordance with manufacturer's instructions. Printed instructions shall be available at the site prior to and during construction.

C. Materials, design, installation and workmanship shall conform to applicable local codes, and to national codes and standards as referenced in this specification.

D. Manufactured Products:

1. When two or more items serve the same function, they shall be products of one manufacturer.

2. Manufacturers of assemblies of products, which include components made by others, shall assume complete responsibility for final assembled unit.
 - a. All components of an assembled unit need not be products of the same manufacturer.
 - b. Constituent parts that are alike shall be products of a single manufacturer.
 - c. Components shall be compatible with each other and with the total assembly for intended service.
 2. All systems and equipment shall be free from defects that would adversely affect the performance, maintainability, or appearance of individual components or overall assembly.
 3. Each product shall be designed for the service conditions specified for that product. If no conditions are specified, the product shall be suitable for the actual service conditions.
- E. Manufacturer's Identification: Components of equipment shall bear manufacturer's name or trademark and model number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- F. Radiographic Testing of Welds: Weld examination methods and procedures and the interpretation of examining films shall conform to ASME B31.1. The testing firm shall utilize the proper film exposure, techniques, and penetrometer to produce density and geometric sharpness required for first quality film, and all radiographs shall be reviewed and interpreted and reading reports signed by not less than an American Society for Non-Destructive Testing (ASNT) Certified Level III Radiographer.

1.5 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit information and materials under this section separate from information and materials submitted under other sections and mark "SUBMITTED UNDER Section 33 63 00, STEAM ENERGY DISTRIBUTION, GROUP ____."
- C. Submit all items listed under each group simultaneously (except for items that can only be submitted during construction and upon completion of construction).

- d. Manufacturer's data sheets on casing coatings. Provide test report that concludes that coating can withstand a minimum 96 hour test at 186 °C (366 °F) without disbonding from the steel jacket.
 - e. A detailed design layout of the system showing the size, type, and location of each component, the design of anchors and manhole and building wall penetrations, the design of the transition points to aboveground or other type systems.
 - f. Manufacturer's quality assurance plan for fabrication, delivery, storage, installation and testing of system.
 - g. Certificate of Qualification from system manufacturer that the manufacturer's field representative regularly performs the specified duties of monitoring the installation of the system and is technically qualified and experienced in the installation of the system and is authorized by the supplier to make and sign the daily reports specified herein.
 - h. Manufacturer's data sheets and thickness of carrier pipe insulation.
 - i. All drawings and calculations shall have Professional Engineer's stamp.
 - j. A proposed schedule of activities indicating when various items of work and tests are to be carried out and when quality control inspectors of the supplier will be present at the job site.
 - k. The daily written report from the manufacturer's representative at the job site during all stages of material delivery and construction.
 - l. Proposed changes in design due to unforeseen conflicts or interferences along the route of the system.
 - m. Upon completion of the work:
 - 1) Certificate of Compliance signed by principal officers of the manufacturer and the contractor certifying that the system has been installed in accordance with contract requirements.
 - 2) Operation and maintenance manual.
 - 3) As-built layout of system including all final elevations (hard copies and AutoCAD on CD).
2. Group II, Piping in Manholes, Concrete Tunnels, Concrete Shallow Trenches, Open Areas:
- c. Pipe hangers, brackets, supports, racks, anchors, guides.

- d. Pipe hanger calculations.
- e. Pipe insulation, jackets, adhesives and cements. Submit samples and technical information.
- 4. Group IV, Concrete Shallow Trenches:
 - a. Trench plans, profiles, sections and details.
 - b. Shop drawings for prefabricated trench sections including removable covers.
- Contractor shall utilize existing concrete trench. Contractor shall re-use existing trench covers and reseal. Damaged covers will be the responsibility of the contractor to replace and reseal.
- D. Independent Weld Testing Firm for Carrier Piping in Pre-Engineered Direct- Buried and Concrete Shallow Trench Systems:
 - 1. Certificate of Qualification of testing firm.
 - 2. Certificate of Acceptability of actual welds.
- F. Proposed test procedures and samples of test data sheets for each required test, 30 days prior to the test date. Provide calibration data on all test instruments. Tests shall not begin until procedures have been approved.
- G. Test reports resulting from testing of installed systems, in booklet form showing all field tests performed to prove compliance with specified performance criteria.

1.6 STORAGE AND HANDLING:

- A. Equipment and material placed on the job shall remain in the custody of the Contractor until final acceptance whether or not the Government has reimbursed the Contractor for the equipment and material.
- B. The Contractor is solely responsible for the protection of the equipment and material against damage from any source. Protect piping systems against entry of water and mud and all foreign substances by installing watertight protection 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 under the custody and responsibility of the Contractor.
- C. All insulated piping systems exposed to water must be replaced with new systems.
- D. Place all damaged items in first class new operating condition or replace damaged items as determined and directed by the Resident

Engineer (RE)/Contracting Officers Technical Representative (COTR), at no additional cost to the Government.

1.7 JOB CONDITIONS:

- A. Interruption of Existing Service: Arrange, phase and perform work and provide temporary facilities, materials, equipment, and connections to utilities, to assure adequate steam and condensate return service for existing installations at all times. Only such absolutely necessary interruptions as may be required for making connections will be permitted, and only at such times when approval is obtained from RE/COTR. Interruptions to steam and condensate service shall be only with prior approval, and be the minimum possible duration.

1.8 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced 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-P-535E.....Plastic Sheet (Sheeting): Plastic Strip: Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate)
- L-S-125B.....Screening, Insect, Nonmetallic
- C. Military Specifications (Mil. Spec.):
- MIL-S-901D.....Shock Tests. H.I. (High Impact) Shipboard Machinery, Equipment and Systems
- D. ASTM International (ASTM):
- A36/A36M-05.....Structural Steel
- A47/A47M-99(2004).....Ferritic Malleable Iron Castings
- A53/A53M-06a.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- A105/A105M-05.....Carbon Steel Forgings for Piping Applications
- A106/A106M-06a.....Seamless Carbon Steel Pipe for High-Temperature Service
- A126-04.....Gray Iron Castings for Valves, Flanges and Pipe Fittings
- A134-96(2005).....Pipe, Steel, Electric-Fusion(Arc)-Welded (Sizes NPS 16 and over)
- A135/A135M-06.....Electric-Resistance Welded Steel Pipe

