Repair Steam lines Specs

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SECTION 23 07 11
HVAC AND BOILER PLANT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Field applied insulation for thermal efficiency and condensation control for

1. HVAC piping, ductwork and equipment.

//2. Boiler plant mechanical systems including burner fuel oil storage and handling facilities but excluding outside steam distribution.//

//3. Re-insulation of HVAC piping, ductwork and equipment, plumbing piping and equipment and boiler plant piping, breeching and stacks and equipment after asbestos abatement.//

B. Definitions

1. ASJ: All service jacket, white finish facing or jacket.
2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
4. Concealed: Ductwork and piping above ceilings and in chases, //interstitial space, // and pipe spaces.
5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical//, Boiler Plant// and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, //interstitial spaces, // unfinished attics, crawl spaces and pipe basements are not considered finished areas.
6. FSK: Foil-scrim-kraft facing.
7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F);HVAC equipment or piping handling media above 41 degrees C (105 degrees F)//; Boiler Plant breechings and stack temperature range 150-370 degrees C(300-700 degrees F) and piping media and equipment 32 to 230 degrees C(90 to 450 degrees F)//.
8. Density: kg/m^3 - kilograms per cubic meter (Pcf - pounds per cubic foot).

9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.
10. Thermal conductance: Heat flow rate through materials.
    a. Flat surface: Watt per square meter (BTU per hour per square foot).
    b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).
11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.
13. HPS: High pressure steam (415 kPa [60 psig] and above).
14. HPR: High pressure steam condensate return.
15. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig].
16. MPR: Medium pressure steam condensate return.
17. LPS: Low pressure steam (103 kPa [15 psig] and below).
18. LPR: Low pressure steam condensate gravity return.
19. PC: Pumped condensate.
20. HWH: Hot water heating supply.
21. HWHR: Hot water heating return.
22. GH: Hot glycol-water heating supply.
23. GHR: Hot glycol-water heating return.
24. FWPD: Feedwater pump discharge.
25. FWPS: Feedwater pump suction.
26. CTPD: Condensate transfer pump discharge.
27. CTPS: Condensate transfer pump suction.
28. VR: Vacuum condensate return.
29. CPD: Condensate pump discharge.
30. R: Pump recirculation.
31. FOS: Fuel oil supply.
32. FOR: Fuel oil return.
33. CW: Cold water.

34. SW: Soft water.
35. HW: Hot water.
36. CH: Chilled water supply.
37. CHR: Chilled water return.
38. GC: Chilled glycol-water supply.
39. GCR: Chilled glycol-water return.
40. RS: Refrigerant suction.
41. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

1.2 RELATED WORK

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
//B. Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.//
//C. Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT.//
D. Section 07 84 00, FIRESTOPPING.
E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
//F. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.//
G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
H. Section 23 21 13, HYDRONIC PIPING.
I. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING
J. Section 23 22 23, STEAM CONDENSATE PUMPS
K. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT
L. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS

1.3 QUALITY ASSURANCE

A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC // and Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION//.
B. Criteria:
1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

> **4.3.3.1** Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2., shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. *(See 4.2.4.2.)*

4.3.3.1.2 The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

4.3.3.2 Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:

(1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors

(2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

4.3.3.3 Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

4.3.3.4 Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.

4.3.3.5* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.

4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

//4.3.10.2.6.2 Pneumatic tubing for control systems shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance

with UL 1820, Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics. //

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

(1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides

(2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

2. Test methods: ASTM E84, UL 723, or NFPA 255.
3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Shop Drawings:

1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
   a. Insulation materials: Specify each type used and state surface burning characteristics.
   b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
   c. Insulation accessory materials: Each type used.
   d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
   e. Make reference to applicable specification paragraph numbers for coordination.

C. Samples:
   1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
   2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
   3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

1.5 STORAGE AND HANDLING OF MATERIAL

Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6 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.):

L-P-535E (2)- 99.....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.

C. Military Specifications (Mil. Spec.):

MIL-A-3316C (2)-90.....Adhesives, Fire-Resistant, Thermal Insulation

MIL-A-24179A (1)-87.....Adhesive, Flexible Unicellular-Plastic Thermal Insulation

MIL-C-19565C (1)-88.....Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier

MIL-C-20079H-87.....Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

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

A167-99(2004).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C411-05.....Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation

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

C533-09.....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

C534-08.....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

C547-07.....Standard Specification for Mineral Fiber pipe Insulation

C552-07.....Standard Specification for Cellular Glass Thermal Insulation

C553-08.....Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

C585-09.....Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)

C612-10.....Standard Specification for Mineral Fiber Block and Board Thermal Insulation

C1126-04.....Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation

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

D1668-97a (2006).....Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing

E84-10.....Standard Test Method for Surface Burning Characteristics of Building Materials

E119-09c.....Standard Test Method for Fire Tests of Building Construction and Materials

E136-09b.....Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C (1380 F)

E. National Fire Protection Association (NFPA):

90A-09.....Standard for the Installation of Air Conditioning and Ventilating Systems

96-08.....Standard~~s~~ for Ventilation Control and Fire Protection of Commercial Cooking Operations

101-09.....Life Safety Code

251-06.....Standard methods of Tests of Fire Endurance of Building Construction Materials

255-06.....Standard Method of tests of Surface Burning Characteristics of Building Materials

F. Underwriters Laboratories, Inc (UL):

723.....UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 09/08

G. Manufacturer’s Standardization Society of the Valve and Fitting Industry (MSS):

SP58-2009.....Pipe Hangers and Supports Materials, Design, and Manufacture

PART 2 - PRODUCTS

SPEC WRITE NOTE: Make material requirements agree with applicable requirements specified in the referenced Applicable Publications. Update and specify only that which applies to the project.