A139/A139M-04.....Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4
 and over)
 A167-99(2004).....Stainless and Heat-Resisting Chromium-Nickel
 Steel Plate, Sheet and Strip
 A193/A193M-07.....Alloy-Steel and Stainless Steel Bolting
 Materials for High Temperature Service
 A194/A194M-07a.....Carbon and Alloy Steel Nuts for Bolts for High-
 Pressure or High-Temperature Service, or Both
 A197/A197M-00(2006).....Cupola Malleable Iron
 A216/A216M-07.....Steel Castings, Carbon, Suitable for Fusion
 Welding, for High-Temperature Service.
 A234/A234M-07.....Pipe Fittings of Wrought Carbon Steel and Alloy
 Steel for Moderate and High Temperature Service
 A240/A240M-07e1.....Chromium and Chromium-Nickel Stainless Steel
 Plate, Sheet and Strip for Pressure Vessels and
 for General Applications
 A395/A395M-99(2004).....Ferritic Ductile Iron Pressure-Retaining
 Castings for Use at Elevated Temperatures
 A536-84(2004).....Ductile Iron Castings
 B61-02.....Steam or Valve Bronze Castings.
 B209-06.....Aluminum and Aluminum-Alloy Sheet and Plate
 C411-05.....Hot-Surface Performance of High-Temperature
 Thermal Insulation
 C449/C449M-00.....Mineral Fiber Hydraulic-Setting Thermal
 Insulating and Finishing Cement
 C533-07.....Calcium Silicate Block and Pipe Thermal
 Insulation
 C547-06.....Mineral Fiber Pipe Insulation
 C552-03.....Cellular Glass Thermal Insulation
 C591-07.....Unfaced Preformed Rigid Cellular
 Polyisocyanurate Thermal Insulation
 C655-04e1.....Reinforced Concrete D-Load Culvert, Storm Drain
 and Sewer Pipe
 C920-05.....Elastomeric Joint Sealants
 C1126-04.....Faced or Unfaced Rigid Cellular Phenolic
 Thermal Insulation
 C1136-06.....Flexible, Low Permeance Vapor Retarders for
 Thermal Insulation

- D1784-06a.....Rigid Poly (Vinyl Chloride) (PVC) Compounds and
Chlorinated Poly (Vinyl Chloride) (CPVC)
Compounds
- D2310-06.....Machine-Made "Fiberglass" (Glass-Fiber
Reinforced Thermosetting-Resin) Pipe
- D2487-06.....Soils for Engineering Purposes (Unified
Classification System)
- D2996-01 (2007)e1.....Filament-Wound Fiberglass (Glass-Fiber-
Reinforced-Thermosetting-Resin) Pipe
- E. American Society of Mechanical Engineers (ASME):
- B16.3-2006.....Malleable Iron Threaded Fittings
- B16.5-2003.....Pipe Flanges and Flanged Fittings NPS $\frac{1}{2}$ - 24
- B16.9-2003.....Factory-Made Wrought Buttwelding Fittings
- B16.11-2005.....Forged Fittings, Socket-Welding and Threaded
- B31.1-2004.....Code for Pressure Piping, Power Piping, with
Amendments
- B31.9-2004.....Code for Pressure Piping, Building Services
Piping, with Amendments
- B40.100-2005.....Pressure Gauges and Gauge Attachments
- Boiler and Pressure Vessel Code, Section VIII: 2007 Edition, with
Amendments
- F. American Welding Society (AWS):
- AWS B2.1-00.....Welding Procedure and Performance Qualification
- G. Manufacturers Standardization Society of the Valve and Fitting Industry
(MSS):
- SP45-03.....By-Pass and Drain Connection Standard
- SP58-02.....Pipe Hangers and Supports-Materials, Design and
Manufacture
- SP69-03.....Pipe Hangers and Supports-Selection and
Application
- SP80-03.....Bronze Gate, Globe, Angle and Check Valves
- H. National Fire Protection Association (NFPA):
- 255-06.....Test of Surface Burning Characteristics of
Building Materials
- I. American Society of Heating, Refrigerating and Air Conditioning
Engineers (ASHRAE):
- ASHRAE Handbook.....2004 HVAC Systems and Equipment

- J. American Concrete Institute (ACI):
318-05.....Building Code Requirements for Reinforced
Concrete
- K. NACE International (Corrosion Engineers) (NACE):
RP0169-02.....Standard Recommended Practice, Control of
External Corrosion on Underground or Submerged
Metallic Piping Systems
- L. Expansion Joint Manufacturers Association (EJMA):
8th Edition-2003.....Standards of the Expansion Joint Manufacturers
Association
- M. American Association of State Highway and Transportation Officials
(AASHTO):
M300-03.....Inorganic Zinc Rich Primer
- N. Society for Protective Coatings (SSPC):
SP-10/NACE No. 2-2004...Near White Blast Cleaning
- O. Unified Facilities Guide Specifications (UFGS):
UFGS 33 63 13.....Exterior Underground Steam Distribution System
(April 2006 or later)

PART 2 - PRODUCTS:

2.1 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, 6.35 mm (0.25 inch) thick steel casing, fusion-bonded epoxy casing coatings, cathodic protection, accessories. Do not locate condensate pipes in casings (conduits) that contain steam pipes.
- B. Design Pressure and Temperature: All components of system shall be suitable for carrier pipe pressures and temperatures as follows:
1. Steam System: 1000 kPa (150 psi); 185 °C (366 °F).
 2. Condensate System: 345 kPa (50 psi); 154 °C (310 °F).
- C. Description of System Design: Refer to Part 1, "DEFINITIONS".
- D. Steam Carrier Pipes: Refer to Paragraph, "STEAM PIPING".
1. No piping joints 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.

E. Condensate Carrier Pipes: Refer to Paragraph, "STEAM CONDENSATE PIPING".

1. No piping joints 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.

F. Carrier Pipe Insulation:

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 300°F, steam pressure is 55 psi. Pumped condensate temperature is 93 °C (200 °F). Drip return temperature is 100 °C (212 °F).
3. Allowable Carrier Pipe Insulation Type and Minimum Insulation Thickness:

TABLE 1 Minimum Pipe Insulation Thickness mm (inches) For Steam 110 to 2800 kPa (16 to 408 psi) gage			
Nominal Pipe Diameter mm (inches)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp
25 (1)	50 (2)	65 (2 1/2)	100 (4)
40 (1 1/2)	50 (2)	65 (2 1/2)	100 (4)
50 (2)	65 (2 1/2)	85 (3 1/2)	110 (4 1/2)
65 (2 1/2)	65 (2 1/2)	85 (3 1/2)	110 (4 1/2)
80 (3)	75 (3)	100 (4)	125 (5)
100 (4)	75 (3)	100 (4)	125 (5)
125 (5)	75 (3)	100 (4)	125 (5)
150 (6)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)
200 (8)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)
250 (10)	100 (4)	125 (5)	150 (6)
300 (12)	100 (4)	125 (5)	150 (6)
350 (14)	100 (4)	125 (5)	150 (6)
400 (16)	100 (4)	125 (5)	150 (6)
450 (18)	100 (4)	125 (5)	150 (6)