2.1 MINERAL FIBER OR FIBER GLASS

A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m^3 (3 pcf), k = 0.037 (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.

SPEC WRITER NOTE: See HVAC Design Manual Appendix 7-A Table 7-A1 for high humidity areas. Specify class B-5 duct insulation for high humidity areas.

B. ASTM C553 (Blanket, Flexible) Type I, // Class B-3, Density 16 kg/m^3 (1 pcf), k = 0.045 (0.31) // Class B-5, Density 32 kg/m^3 (2 pcf), k = 0.04 (0.27) // at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.

C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

2.2 MINERAL WOOL OR REFRACTORY FIBER

A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

2.3 RIGID CELLULAR PHENOLIC FOAM

A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1, k = 0.021(0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, k = 0.021 (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket.

2.4 CELLULAR GLASS CLOSED-CELL

A. Comply with Standard ASTM C177, C518, density 120 kg/m^3 (7.5 pcf) nominal, k = 0.033 (0.29) at 240 degrees C (75 degrees F).

B. Pipe insulation for use at temperatures up to 200 degrees C (400 degrees F) with all service vapor retarder jacket.

SPEC WRITER NOTE: Polyisocyanurate insulation does not meet the 50 smoke rating and therefore shall not be specified for piping or ductwork located indoors (only suitable for exterior locations per paragraph 1.3.B).

2.5 POLYISOCYANURATE CLOSED-CELL RIGID

A. Preformed (fabricated) pipe insulation, ASTM C591, type IV, K=0.027(0.19) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service vapor retarder jacket with polyvinyl chloride premolded fitting covers.

B. Equipment and duct insulation, ASTM C 591,type IV, K=0.027(0.19) at 24 degrees C (75 degrees F), for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL

ASTM C177, C518, k = 0.039 (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

2.7 DUCT WRAP FOR KITCHEN HOOD GREASE DUCTS

A. Light weight, high temperature mineral fiber or ceramic fiber insulating material with low thermal conductivity K value of 0.060 W/m^2 degrees C (0.417 Btu in/hr ft^2 degrees F) at mean temperature of 260 degrees C (500 degrees F).

B. Material shall be fully encapsulated by UL classified aluminum foil and tested to ASTM E84 standard.

C. Material shall be UL tested for internal grease fire to 1093 degrees C (2,000 degrees F) with zero clearance and for through-penetration firestop.

D. Material shall be UL classified for // 1 hour // 2 hour // fire rating for grease duct enclosure, and meet NFPA 96 requirements for direct applied insulating material to grease ducts with zero clearance.

E. Material flame spread and smoke developed ratings shall not be higher than 5, as per ASTM E 84/UL 723 Flammability Test.

2.8 CALCIUM SILICATE

A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.

B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.

C. Equipment Insulation: ASTM C533, Type I and Type II

D. Characteristics:

Insulation Characteristics		
ITEMS	**TYPE I**	**TYPE II**
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m^3 (lb/ ft3)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft^2 degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

2.9 INSULATION FACINGS AND JACKETS

A. Vapor Retarder, higher strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.

B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.

C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.

DESIGNER'S NOTE: See HVAC Design Manual Appendix 7-A Table 7-A1 for high humidity areas. Field applied vapor barrier jackets shall be provided for all exterior piping piping and ductwork as well as on interior piping and ductwork

//exposed to outdoor air conveying fluids below ambient temperature. In addition, in high humidity areas, field applied vapor barrier jackets shall be provided for all interior piping conveying fluids below ambient temperature. The application of vapor barriers in areas other than high humidity areas and/or for all interior piping and/or ductwork conveying fluids below ambient temperature is optional for the designer.

D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork //exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.)in high humidity areas//conveying fluids below ambient temperature//. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

E. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.

F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.

G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.

H. Aluminum Jacket-Piping systems// and circular breeching and stacks//: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm

(0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

//I. Aluminum jacket-Rectangular breeching: ASTM B209, 3003 alloy, H-14 temper, 0.5 mm (0.020 inches) thick with 32 mm (1-1/4 inch) corrugations or 0.8 mm (0.032 inches) thick with no corrugations. System shall be weatherproof if used for outside service. //

DESIGNER'S NOTE: Removable insulation jackets shall be used on steam equipment and piping that will contribute to energy loss if not insulated but will still require maintenance access (This typically includes steam meters, large PRV stations, etc.).

//2.10 REMOVABLE INSULATION JACKETS

A. Insulation and Jacket:

1. Non-Asbestos Glass mat, type E needled fiber.
2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
4. Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.//

2.11 PIPE COVERING PROTECTION SADDLES

A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at

supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

//C. Boiler Plant Pipe supports: MSS SP58, Type 39. Apply at all pipe support points, except where MSS SP58, Type 3 pipe clamps provided as part of the support system. //

2.12 ADHESIVE, MASTIC, CEMENT

A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.

B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.

C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.

D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.

E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.

F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.

G. Other: Insulation manufacturers' published recommendations.

2.13 MECHANICAL FASTENERS

A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.

B. Staples: Outward clinching // monel or // galvanized steel.

C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.

D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.14 REINFORCEMENT AND FINISHES

A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).

B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.

C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.

D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.

E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick

(28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.

F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

2.15 FIRESTOPPING MATERIAL

Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

2.16 FLAME AND SMOKE

Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.

//C. Where removal of insulation of piping, ductwork and equipment is required to comply with Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT and Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT, such areas shall be reinsulated to comply with this specification. //

D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal

projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.

F. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

G. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.

H. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.

//I. Insulate PRVs, flow meters, and steam traps.//

I. HVAC work not to be insulated:

1. Internally insulated ductwork and air handling units.
2. Relief air ducts (Economizer cycle exhaust air).
3. Exhaust air ducts and plenums, and ventilation exhaust air shafts.