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

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

TABLE 2 Minimum Pipe Insulation Thickness mm (inches) For Steam Less than 110 kPa (16 psi) gage, Condensate Return			
Nominal Pipe Diameter mm (inches)	MPT-PF MPT-PC	Delta	Thermo-12 Super Caltemp
25 (1)	40 (1 1/2)	50 (2)	75 (3)
40 (1 1/2)	40 (1 1/2)	50 (2)	75 (3)
50 (2)	40 (1 1/2)	50 (2)	75 (3)
65 (2 1/2)	40 (1 1/2)	50 (2)	75 (3)
80 (3)	50 (2)	65 (2 1/2)	85 (3 1/2)
100 (4)	50 (2)	65 (2 1/2)	85 (3 1/2)
125 (5)	50 (2)	65 (2 1/2)	85 (3 1/2)
150 (6)	65 (2 1/2)	80 (3)	110 (4.5)
200 (8)	65 (2 1/2)	80 (3)	110 (4.5)
250 (10)	80 (3)	100 (4)	125 (5)
300 (12)	80 (3)	100 (4)	125 (5)
350 (14)	80 (3)	100 (4)	125 (5)
400 (16)	80 (3)	100 (4)	125 (5)
450 (18)	80 (3)	100 (4)	125 (5)

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 25 mm (1 inch) shall have the same insulation thickness as required for 25 mm (1 inch) pipe.

"Delta" is available from Rockwool, Leeds, AL.

"MPT" is available from Mineral Products of Texas, Houston, TX.

"Thermo-12" and "Super Caltemp" is available from Industrial Insulation Group, Brunswick, GA.

5. Insulation Banding and Jacket: Stainless steel bands and clips, at least 13 mm (0.5 inches) wide, ASTM A-167 (304 stainless steel), maximum spacing 460 mm (18 inches). A minimum of two bands is required for each 1300 mm (4 foot) section of insulation. 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

0.335 mm (0.013 inches) diameter vinyl-coated fibrous glass yarn.
Install bands over the jacket to secure the insulation to the carrier pipe.

- G. Casing: Smooth-wall steel, electric resistance welded, conforming to ASTM A134, ASTM A135, or ASTM A139. 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 mm (in.)	Minimum Thickness mm (in.)
150 - 1170 (6 - 46)	6.35 (0.250)

- H. Casing End Seal Plates with Vents and Drains: ASTM A36 steel, minimum thickness 9.5 mm (0.375 inches) for casings up thru 300 mm (12 inches) diameter and 13 mm (0.5 inches) for casings over 300 mm (12 inches) diameter. Provide 25 mm (one inch) drain at the bottom and vent at the top. Construct with threaded steel half couplings. Install threaded brass plugs in drains. Install vent riser pipes, ASTM A53, Schedule 40, galvanized, extending through top of manhole and terminate 300 mm (12 inches) above grade with 180-degree bend.
- I. Gland Seals: Not permitted because of the possibility of water entering the system thru the gland seal from a flooded manhole.
- J. Air Space: Provide continuous 25 mm (one inch) minimum air space between carrier pipe insulation and casing.
- K. Casing Coating: Dual layers of fusion-bonded epoxy, inner green-colored layer minimum thickness 0.5 mm (0.020 inches), outer black-colored layer minimum thickness 0.25 mm (0.010 inches). Rated by coating manufacturer for continuous service for at least 25 years at minimum temperature of 110 °C (230 °F) 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.
- L. Coating of End Plates and Casing (Conduit) Sections Extending in Manholes: Zinc-rich coating that conforms to AASHTO M300, Type IA except that volatile organic compounds shall not exceed 0.34 kg per liter (2.8 pounds per gallon). 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: Maximum spacing 3000 mm (10 feet) on centers, no more than 1500 mm (5 feet) 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.
- N. Anchor Plates: ASTM A36 steel, welded to carrier pipe and casing, 13 mm (0.5 inches) 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 900 to 1500 mm (3 to 5 feet) 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: 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 1.3 mm (0.05 inch) minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 80 °C (176 °F).
- P. Manhole and Building Wall Penetrations: Provide steel leak plates welded to wall sleeves or to casings. Where wall sleeve is utilized, allow sufficient annular space between the sleeve and the casing and install a watertight EPDM Link-Seal (Thunderline Corp) or equal, rated for 121 °C (250 °F) minimum. Manhole and building walls cannot be used as anchor points.
- Q. Manufacturer's Identification: 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. Manufacturers: Perma-Pipe, Rovanco, Thermacor, or equal.

2.3 MANHOLES:

- A. Contractor shall re-use existing manholes.

2.5 CONCRETE SHALLOW TRENCHES:

CONTRACTOR SHALL RE-USE THE EXISTING CONCRETE TRENCHES AND COVERS. SPECIFICATIONS NOTED BELOW WILL COME INTO EFFECT IF ANY DAMAGE OCCURS DURING EXCAVATION AND REMOVAL OF THE TRENCH COVERS.

- A. Construct with tops of trench covers at grade.
- B. Construction: Reinforced concrete with minimum thickness 150 mm (6 inches). Construct trenches of poured concrete conforming to Section 03 30 00, CAST-IN-PLACE CONCRETE. Construct trenches of precast concrete in full compliance with the requirements of ACI 318 and conforming to ASTM C655. Manufacturer shall have a minimum of five years successful experience in the design and fabrication of similar precast concrete units and shall have an established quality assurance program in operation and show current certification in the Precast/Prestressed Concrete Institute (PCI) plant certification program. Concrete mix and reinforcing shall be manufacturers standard product.
- C. Concrete Trench Covers: Pre-cast reinforced concrete sections meeting requirements of ACI 318 and ASTM C655. Cover shall be flat and true at all points of contact on trench wall. Design trench and cover to form a watertight envelope when assembled.
- D. Waterproofing: Apply as specified to all below grade portions of the trench. Conform to //Section 07 12 00, BUILT-UP BITUMINOUS WATERPROOFING //Section 07 13 52, MODIFIED BITUMINOUS SHEET WATERPROOFING //.
- E. Gaskets and sealants: Provide 6 mm (1/4 inch) thick neoprene pad with a minimum width of 50 mm (2 inches) between covers and tops of walls. All trench joints must be sealed with ASTM C920 elastomeric sealants that are available as a one or two component system. Asphaltic sealants are not permitted. Sealants must resist 50% total joint movement. Non-sagging sealant must be used for vertical joints. Self-leveling sealant must be used for trench top butt joints.
- F. Drainage: Design precast trench so that, when assembled, a watertight envelope incorporating a gravity drainage system is formed sloping toward manholes or buildings. Trench shall slope towards manholes or buildings a minimum of 50 mm in 12 m (1 inch in 20 feet). Provide a

drainage collection and disposal system at all low points in the trench system.