SPEC WRITER NOTE: Edit this list if additional equipment is required, or if certain equipment is insulated for safety reasons.

4. Equipment: Expansion tanks, flash tanks, hot water pumps, //steam condensate pumps. //
5. In hot piping: Unions, flexible connectors, control valves, //PRVs//, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.

//J. Boiler plant work not to be insulated(NI)or if insulated the insulation shall be removal jacket type (RJ):

1. Pipes, valves and fittings:

a. Gas fuel(NI)
b. Oil unheated (NI)
c. Compressed Air (NI)
//d. Flowmeter sensing piping and blowdown // (NI)
e. Level sensor piping and blowdown (NI)
f. Tank drains (NI)
g. Vents-tank, safety and back pressure valves except protective. (NI)
h. Continuous blowdown and boiler water sampling except protective. (NI)
i. Threaded valves (RJ)
j. Check valves (RJ)
k. Unions (RJ)
l. Orifice flanges (RJ)
m. Dielectric flanges and unions (RJ)
n. Steam header drains (NI)
o. Non-return stop and check valve drains (NI)
p. Pneumatic controls (NI)
q. Pressure transmission to gages (NI)
r. Piping in control panels (NI)
s. Tube cleaning piping (NI)
t. Chemical feed from pump-type feeders (NI)
u. Condensate piping from flash tank to condensate return pump (NI)

2. Boilers:
a. Water column, piping and blowdown (NI)
b. Auxiliary low water cutoff, piping and blowdown(NI)
c. Remote water level indicators and piping blowdown(NI)
d. Steam gage piping(NI)
e. Soot blower and piping(NI)
f. Safety valves and drip pan ells(NI)
g. Water level sensors and piping except where required by equipment manufacturer(NI)
h. Control piping and devices or interlocks(NI)
i. Drum heads (watertube boilers) (NI)

3. Equipment:
a. Condensate return pump units(NI)
b. Vacuum return pump units(NI)
c. Pumps-inlet to outlet(NI)

d. Flash tanks(NI)
e. Safety valves(NI)
f. Water meters(NI)
g. Oil meters(NI)
h. Air compressors and tanks(NI)
i. Refrigerated or desiccant air drier(NI)
j. Chemical feeders(NI)
k. Boiler and feedwater sampler(NI)
l. All nameplates (NI)

4. Specialties:

//a. Pressure reducing valves//(RJ)
b. Control valves-water and steam(NI)
c. Level sensors-piping, valves and blowdown(NI)
d. Back pressure regulators-oil and steam(NI)
e. Strainers under 65 mm (2-1/2 inch) pipe size(RJ)
f. Expansion bellows(RJ)
g. Flexible connectors(RJ)
h. Ball joints except piping between joints//(NI)

K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.

L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. // The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting.// Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.

M. Firestop Pipe and Duct insulation:

1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
   a. Pipe risers through floors
   b. Pipe or duct chase walls and floors
   c. Smoke partitions
   d. Fire partitions

N. Freeze protection of above grade outdoor piping (over heat tracing tape): 26 mm (10 inch) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide for cold water make-up to cooling towers and condenser water piping and chilled water piping as described in Section 23 21 13, HYDRONIC PIPING (electrical heat tracing systems).

O. Provide vapor barrier jackets over insulation as follows:

1. All piping and ductwork exposed to outdoor weather.

DESIGNER'S NOTE: See HVAC Design <Manual Appendix 7-A Table 7-A1 for high humidity areas. The application of vapor barriers in areas other than high humidity areas and/or for all interior piping and ductwork conveying fluids below ambient temperature is optional for the designer.

//2. All interior piping and ducts conveying fluids //exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.)// below ambient air temperature //in high humidity areas//.

P. Provide metal jackets over insulation as follows:

1. All piping and ducts exposed to outdoor weather.
2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

3.2 INSULATION INSTALLATION

A. Mineral Fiber Board:

1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
2. Plain board:

a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.

b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.

c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.

d. Chilled water pumps: Insulate with removable and replaceable 1 mm thick (20 gage) aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.

SPEC WRITER NOTE: Provide 50 mm (2 inch) duct insulation for supply and return duct work exposed to outdoor conditions. In paragraph 3.c below delete outdoor air duct insulation in mild climates (where the design temperature difference between the interior and exterior of the duct does not exceed 8 degrees C (15 degree F)).

3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics, //interstitial spaces// and duct work exposed to outdoor weather:

a. // 40 mm (1-1/2 inch) // 50 mm (2 inch) // thick insulation faced with ASJ (white all service jacket): Supply air duct // unlined air handling units // and afterfilter housing.

b. // 40 mm (1-1/2 inch) // 50 mm (2 inch) // thick insulation faced with ASJ: Return air duct, mixed air plenums and prefilter housing.

c. Outside air intake ducts: // no insulation required // 25 mm (one inch) thick insulation faced with ASJ.

d. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a maximum water vapor permeability of 0.001 perms.

4. Supply air duct in the warehouse and in the laundry: 25 mm (one inch) thick insulation faced with ASJ. //
5. Cold equipment: 40 mm (1-1/2inch) thick insulation faced with ASJ.
   a. Chilled water pumps, water filter, chemical feeder pot or tank.
   b. Pneumatic, cold storage water and surge tanks.
6. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.

SPEC WRITER NOTE: Insulate steam condensate pump receivers, flash tanks, and similar equipment if room is very small and would become excessively hot, or if it could represent a work hazard in areas of frequent maintenance.

   a. Convertors, air separators, steam condensate pump receivers.
   b. Reheat coil casing and separation chambers on steam humidifiers located above ceilings.
   c. Domestic water heaters and hot water storage tanks (not factory insulated).
   d. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.
7. Laundry: Hot exhaust ducts from dryers and from ironers, where duct is exposed in the laundry.