2.6 STEAM CARRIER PIPING:

- A. Pipe: Steel; seamless, ASTM A53, Grade B or ASTM A106, Grade B; electric resistance welded ASTM A53, Grade B; Schedule 40. Standard weight permitted for pipe sizes 300 mm (12 inches) and above. Grade F, furnace butt-welded pipe, is not permitted.
- B. Joints:
 - 1. In trenches and direct-buried systems: Butt-weld except socket-weld for pipe sizes two-inches and below. Manufacturer's standard sliding gasketed joints permitted between sections of WSL pre-engineered direct-buried systems. No joints 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 50 mm (2 inches) and below.
 - 2. In tunnels, manholes and open areas: Butt-weld pipe sizes 65 mm (2-1/2 inches) and above; thread or socket-weld pipe sized 50 mm (two inches) and below.
- C. Fittings:
 - 1. Butt-Welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, 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: Malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 pound) class.
 - 3. Socket-Welded Joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- D. Flanges and Bolts: Weld neck, ASME B16.5, forged steel, ASTM A105. Pressure class 1025 kPa (150 psi). Bolts shall be high strength ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.
- E. Unions: On pipe 50 mm (two inches) and smaller, threaded, malleable iron or steel, 2050 kPa (300 psi) class.

2.7 STEAM CONDENSATE CARRIER PIPING:

- A. Pipe: Seamless, ASTM A53, Grade B or ASTM A106, Grade B; electric resistance welded ASTM A53, Grade B; Schedule 80. Grade F, furnace butt-welded, pipe is not permitted.
- B. Joints:
 - 1. In Trenches and direct-buried systems: Butt-weld except socket-weld is required for pipe sizes 50 mm (two inches) and below.
Manufacturer's standard sliding, gasketed joints permitted between factory-fabricated sections of direct buried WSL system. No joints 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 a 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 50 mm (2 inches) and below.
 - 2. In Tunnels, Manholes and Open Areas: Butt-weld pipe sizes 65 mm (2-1/2 inches) and above; thread or socket-weld for pipe sizes 50 mm (two inches) and below.
- C. Fittings:
 - 1. Welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
 - 2. Threaded Joints: Malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
 - 3. Socket-Welded Joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- D. Unions (Except in Trenches): On piping 50 mm (two inches) and under, 2050 kPa (300 psi) malleable iron or steel.
- E. Flanges: Weld neck ASME B16.5, forged steel, ASTM A105, 1025 kPa (150 psi).

2.9 EXPANSION JOINTS:

- A. Factory built devices, inserted in the pipelines, and designed to absorb axial cyclical pipe movement that results from thermal expansion and contraction. Provide factory-built or field-fabricated guides

located along the pipelines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.

B. Minimum Service Requirements:

1. Pressure Containment:

- a. Steam Service 35-200 kPa (5-30 psi): Rated 345 kPa (50 psi) at 148 °C (298 °F).
- b. Steam Service 214-850 kPa (31-125 psi): Rated 1025 kPa (150 psi) at 186 °C (366 °F).
- c. Steam Service 869-1025 kPa (126-150 psi): Rated 1375 kPa (200 psi) at 194 °C (382 °F).
- d. Condensate Service: Rated 690 kPa (100 psi) at 154 °C (310 °F).

2. Number of Full Reverse Cycles without failure: Minimum 1000.

3. Movement: As shown on drawings plus recommended safety factor of manufacturer.

C. Manufacturing Quality Assurance: Conform to EJMA Standards.

D. Bellows - Internally Pressurized Type:

1. Multiple corrugations of ASTM A240, Type 304 or 321 stainless steel.
2. Internal stainless steel sleeve entire length of bellows.
3. External cast iron equalizing rings for services exceeding 340 kPa (50 psi).
4. Welded ends.
5. Design shall conform to standards of EJMA and ASME B31.1.
6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
7. Integral external cover.

E. Bellows - Externally Pressurized Type:

1. Multiple corrugations of ASTM A240, Type 304 stainless steel.
2. Internal and external guides integral with joint.
3. Design for external pressurization of bellows to eliminate squirm.
4. Welded ends.
5. Conform to the standards of EJMA and ASME B31.1.
6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
7. Integral external cover and internal sleeve.

F. Slip-Type Joints:

1. Steel construction, except guides.

2. Base with integral anchor.
3. Internally and externally guided steel slip, chrome plated to reduce corrosion, ground to reduce friction.
4. Guides shall be non-ferrous, non-corroding, low friction, designed to prevent scoring or binding of the slip.
5. Welded ends.
6. Limit stop to prevent slip disengagement if pipe anchor fails.
7. Semi-plastic, self-lubricating injectable packing contained between sealing rings.
8. Injection devices to allow addition of packing under full line pressure. Provide one-year supply of packing.
9. Threaded connection at bottom, one-inch minimum, for drain or drip point.

G. Expansion Compensators:

1. Permitted for condensate lines where pipe expansion is within limits of compensator.
2. Corrugated bellows, externally pressurized, stainless steel or bronze.
3. Internal guides and anti-torque devices.
4. Threaded ends.
5. External shroud.
6. Conform to standards of EJMA.

H. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

I. Guides: Provide factory-built guides along the pipeline to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15% of the axial force that will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings. Guide locations must conform to recommendations of expansion joint manufacturer and EJMA.

2.10 BALL JOINTS:

- A. Factory-built devices, inserted in pipe line offsets in groups of two or three as shown to absorb cyclical pipe movement which results from thermal expansion and contraction.

- B. Minimum Service Requirements: Rated 1725 kPa (250 psi), 232 °C (450 °F), continuous on steam and condensate.
- C. Quality Assurance: Submit independent certification that similar units have passed the following tests with no leaks.
 - 1. Low Pressure Leakage Test: Minimum 40 kPa (6 psi) saturated steam for 60 days.
 - 2. Life Cycle Flex Test: Minimum 8000 flex cycles at 1725 kPa (250 psi) saturated steam.
 - 3. Thermal Cycling Test: Minimum 100 cycles from atmospheric pressure to operating pressure and back to atmospheric pressure with saturated steam.
 - 4. Environmental Shock Test: In accordance with MIL-S-901.
 - 5. Vibration Test: Test for 170 hours on each of three mutually perpendicular axes at 25 to 125 HZ; 1 to 2 mm (0.05 to 0.10 inch) double amplitude on a single ball joint and on a three ball joint offset.
- D. Construction:
 - 1. Cast or forged carbon steel, weld ends.
 - 2. Standard weight pipe wall thickness.
 - 3. Conform to ASME B31.1.
 - 4. Provide minimum angular movement capability of 15 degrees and 360 degrees rotational movement.
 - 5. Non-asbestos gaskets.
 - 6. Packing injection devices, if provided, shall allow injection under full line pressure. Provide one-year supply of packing.

2.11 VALVES:

- A. Valves for particular services are generally specified as Type Numbers. The Type Numbers are defined below. All valves of the same type shall be the products of a single manufacturer and shall comply with MSS SP45, MSS SP80 and ASME B31.1. Design valves for the service fluids and conditions. Pressure - temperature ratings listed are minimum requirements. Packing and gaskets must be asbestos-free.
- B. Valve Type Designations:
 - 1. Gate Valves:
 - a. Type 101: Cast steel body ASTM A216 WCB, rated 1025 kPa (150 psi) at 260 °C (500 °F), 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel-copper alloy

seats, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet.

1) Provide factory installed globe valved bypass on all steam valves larger than 80 mm (3 inches). Conform to MSS SP45.

2) Drill and tap bosses for connection of drains where shown. Conform to MSS SP45.

b. Type 102: Not used.

c. Type 103: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze faced wedge and seats, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

d. Type 104: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.

e. Type 105: Not used.

f. Type 106: Forged steel body ASTM A105, rated for 2050 kPa (300 psi) at 216 °C (420 °F) minimum (Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi)), hardened stainless steel or stellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.

2. Globe valves:

a. Type 201: Cast steel body ASTM A216 WCB, rated 1025 kPa (150 psi) at 260 °C (500 °F), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown to conform to MSS SP45.

b. Type 202: Not used.

c. Type 203: Cast iron body ASTM A126, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

d. Type 204: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.

3. Check valves:

- a. Type 401: Cast steel body ASTM A216, swing-type, rated for 1025 kPa (150 psi) at 260 °C (500 °F), stainless steel or stainless steel - faced disc and seat, 1025 kPa (150 psi) ASME flanged ends, bolted cover, renewable disc.
 - b. Type 402: Not used.
 - c. Type 403: Cast iron body ASTM A126 Class B, swing-type, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc and seat, 850 kPa (125 psi) ASME flanged ends, bolted cover, renewable disc and seat.
 - d. Type 404: Bronze body ASTM B61, swing-type, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze disc, threaded ends, regrinding disc.
4. Ball valves: Reduced port permitted for bypass (throttling) service, full port required for all other services, one-fourth turn to open.
- a. Type 501: Not used.
 - b. Type 502: Bronze body, rated for 1025 kPa (150 psi) at 185 °C (365 °F), 1725 kPa (250 psi) at 121 °C (250 °F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, one-fourth turn to open.
 - c. Type 503: Not used.
 - d. Type 504: Carbon steel or ASTM A536 ductile iron body, saturated steam service, rated for 1030 kPa (150 psi), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, 1025 kPa (150 psi) ASME flanged ends. Manufacturer: American, Worcester, or equal.
5. Butterfly valves:
- a. Type 601: Ductile iron body ASTM A395 or A536, wafer style, rated for 850 kPa (125 psi), 100 °C (212 °F), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and larger, ratchet handle operator for smaller pipe sizes.
 - b. Type 602: Triple-offset, lug or flanged type, carbon steel body, steam service, rated for 1025 kPa (150 psi) at 260 °C (500 °F), 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 100 mm (4 inch) pipe size and larger, ratchet handle

operator for smaller pipe size valves. Manufacturer: Flowseal MS (Crane Co.) or equal.

C. Valve Applications (Steam Lines):

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

D. Valve Applications (Condensate Lines):

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

2.12 STEAM PRESSURE REDUCING VALVES:

- A. Type: Single-seated, diaphragm operated, spring-loaded, steam pilot-controlled, normally closed, packless, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
- B. Service: Provide controlled reduced pressure to steam piping systems. Design for saturated steam at pressures shown on drawings.
- C. Performance: Pressure control shall be smooth, continuous. Maximum 10 percent deviation from set pressure over an 18/1 turndown. Refer to schedules on drawings for flow and pressure requirements. Maximum flow capability of each valve shall not exceed capacity of downstream safety valves.
- D. Construction:
1. Main Valve - Pipe Sizes 50 mm (2 inches) and under: Cast iron body rated for 1725 kPa (250 psi), threaded ends. Valve plug and seat shall be replaceable, Type 316 stainless steel or Monel. Stainless steel stem.

2. Main Valves - Pipe Sizes Above 50 mm (2 inches): Cast steel body rated for 1025 kPa (150 psi) ASME flanged ends, or cast iron body 1725 kPa (250 psi) ASME flanged ends. Valve plug and seat shall be replaceable, Type 316 stainless steel or Monel. Stainless steel stem.
3. Pilot Valve: Valve plug and seat shall be replaceable, stainless steel or Monel.

2.13 STEAM TRAPS:

- A. Apply at steam line drip points.
- B. 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. Cast iron or stainless steel bodies. Construction shall permit ease of removal and servicing working parts without disturbing connecting piping.
- D. Stainless steel floats. Hardened chrome steel valves. Stainless steel mechanisms. Bi-metallic air vent on inverted bucket traps.
- E. Factory-Packaged Trap Station: As an option for drip points requiring isolating valves, strainer, trap, and valved test connection, provide factory-packaged trap station including these features. Manufacturer: Armstrong or equal.
- F. Identification: 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.

2.14 STRAINERS, Y-TYPE:

- A. Provide as shown on steam and condensate piping systems.
- B. Type: Open-end removable cylindrical screen; threaded blow-off connection.
- C. Construction:
 1. Steam Service to 1025 kPa (150 psi) and at Drip Traps: Rated for minimum 1025 kPa (150 psi) saturated steam. Rated for 1025 kPa (150 psi) ASME flanged ends, cast steel, for pipe sizes above 50 mm (two inches). Cast iron or bronze, rated for 1725 kPa (250 psi) saturated steam, threaded ends, for pipe sizes 50 mm (two inches) and under.
 2. Condensate Service: Rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG. Provide 850 kPa (125 psi) ASME flanged ends,

cast iron, for pipe sizes above 50 mm (two inches). Provide cast iron or bronze, threaded ends, for pipe sizes 50 mm (two inches) and under.