B. Flexible Mineral Fiber Blanket:

1. Adhere insulation to metal with 75 mm (3 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units,

coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.

3. Concealed supply air ductwork.
   a. Above ceilings at a roof level, in attics, and duct work exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with FSK.
   b. Above ceilings for other than roof level: 40 mm (1 ½ inch) thick insulation faced with FSK.
4. Concealed return air duct:
   a. //In attics (where not subject to damage) and where exposed to outdoor weather: 50mmm (2 inch)thick insulation faced with FSK, //
   b. Above ceilings at a roof level, unconditioned areas, and in chases with external wall or containing steam piping; 40 mm (1-1/2 inch) thick, insulation faced with FSK.
   //c. In interstitial spaces (where not subject to damage): 40 mm (1-1/2 inch thick insulation faced with FSK. //
   d. Concealed return air ductwork in other locations need not be insulated.
5. Concealed outside air duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.
6. Exhaust air branch duct from autopsy refrigerator to main duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.

C. Molded Mineral Fiber Pipe and Tubing Covering:
1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
2. Contractor's options for fitting, flange and valve insulation:
   a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.

b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.

c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.

d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).

3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

SPEC WRITER NOTE: Specify only cellular glass, polyisocyanurate (exterior only) or phenolic closed cell insulation for chilled water piping systems conveying fluids below ambient temperatures and/or where insulation for condensation control is specified.

D. Rigid Cellular Phenolic Foam:

1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).
2. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
3. Provide secure attachment facilities such as welding pins.
4. Apply insulation with joints tightly drawn together
5. Apply adhesives, coverings, neatly finished at fittings, and valves.
6. Final installation shall be smooth, tight, neatly finished at all edges.
7. Minimum thickness in millimeters (inches) specified in the schedule at the end of this section.
8. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a maximum water vapor permeance of 0.00 perms.

9. Condensation control insulation: Minimum 25 mm (1.0 inch) thick for all pipe sizes.
    a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.

E. Cellular Glass Insulation:
1. Pipe and tubing, covering nominal thickness in millimeters and inches as specified in the schedule at the end of this section.
2. Underground Piping Other than or in lieu of that Specified in Section 23 21 13, HYDRONIC PIPING and Section 33 63 00, STEAM ENERGY DISTRIBUTION: Type II, factory jacketed with a 3 mm laminate jacketing consisting of 3000 mm x 3000 mm (10 ft x 10 ft) asphalt impregnated glass fabric, bituminous mastic and outside protective plastic film.
    a. 75 mm (3 inches) thick for hot water piping.
    b. As scheduled at the end of this section for chilled water piping.
    c. Underground piping: Apply insulation with joints tightly butted. Seal longitudinal self-sealing lap. Use field fabricated or factory made fittings. Seal butt joints and fitting with jacketing as recommended by the insulation manufacturer. Use 100 mm (4 inch) wide strips to seal butt joints.
    d. Provide expansion chambers for pipe loops, anchors and wall penetrations as recommended by the insulation manufacturer.
    e. Underground insulation shall be inspected and approved by the Resident Engineer as follows:
        1) Insulation in place before coating.
        2) After coating.
    f. Sand bed and backfill: Minimum 75 mm (3 inches) all around insulated pipe or tank, applied after coating has dried.
3. Cold equipment: 50 mm (2 inch) thick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, air separators and air purgers.
4. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a water vapor permeability of 0.00 perms.

SPEC WRITER NOTE: Polyisocyanurate insulation does not meet the 50 smoke rating and therefore shall not be specified for piping or ductwork located indoors (only suitable for exterior locations per paragraph 1.3.B).

F. Polyisocyanurate Closed-Cell Rigid Insulation:

1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for exterior piping, equipment and ductwork for temperature up to 149 degree C (300 degree F).
2. Install insulation, vapor barrier and jacketing per manufacturer’s recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor barrier integrity.
3. Install insulation with all joints tightly butted (except expansion) joints in hot applications).
4. If insulation thickness exceeds 63 mm (2.5 inches), install as a double layer system with longitudinal (lap) and butt joint staggering as recommended by manufacturer.
5. For cold applications, vapor barrier shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor barrier shall be used to attach the vapor barrier or jacketing. No wire ties capable of penetrating the vapor barrier shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
6. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill PVC elbow jacket is prohibited on cold applications.
7. For cold applications, the vapor barrier on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor barrier adhesive tape.
8. All PVC and metal jacketing shall be installed so as to naturally shed water. Joints shall point down and shall be sealed with either adhesive or caulking (except for periodic slip joints).

9. Underground piping: Follow instructions for above ground piping but the vapor retarder jacketing shall be 6 mil thick PVDC or minimum 30 mil thick rubberized bituminous membrane. Sand bed and backfill shall be a minimum of 150 mm (6 inches) all around insulated pipe.
10. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.
11. Note the NFPA 90A burning characteristic requirements of 25/50 in paragraph 1.3B. Refer to paragraph 3.1 for items not to be insulated.
12. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section.

SPEC WRITER NOTE: Flexible elastomeric thermal insulation may be specified in lieu of mineral fiber insulation. However its use greater than 38 mm (1-1/2 inch) thickness is restricted and shall not be specified for ceiling spaces used as unducted return air plenums.

G. Flexible Elastomeric Cellular Thermal Insulation:
   1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
   2. Pipe and tubing insulation:
      a. Use proper size material. Do not stretch or strain insulation.
      b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC //and Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION//.
      c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.