- D. Screen: Monel or stainless steel, free area not less than 2-1/2 times flow area of pipe. Diameter of openings shall be 1.3 mm (0.05 inch) or less on steam service and 1.5 mm (0.06 inch) or less on water service.
- E. Accessories: Gate type valve and quick-couple hose connection on all blowoff connections.

2.15 SAFETY VALVES AND VENT CONNECTORS:

- A. Safety valves shall conform to the requirements of ASME Boiler and Pressure Vessel Code (Section VIII, Unfired Pressure Vessels) and be approved by the National Board of Boiler and Pressure Vessel Inspectors.
- B. Relieving capacity shall not be less than that shown on the drawings with a pressure rise above set pressure not to exceed 10 percent of set pressure.
- C. Provide at the discharge of each safety valve a special flexible connector attached to the vent pipe and the safety valve. Multi-ply stainless steel bellows, full internal pipe liner, protective exterior shroud, drip catching configuration with drain, designed to prevent blow back of steam into space, pressure tested at not less than 100 kPa (15 psi). Drip pan ells not allowed in tunnels or constricted spaces because of "blow-back" of steam from the drip pan ells openings.

2.16 PRESSURE GAGES:

- A. Provide gages immediately downstream of each steam line isolation valve, before and after each steam pressure reducing station and where shown on the drawings.
- B. Construction:
 - 1. Case: Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.
 - 2. Dial: Non-corrosive, 110 mm (4-1/2 inch) diameter face with black markings on white background.
 - 3. Measuring Element: Bourdon tube designed for service. Provide bellows for pressure ranges under 100 kPa (15 psi).
 - 4. Movement: Stainless steel, rotary.
 - 5. Pointer: Micrometer adjustable, black color.
 - 6. Window: Plastic.
 - 7. Liquid Filled Gages: Provide at outlet of all pumps.

C. Accuracy: ANSI B40.100, Grade 2A, 1/2 percent, on all gages; except Grade A, one percent permitted on diaphragm actuated gages, liquid filled gages, and compound gages.

D. Accessories:

1. Red set hands on gages located at automatic pressure regulator valve outlets.
2. Needle valve or gage cock rated for the service.
3. Syphon on all steam gages.
4. Overload stop on all pressure gages.

E. Ranges: Except where otherwise shown on the drawings, pressure ranges shall be as follows:

SERVICE	RANGE
Steam to 100 kPa (15 psi)	0 to 200 kPa (0 to 30 psi)
Steam to 407 kPa (59 psi)	0 to 700 kPa (0 to 100 psi)
Steam above 407 kPa (59 psi)	0 to 1500 kPa (0 to 200 psi)
Condensate Pump Discharge	0 to 700 kPa (0 to 100 psi)
Vacuum Return	100 kPa vacuum to 100 kPa (30 inches HG - 0 - to 15 psi)

2.18 PIPE HANGERS AND SUPPORTS:

A. 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, seismic shock (if applicable), 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.

B. Standards: Comply with recommendations and requirements of MSS SP-58, MSS SP-69, ASME B31.1.

C. Design:

1. Components: Factory-built products of a manufacturer whose principle business is pipe supports. All components must have published load ratings. For concrete trenches, non-factory built products that comply with details shown on the contract drawings may also be utilized.

2. Selection of Components: Types, sizes, locations, and spacing must conform to MSS SP-69. Horizontal steam and condensate piping shall have roller or slider supports. Supports at risers shall be spring type that accommodates the thermal expansion. Contract drawings may show locations and types of supports including rollers and springs, and may also show special supports including anchors, guides and braces. Rigid supports such as clevises are generally not shown. Technical personnel employed by the support manufacturer shall do final selection of components, locations and sizes. 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. Locate supports to permit removal of valves and strainers from pipelines without disturbing supports.
3. Spring Hangers: Provide on all systems subject to vertical movement.
4. Roller Hangers and Sliding Supports: Provide on all systems subject to horizontal movement due to thermal expansion except when long hanger rods permit sufficient horizontal movement. If vertical angle of hanger rod exceeds four degrees, rollers or sliders are required.
5. Calculations: Calculate loads for all supports. On systems utilizing variable spring supports, determine the loads at each support by calculating the forces and moments throughout the system.
6. Deflection of Supported Systems: Vertical deflection due to system weight shall not exceed 2.5 mm (0.1 inch) between supports when system is filled with fluid normally carried.
7. All support assemblies from above shall include threaded connections that permit vertical position adjustment.
8. Layout Drawings and Identification of Hanger Parts: Prepare drawings showing each hanger location and identifying each hanger by number. Prepare individual drawing for each hanger assembly showing all components, sizes, calculated loadings. Provide identification tags, on each hanger part, keyed to the layout drawings.
- D. Upper Attachments to Structure: MSS SP-58, Type 18, 20, 21, 22, 23, 29, and 30.
- E. Roller Supports: MSS SP-58, Types 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.

- F. Variable Spring Support Assembly: MSS SP-58, Type 51 variable spring, Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring within 300 mm (one foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
- G. Spring Cushion Support Assembly:
1. Double Rod Assembly: MSS SP-58, Type 41 and 49.
 2. Single Rod Assembly: MSS SP-58, Type 48 spring cushion, Type 3 pipe clamp or Type 1 clevis. Locate spring cushion within 300 mm (one foot) above pipe attachment.
- H. Clevis Supports: MSS SP-58, Type 1.
- I. Wall Brackets: MSS SP-58, Type 31, 32, and 33.
- J. Pipe Stands: MSS SP-58, Type 38.
- K. Riser Clamp: MSS SP-58, Type 42.
- L. Alignment Guides: Construct guides of welded steel as shown to restrain movement perpendicular to the long axis of the piping. If not shown, provide steel spider clamped to pipe, enclosed within steel sleeve that is bolted or welded to structural support. Spider-type guide shall be a standard manufactured product. Design to withstand lateral force equal to minimum of 15 percent of anchor loading.
- M. Trapeze Supports: May be used where pipes are close together and parallel. Construct with structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with u-bolts.
- N. 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.
- O. 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.
- P. Pipe Racks and miscellaneous supports: Provide as shown. Construct of standard structural steel shapes, ASTM A36. Manufactured strut systems are acceptable if they have the required load-carrying ability.
- Q. All supports, including all structural steel, in trenches and manholes shall be hot-dip galvanized as specified in Section 05 50 00, METAL FABRICATIONS.

2.19 PIPE ANCHORS:

Provide as shown. Construct with all welded steel, ASTM A36.

2.20 INSULATION MATERIALS (IN MANHOLES, TUNNELS, CONCRETE TRENCHES, OPEN AREAS) :

A. Calcium Silicate Insulation:

1. Preformed Piping Insulation: ASTM C533, Type I.
2. Blocks: ASTM C533, Type I.
3. Fitting Insulation: ASTM C533, with polyvinyl chloride, Fed. Spec. L-P-535, Type II Grade GU, and Type III, premolded fitted covering 0.5 mm (0.020 inches) thick.

B. Fiberglass Insulation:

1. Preformed Piping Insulation: ASTM C547, 230 °C (450 °F).
2. Fitting Insulation: ASTM C547, 230 °C (450 °F), with polyvinyl chloride, Fed. Spec. L-P-535, Type II Grade GU, and Type III, premolded fitted covering 0.5 mm (0.020 inches) thick.

C. Rigid Closed Cell Phenolic Foam: Preformed Piping Insulation: ASTM C1126, Type III, Grade 1, 121 °C (250 °F).

D. Cellular Glass Insulation: Preformed Piping Insulation: ASTM C552.

E. Insulating and Finishing Cements: Best grade recommended by printed instructions of manufacturer for the type of insulation system and service conditions. Conform to ASTM C449.

F. Insulation Bands: Minimum 12 mm (1/2 inch) wide by 0.4 mm (0.015 inch) thick ASTM A167 stainless steel.

G. Aluminum Jackets: Minimum 0.4 mm (0.016 inch) thick aluminum, ASTM B209, 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 20 mm (0.75 inch) wide on 450 mm (18 inch) centers. Bands shall be applied with manufacturers recommended sealant. Entire system shall be watertight.

H. All-Service Jackets: White kraft bonded to 0.025 mm ((0.001 inch) thick aluminum foil, fiberglass reinforced, pressure sensitive adhesive closure. Beach puncture 50 units, suitable for painting without sizing. Comply with ASTM C1136. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and not less than 100 mm (4 inch) butt strips on end joints. Butt strip material shall be same as the jacket.

Lap and butt strips may be self-sealing type with factory-applied pressure sensitive adhesive.

- I. Glass Cloth Jacket: Minimum 0.24 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psi) bursting strength, weathertight for outside service. Beach puncture 50 units.
- J. Pipe Covering Protection Saddles: MSS SP-58, Type 39 at all hanger points except where Type 3 pipe clamps are provided.
- K. Fire and Smoke Ratings: Assembled insulation systems shall meet flame spread (25) and smoke developed (50) ratings as developed under ASTM C411 and NFPA 255 standards and specifications.

2.21 PIPE AND VALVE FLANGE GASKETS:

Non-asbestos, designed for the service conditions. On steam service utilize "Flexitallic" spiral-wound, "Lamons Grafoil Grade GHR", "Lamons Spira-wound", "Garlock ST-706", or equal.

PART 3 - EXECUTION:

3.1 GENERAL:

- A. Connecting to Existing Work: 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. Work disturbed or damaged shall be replaced to its prior condition, as required by Section 01 00 00, GENERAL REQUIREMENTS. Piping connections shall be made only in manholes, tunnels or buildings.
- B. Coordination: 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. Excavation, trenching, shoring, sheathing, bracing, and backfilling shall conform to Section 31 20 00, EARTH MOVING.
- D. Grading: Unless otherwise shown on drawings, steam lines shall be graded downward not less than 50 mm in 12 meters (two inches in 40 feet) 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 DEMOLITION:

- A. Perform work in accordance with requirements for phasing.
- 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 within one week 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 Resident Engineer.
- F. Asbestos Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT or Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT.

3.3 PIPING JOINTS AND FITTINGS:

- A. Welded Joints:
 - 1. 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.
 - 2. Clean pipe and fittings before welding and installation in system.
- B. Threaded Joints:
 - 1. Pipe threads shall be cut to give proper engagement in threaded fittings. Threaded pipe shall have clean-cut threads; dull or damaged pipe dies shall not be used.
 - 2. Clean pipe and fittings before installation and ream pipe after cutting threads. Joints shall be made with oil and graphite pipe joint compound applied to male threads only.
- C. Fittings: All pipe intersections and all changes in direction shall be made with factory-built-reinforced fittings. Field-fabricated fittings and miters are not permitted.
- D. Flanged Joints: 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.

3.4 CLEANING OF PIPING:

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.

3.5 WELDING:

- A. The Contractor is entirely responsible for the quality of the welding and shall:
 - 1. Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
 - 2. Comply with ASME B31.1 and AWS B2.1.
 - 3. Perform all welding operations required for construction and installation of the heat-distribution system.
- B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1 and AWS B2.1, and also as outlined below.
- C. Examining Welder: Examine each welder at job site, in the presence of the Resident Engineer (RE)/Contracting Officer's Technical Representative (COTR), to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be:
 - 1. Allowed to weld only in the position in which he has qualified.
 - 2. Required to identify his welds with his specific code marking signifying his name and number assigned.
- D. Examination Results: Provide the RE/COTR with a list of names and corresponding code markings. Retest welders that fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.
- E. Beveling: Field bevels and shop bevels shall be 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.
- F. Alignment: Utilize split welding rings or approved alternate method for field joints on all carrier pipes above 50 mm (two inches) to assure proper alignment, complete weld penetration, and prevention of weld

spatter reaching the interior of the pipe. Make field joints 50 mm (two inches) and smaller with welding sockets.

- G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged either before, during, or after installation. Where the pipe temperature falls to 0 °C (32 °F) or lower, the pipe shall be heated to approximately 38 °C (100 °F) for a distance of 300 mm (one foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 °C (32 °F).
- H. Defective Welds: 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.
- I. Electrodes: 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.
- J. Radiographic Testing: An approved independent testing firm regularly engaged in radiographic testing shall perform radiographic examination of all field welds in the carrier piping of direct-buried systems and concrete trench systems, in manholes and in walk-through tunnels, in accordance with ASME B31.1. Furnish a set of films showing each weld inspected, a reading 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 RE/COTR 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.