3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section.
5. Minimum 20 mm (0.75 inch) thick insulation for pneumatic control lines for a minimum distance of 6 m (20 feet) from discharge side of the refrigerated dryer.
6. Use Class S (Sheet), 20 mm (3/4 inch) thick for the following:
   a. Chilled water pumps
   b. Bottom and sides of metal basins for winterized cooling towers (where basin water is heated).
   c. Chillers, insulate any cold chiller surfaces subject to condensation which has not been factory insulated.
   d. Piping inside refrigerators and freezers: Provide heat tape under insulation.
7. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.

H. Duct Wrap for Kitchen Hood Grease Ducts:
1. The insulation thickness, layers and installation method shall be as per recommendations of the manufacturer to maintain the fire integrity and performance rating.
2. Provide stainless steel jacket for all exterior and exposed interior ductwork.

I. Calcium Silicate:
1. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section for piping other than in boiler plant. See paragraphs 3.3 through 3.7 for Boiler Plant Applications.
2. Engine Exhaust Insulation for Emergency Generator and Diesel Driven Fire Pump: Type II, Class D, 65 mm (2 1/2 inch) nominal thickness. Cover exhaust completely from engine through roof or wall construction, including muffler. Secure with 16 AWG galvanized annealed wire or 0.38 x 12 mm 0.015 x 1/2 IN wide galvanized bands on 300 mm 12 IN maximum centers. Anchor wire and bands to welded pins, clips or angles. Apply 25 mm 1 IN hex galvanized wire over insulation. Fill voids with 6 mm 1/4 IN insulating cement.

3. ETO Exhaust (High Temperature): Type II, class D, 65 mm (2.5 inches) nominal thickness. Cover duct for entire length. Provide sheet aluminum jacket for all exterior ductwork.

//4. Kitchen Exhaust Duct work: Type II, class D, 65 mm (2.5 inches) nominal thickness. Wire insulation in place with 12 gauge galvanized wire. //

5. MRI Quench Vent Insulation: Type I, class D, 150 mm (6 inch) nominal thickness.

//3.3 APPLICATION –BOILER PLANT, PIPE, VALVES, STRAINERS AND FITTINGS:

A. Temperature range 120 to 230 degrees C (251 to 450 degrees F);

1. Application; Steam service 110 kpa (16 psig nominal) and higher, high pressure condensate to trap assembly, boiler bottom blowoff from boiler to blowoff valve closest to boiler.
2. Insulation and Jacket:
   a. Calcium silicate for piping from zero to 1800 mm (6 feet) above boiler room floor, feedwater heater mezzanine floor or access platform and any floors or platforms on which tanks or pumps are located.
   b. Mineral fiber for remaining locations.
   c. ASJ with PVC premolded fitting coverings.
   d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on atomizing steam and condensate lines at boilers and burners.
3. Thickness:

Nominal Thickness Of Calcium Silicate Insulation (Boiler Plant)

Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	125 (5)
25 to 38 (1-1/4 to 1-1/2)	125 (5)
38 (1-1/2) and above	150 (6)

B. Temperature range 100 to 121 degrees C (211 to 250 degrees F):

1. Application: Steam service 103 kpa (15 psig) and below, trap assembly discharge piping, boiler feedwater from feedwater heater to boiler feed pump recirculation, feedwater heater overflow, heated oil from oil heater to burners.

2. Insulation and Jacket:
   a. Calcium silicate for piping from zero to 1800 mm (0 to 6 feet) above boiler room floor, feedwater heater mezzanine floor and access platform, and any floors or access platforms on which tanks or pumps are located.
   b. Mineral Fiber or rigid closed cell phenolic foam for remaining locations.
   c. ASJ with PVC premolded fitting coverings.
   d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on condensate lines at boilers and burners.
3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	50 (2)
25 to 38 (1-1/4 to 1-1/2)	50 (2)
38 (1-1/2) and above	75 (3)

4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	38 (1.5)
25 to 38 (1-1/4 to 1-1/2)	38 (1.5)
38 (1-1/2) and above	75(3)

C. Temperature range 32 to 99 degrees C (90 to 211 degrees F):
   1. Application: Pumped condensate, vacuum heating return, gravity and pumped heating returns, condensate transfer, condensate transfer pump recirculation, heated oil system to heaters and returns from burners, condensate return from convertors and heated water storage tanks.
   2. Insulation Jacket:
      a. Calcium silicate for piping from zero to 1800 mm (six feet above boiler room floor, feedwater heater mezzanine floor and access

platform and any floor or access platform on which tanks or pumps are located.

b. Mineral fiber or rigid closed-cell phenolic foam for remaining locations.

c. ASJ with PVC premolded fitting coverings.

3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	38 (1.5)
25 to 38 (1-1/4 to 1-1/2)	50(2)
38 (1-1/2) and above	75 (3)

4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	19 (0.75)
25 to 38 (1-1/4 to 1-1/2)	19 (0.75)
38 (1-1/2) and above	25 (1)

D. Protective insulation to prevent personnel injury:

1. Application: Piping from zero to 1800 mm (6 feet) above all floors and access platforms including continuous blowoff, feedwater and boiler water sample, blowoff tank vent, flash tank vents and condensater tank vent, shot-type chemical feed, fire tube boiler bottom blowoff after valves, valve by-passes.
2. Insulation thickness: 25 mm (1 inch).
3. Insulation and jacket: Calcium silicate with ASJ except provide aluminum jacket on piping at boilers within 1800 mm (6 feet) of floor. Use PVC premolded fitting coverings when all service jacket is utilized.

E. Installation:

1. At pipe supports, weld pipe covering protection saddles to pipe, except where MS-SP58, type 3 pipe clamps are utilized.
2. Insulation shall be firmly applied, joints butted tightly, mechanically fastened by stainless steel wires on 300 mm (12 inch) centers.

3. At support points, fill and thoroughly pack space between pipe covering protective saddle bearing area.
4. Terminate insulation and jacket hard and tight at anchor points.
5. Terminate insulation at piping facilities not insulated with a 45 degree chamfered section of insulating and finishing cement covered with jacket.
6. On calcium silicate, mineral fiber and rigid closed-cell phenolic foam systems, insulated flanged fittings, strainers and valves with sections of pipe insulation cut, fitted and arranged neatly and firmly wired in place. Fill all cracks, voids and coat outer surface with insulating cement. Install jacket. Provide similar construction on welded and threaded fittings on calcium silicate systems or use premolded fitting insulation.
7. On mineral fiber systems, insulate welded and threaded fittings more than 50 mm (2 inches) in diameter with compressed blanket insulation (minimum 2/1) and finish with jacket or PVC cover.
8. Insulate fittings 50 mm (2 inches) and smaller with mastic finishing material and cover with jacket.
9. Insulate valve bonnet up to valve side of bonnet flange to permit bonnet flange removal without disturbing insulation.
10. Install jacket smooth, tight and neatly finish all edges. Over wrap ASJ butt strips by 50 percent. Secure aluminum jacket with stainless steel bands 300 mm (12 inches) on center or aluminum screws on 200 mm (4 inch) centers.
11. Do not insulate basket removal flanges on strainers.

3.4 APPLICATION-BOILER FLUE GAS SYSTEMS

A. Temperature range 150 to 370 degrees C (300 to 700 degrees F):
   1. Application: Transitions, stacks and breechings from boiler outlet to stack outlet; induced draft fans (if provided); flue gas recirculation fans and ductwork (if provided).
   2. Thickness:
      a. Single-wall duct systems: 50 mm (2 inches).
      b. Double-wall factory-fabricated duct systems with air space between walls: None.
   3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.

B. Protective Insulation to Prevent Personnel Injury:

1. Application: Double wall factory-fabricated duct system with uninsulated air space between walls within 900 mm (3 feet) horizontally and 1800 mm (6 feet) vertically of platform or floor.
2. Insulation thickness; 25 mm (1 inch).
3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.

C. Insulating:

1. Provide attachment facilities such as angles, welded studs, clip angles.
2. Apply insulation with joints tightly butted and staggered. Seal joints with high temperature cement.
3. Provide metal corner beads.
4. Band insulation firmly in place to provide a smooth surface. Maximum band spacing shall not be more than 300 mm (12 inches).
5. Install jacket. All surfaces outside of building must be weather tight. At termination of stub stacks, provide metal closure system which is connected and sealed to perimeter of stack to prevent water penetration of insulation.

3.5 APPLICATION-BOILER DEAERATING FEEDWATER HEATER, TANKS

A. Temperature range 38 to 120 degrees C (100 to 250 degrees F)

1. Application: Deaerating feedwater heater and storage tank, condensate storage tanks, heat exchangers, blowoff tank.
2. Insulation Thickness:
   a. Feedwater heater and storage tanks: 75 mm (3 inches)
   b. Condensate storage tanks: 50 mm (2 inches)
   c. Blowoff tank, heat exchangers: 25 mm (1 inch).
3. Insulation and covering: Calcium silicate with glass cloth jacket.

B. Insulating:

1. Insulate tanks with an assembly of chamfered block to fit curvature. Secure with 1.6 mm diameter (16 gage) wire or stainless steel bands 300 mm (12 inches) on centers, fill all voids and interstices with finishing cement coat, imbed hexagonal wire mesh in first finish coat. Provide a second finish coat and a glass cloth covering.
2. Apply glass cloth with adhesive, smooth, tight and neatly finished at all cloth edges; prime to receive paint.
3. Do not insulate over nameplates and data plates. Nameplates and data plates must be legible.

3.6 APPLICATION ON HEATED OR TRACED OIL FACILITIES OUTSIDE OF BUILDING

A. Temperature range 30 to 120 degrees C (85 to 250 degrees F).
   1. Application: Aboveground oil storage tank, oil and steam or hot water underground and aboveground piping systems.
   2. Insulation thickness:
      a. Tanks; 38 mm (1-1/2 inches) plus finish.
      b. Oil suction and return piping: 38 mm (1-1/2 inches plus finish).
      c. Steam or hot water piping: 38 mm (1-1/2 inches) plus finish.

B. Insulation and jacket (aboveground tanks and piping): Calcium silicate with glass cloth or aluminum jacket, weatherproof jacket when used outside of building.

C. Insulation and Jacket (underground piping); Calcium silicate with fiberglass scrim jacket located within secondary containment. Allow space for heating cable (if provided) along bottom line of piping. //

3.7 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.8 PIPE INSULATION SCHEDULE

Provide insulation for piping systems as scheduled below:

SPEC WRITER NOTE: Insulate vent piping for PRV safety valves, receivers and flash tanks where protection to personnel is required.