3.6 DRAIN VALVES AND VENT VALVES:

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

3.7 PIPE SUPPORT INSTALLATION (IN TRENCHES, TUNNELS, MANHOLES):

- A. Coordinate support locations with structure prior to erection of piping. Arrangement of supports shall facilitate operating, servicing

and removal of valves, strainers, and piping specialties. 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: Concrete inserts.
2. Existing Reinforced Concrete Construction: Upper attachment 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. Steel Deck and Structural Framing: Upper attachments welded or clamped to structural steel members.

C. Expansion Fasteners and Power Set Fasteners: 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 directed by the RE/COTR.
3. Do not attach pipe supports, hangers, clamps or anchors to equipment unless specified for that equipment or unless the RE/COTR gives written permission.

E. Spring Hangers: Locate spring units within 300 mm (one foot) of the pipe attachment, except in locations where spring assemblies interfere with pipe insulation.

F. Minimum Clearances in Tunnels and Trenches:

1. Floor to bottom of pipe support beam: 50 mm (two inches).
2. Floor to bottom of pipe insulation jacket: 150 mm (six inches).
3. Wall to side of pipe insulation jacket: 75 mm (three inches).
4. Ceiling to top of pipe insulation jacket: 25 mm (one inch).

3.10 BALL JOINT INSTALLATION:

Location, spacing and cold set shall conform to layout drawings approved by manufacturer of ball joints. Representative of manufacturer shall visit site and verify that installation is proper. Locate to allow access to all packing injection devices, when provided.

3.11 EXPANSION JOINTS (BELLOWS AND SLIP TYPE) :

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments that will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Clean all sliding surfaces, add packing as necessary, remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible manhole or in walk-through tunnel. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

3.12 INSTALLATION - SAFETY VALVES:

- A. Location: Valves must be upright and oriented so that lifting levers are accessible from nearest walkway.
- B. Vent System: Instead of drip pan ells, provide special flexible connector on each safety valve that is designed to avoid blow-back of steam into the tunnel or manhole. Provide slip joint arranged to prevent vent line from imposing any strain on safety valve and to prevent moisture accumulation in safety valve. Support vent line from above. Provide drain line to nearest floor drain from flexible connector. Provide separate vent line from each safety valve to atmosphere unless otherwise shown. Piping weight on safety valve outlet shall not exceed that allowed by valve manufacturer.
- C. Accessibility: Provide union or flanged connection at safety valve outlet to allow removal of safety valves without disassembling vents.

3.13 INSTALLATION - PRESSURE GAGES:

Locate at inlet and outlet of each pressure reducing station, on each pump discharge and after main stop valves (gate and butterfly valves) on steam distribution lines. Orient gages so that dials are upright and visible from nearest walkway and from operating point of main steam stop valves. Provide gage cock. Provide syphon on steam service. Provide liquid - filled gages on pump discharge.

3.14 INSTALLATION - THERMOMETERS:

Orient thermometers so that scales are upright and visible from nearest walkway. Locate wells in flow stream.

3.15 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 19 mm (3/4 inch) globe-valved warm-up bypasses at all steam gate and butterfly valves 80 mm (3 inch) pipe size and larger.
- D. Provide 19 mm (3/4 inch) 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.

3.16 THERMAL INSULATION:

- A. For piping in pre-engineered direct-buried systems refer to Part 2 of this specification.
- B. 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 shall be insulated with calcium silicate, fiberglass, or cellular glass pipe insulation, glass cloth or aluminum jacket.
 - 2. Exposed piping in walk-through tunnels shall be insulated with calcium silicate, fiberglass, or cellular glass pipe insulation, all service jacket. Condensate return piping may be insulated with rigid cellular phenolic, all service jacket.
 - 3. Piping in manholes shall be insulated with calcium silicate or cellular glass pipe insulation, glass cloth or aluminum jacket.
 - 4. Minimum Insulation Thickness: Insulation thicknesses given in Table 5 and 6 are manufacturer's nominal thickness.

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

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

Insulation listed has passed a boiling test:

Delta is available from Rockwool Manufacturing Co., Leeds, AL.

Foamglass is available from Pittsburgh Corning Corp., Pittsburgh, PA.

MPT is available from Mineral Products of Texas, Houston, TX.

Thermo-12 and Super Caltemp are available from Johns-Manville, Denver, CO.

Insul-phen is available from Resolco International Div.

www.resolco.com

5. Parts Not Insulated:

Threaded valves

Steam traps

Check valves

Unions

Threaded strainers

Strainer basket removal cover and bolting

Dielectric flanges and unions

Expansion joints

Flexible connectors

Ball joints except piping between joints

6. Installation:

a. Complete all pressure tests before installing insulation.

b. All insulation material shall be new, clean, dry and stored in a clean dry environment; jacketing materials shall 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 manufacturers 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 for covering with glass cloth. 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 or PVC premolded cover. On sizes 50 mm (two inches) and smaller it is permissible to apply insulating and finishing cements, and cover with jacket or PVC premolded cover.
- l. Fiberglass insulated piping systems fittings over 50 mm (two inch) size shall be insulated with specified molded pipe fitting insulation or compressed blanket, finished with specified insulating and finishing cements and covered with specified PVC fitting jacket. On sizes 50 mm (two inches) and under apply insulating and finishing cements and cover with PVC fitting jacket.
- m. Apply glass cloth jacket using an approved adhesive. Glass cloth shall be smooth, tight and neatly finished at all edges; prime cloth to receive paint specified in Section 09 91 00, PAINTING.

3.17 BURIED UTILITY WARNING TAPE:

Bury directly above direct-buried system approximately 300 mm (12 inches) below grade.

3.18 IDENTIFICATION SIGNS:

- A. Valve Identification: Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16 inch) 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. Pipe Identification: Label service of all pipes in manholes and walk-thru tunnels. Refer to Section 09 91 00, PAINTING.

3.19 TESTS:

- 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 RE/COTR.
- 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. Radiographic testing of carrier pipe welds: Refer to Article, WELDING, in Part 3 of this specification.
- E. 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 RE/COTR.
- F. Hydrostatic and Operational Tests of Carrier Piping: 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 RE/COTR 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 RE/COTR 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 1 kPa (0.1 psi).
5. Repeat tests when failures occur.
6. After completion of satisfactory test, replace all elements that have been removed prior to testing.

G. 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 100 kPa (15 psi) 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 1 kPa (0.1 psi).
4. Each casing field joint shall be tested for leaks by means of soap solution or equivalent.

I. Deficiencies discovered shall be corrected at the Contractor's expense, to satisfaction of RE/COTR. Major deficiencies or failure to correct deficiencies, to the satisfaction of the RE/COTR, may be considered cause for rejecting the entire installation.

- - - END - - -