Insulation Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 – 32 (1 – 1¼)	38 – 75 (1½ - 3)	100 (4) and Above
122-177 degrees C (251-350 degrees F)	Mineral Fiber (Above ground piping only)	75 (3)	100 (4)	113 (4.5)	113 (4.5)

(HPS, MPS)					
93-260 degrees C (200-500 degrees F) (HPS, HPR)	Calcium Silicate	100 (4)	125 (5)	150 (6)	150 (6)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Mineral Fiber (Above ground piping only)	62 (2.5)	62 (2.5)	75 (3.0)	75 (3.0)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Rigid Cellular Phenolic Foam	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-99 degrees C (100-211 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
39-99 degrees C (100-211 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Polyiso-cyanurate Closed-Cell Rigid (Exterior Locations only)	38 (1.5)	38 (1.5)	----	----
38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	----	----
4-16 degrees C (40-60 degrees F)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

(CH, CHR, GC, GCR and RS for DX refrigeration)					
4-16 degrees C (40-60 degrees F) (CH and CHR within chiller room and pipe chase and underground)	Cellular Glass Closed-Cell	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Cellular Glass Closed-Cell	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC and GCR (where underground)	Polyiso-cyanurate Closed-Cell Rigid	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Polyiso-cyanurate Closed-Cell Rigid (Exterior Locations only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
(40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

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SECTION 23 22 13
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Steam, condensate and vent piping inside buildings. Boiler plant and outside steam distribution piping is covered in specification Section 33 63 00, STEAM ENERGY DISTRIBUTION and Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

1.2 RELATED WORK

A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

F. Section 23 07 11, HVAC, - AND BOILER PLANT INSULATION.

L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

E. Section 23 22 23, STEAM CONDENSATE PUMPS.

1.3 QUALITY ASSURANCE

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, which includes welding qualifications.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Manufacturer's Literature and Data:

1. Pipe and equipment supports.//Submit calculations for variable spring and constant support hangers//.
2. Pipe and tubing, with specification, class or type, and schedule.
3. Pipe fittings, including miscellaneous adapters and special fittings.
4. Flanges, gaskets and bolting.
5. Valves of all types.
6. Strainers.
7. Pipe alignment guides.
8. Expansion joints.
9. Expansion compensators.
10. Flexible ball joints: Catalog sheets, performance charts, schematic drawings, specifications and installation instructions.
11. All specified steam system components.
12. Gages.

13. Thermometers and test wells.
14. Electric heat tracing systems.

//15. Seismic bracing details for piping.//

C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
1. Heat Exchangers (Steam-to-Hot Water).
2. Flash tanks.

D. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

E. As-Built Piping Diagrams: Provide drawing as follows for steam and steam condensate piping and other central plant equipment.
1. One wall-mounted stick file for prints. Mount stick file in the chiller plant or adjacent control room along with control diagram stick file.
2. One set of reproducible drawings.

1.5 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 the basic designation only.

B. American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI):

B1.20.1-83(R2006).....Pipe Threads, General Purpose (Inch)
B16.4-2006.....Gray Iron Threaded Fittings

C. American Society of Mechanical Engineers (ASME):

B16.1-2005.....Gray Iron Pipe Flanges and Flanged Fittings
B16.3-2006.....Malleable Iron Threaded Fittings
B16.9-2007.....Factory-Made Wrought Buttwelding Fittings
B16.11-2005.....Forged Fittings, Socket-Welding and Threaded
B16.14-91.....Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads
B16.22-2001.....Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
B16.23-2002.....Cast Copper Alloy Solder Joint Drainage Fittings
B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500

B16.39-98.....Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300
B31.1-2007.....Power Piping
B31.9-2008.....Building Services Piping
B40.100-2005.....Pressure Gauges and Gauge Attachments
Boiler and Pressure Vessel Code: SEC VIII D1-2001, Pressure Vessels, Division 1

D. American Society for Testing and Materials (ASTM):
A47-99.....Ferritic Malleable Iron Castings
A53-2007.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A106-2008.....Seamless Carbon Steel Pipe for High-Temperature Service
A126-2004.....Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
A181-2006.....Carbon Steel Forgings, for General-Purpose Piping
A183-2003 ..... Carbon Steel Track Bolts and Nuts
A216-2008 ..... Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
A285-01 ..... Pressure Vessel Plates, Carbon Steel, Low-and-Intermediate-Tensile Strength
A307-2007 ..... Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A516-2006 ..... Pressure Vessel Plates, Carbon Steel, for Moderate-and- Lower Temperature Service
A536-84(2004)e1 ..... Standard Specification for Ductile Iron Castings
B32-2008 ..... Solder Metal
B61-2008 ..... Steam or Valve Bronze Castings
B62-2009 ..... Composition Bronze or Ounce Metal Castings
B88-2003 ..... Seamless Copper Water Tube
F439-06 ..... Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
F441-02(2008) ..... Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

E. American Welding Society (AWS):
A5.8-2004.....Filler Metals for Brazing and Braze Welding
B2.1-00.....Welding Procedure and Performance Qualifications

F. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:

SP-67-95.....Butterfly Valves
SP-70-98.....Cast Iron Gate Valves, Flanged and Threaded Ends
SP-71-97.....Gray Iron Swing Check Valves, Flanged and Threaded Ends
SP-72-99.....Ball Valves with Flanged or Butt-Welding Ends for General Service
SP-78-98.....Cast Iron Plug Valves, Flanged and Threaded Ends
SP-80-97.....Bronze Gate, Globe, Angle and Check Valves
SP-85-94.....Cast Iron Globe and Angle Valves, Flanged and Threaded Ends

G. Military Specifications (Mil. Spec.):

MIL-S-901D-1989.....Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, and Systems

H. National Board of Boiler and Pressure Vessel Inspectors (NB): Relieving Capacities of Safety Valves and Relief Valves

I. Tubular Exchanger Manufacturers Association: TEMA 18th Edition, 2000

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

2.2 PIPE AND TUBING

A. Steam Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40.

B. Steam Condensate and Pumped Condensate Piping:

1. Concealed above ceiling, in wall or chase: Copper water tube ASTM B88, Type K, hard drawn.
2. All other locations: Copper water tube ASTM B88, Type K, hard drawn; or steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80.

C. Vent Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40, galvanized.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded.

1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
2. Forged steel, socket welding or threaded: ASME B16.11.
3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron, except for steam and steam condensate piping. Provide 300 pound malleable iron, ASME B16.3 for steam and steam condensate piping. Cast iron fittings or piping is not acceptable for steam and steam condensate piping. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: ASME B16.39.
5. Steam line drip station and strainer quick-couple blowdown hose connection: Straight through, plug and socket, screw or cam locking type for 15 mm (1/2 inch) ID hose. No integral shut-off is required.

B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.
1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
2. Welding flanges and bolting: ASME B16.5:
a. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for saturated and superheated steam service 750 degrees F and 1500 psi.
b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.

2.4 FITTINGS FOR COPPER TUBING

A. Solder Joint:
1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

2.5 DIELECTRIC FITTINGS

A. Provide where copper tubing and ferrous metal pipe are joined.

B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.

E. Contractor’s option: On pipe sizes 2” and smaller, screwed end brass gate valves // or dielectric nipples // may be used in lieu of dielectric unions.

2.6 SCREWED JOINTS

A. Pipe Thread: ANSI B1.20.

B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.7 VALVES

A. Asbestos packing is not acceptable.

B. All valves of the same type shall be products of a single manufacturer.

C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2100 mm (7 feet) or more above the floor or operating platform.

D. Shut-Off Valves

1. Gate Valves:

a. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.

b. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.

1) High pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1 inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.

2) All other services: MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves:

1. Globe Valves:

a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.

b. 65 mm (2 1/2 inches) and larger:

1) Globe valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

2. Angle Valves

a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.

b. 65 mm (2 1/2 inches) and larger:

1) Angle valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle valves.

F. Swing Check Valves

1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 psig), 45 degree swing disc.

2. 65 mm (2-1/2 inches) and Larger:

a Check valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system: Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

b. All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

G. Manual Radiator/Convector Valves: Brass, packless, with position indicator.

2.8 STRAINERS

A. Basket or Y Type. Tee type is acceptable for gravity flow and pumped steam condensate service.

B. High Pressure Steam: Rated 1034 kPa (150 psig) saturated steam.

1. 50 mm (2 inches) and smaller: Iron, ASTM A116 Grade B, or bronze, ASTM B-62 body with screwed connections (250 psig).
2. 65 mm (2-1/2 inches) and larger: Flanged cast steel or 1723 kPa (250 psig) cast iron.

C. All Other Services: Rated 861 kPa (125 psig) saturated steam.

1. 50 mm (2 inches) and smaller: Cast iron or bronze.
2. 65 mm (2-1/2 inches) and larger: Flanged, iron body.

D. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:

1. 75 mm (3 inches) and smaller: 20 mesh for steam and 1.1 mm (0.045 inch) diameter perforations for liquids.
2. 100 mm (4 inches) and larger: 1.1 mm (0.045) inch diameter perforations for steam and 3.2 mm (0.125 inch) diameter perforations for liquids.

2.9 PIPE ALIGNMENT

A. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

DESIGNER NOTE: Pipe loops are preferred. Provide pipe loops where possible.

2.10 EXPANSION JOINTS

A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines 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 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
   b. Steam Service 214-850 kPa (31-125 psig): Rated 1025 kPa (150 psig) at 186 degrees C (366 degrees F).

c. Steam Service 869-1025 kPa (126-150 psig): Rated 1375 kPa (200 psig) at 194 degrees C (382 degrees F).
d. Condensate Service: Rated 690 kPa (100 psig) at 154 degrees C (310 degrees 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 Expansion Joints Manufacturers Association Standards.

D. Bellows - Internally Pressurized Type:
1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
2. Internal stainless steel sleeve entire length of bellows.
3. External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
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 Type 304 stainless steel.
2. Internal and external guide 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. 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.

2.11 FLEXIBLE BALL JOINTS

A. Design and Fabrication: One piece component construction, fabricated from steel with welded ends, designed for a working steam pressure of 1720 kPa (250 psig) and a temperature of 232 degrees C (450 degrees F).

Each joint shall provide for 360 degrees rotation in addition to a minimum angular flexible movement of 30 degrees for sizes 6 mm (1/4 inch) to 150 mm (6 inch) inclusive, and 15 degrees for sizes 65 mm (2-1/2 inches) to 750 mm (30 inches). Joints through 350 mm (14 inches) shall have forged pressure retaining members; while size 400 mm (16 inches) through 760 mm (30 inches) shall be of one piece construction.

B. Material:

1. Cast or forged steel pressure containing parts and bolting in accordance with Section II of the ASME Boiler Code or ASME B31.1. Retainer may be ductile iron ASTM A536, Grade 65-45-12, or ASME Section II SA 515, Grade 70.
2. Gaskets: Steam pressure molded composition design for a temperature range of from minus 10 degrees C (50 degrees F) to plus 274 degrees C (525 degrees F).

C. Certificates: Submit qualifications of ball joints in accordance with the following test data:

1. Low pressure leakage test: 41 kPa (6psig) saturated steam for 60 days.
2. Flex cycling: 800 Flex cycles at 3445 kPa (500 psig) saturated steam.
3. Thermal cycling: 100 saturated steam pressure cycles from atmospheric pressure to operating pressure and back to atmospheric pressure.
4. Environmental shock tests: Forward certificate from a recognized test laboratory, that ball joints of the type submitted has passed shock testing in accordance with Mil. Spec MIL-S-901.
5. Vibration: 170 hours on each of three mutually perpendicular axis at 25 to 125 Hz; 1.3 mm to 2.5 mm (0.05 inch to 0.1 inch) double amplitude on a single ball joint and 3 ball joint off set.

2.12 STEAM SYSTEM COMPONENTS

A. Heat Exchanger (Steam to Hot Water): Shell and tube type, U-bend removable tube bundle, steam in shell, water in tubes, equipped with support cradles.

1. Maximum tube velocity: 2.3 m/s (7.5 feet per second).
2. Tube fouling factor: TEMA Standards, but not less than 0.00018 m^2K/W (0.001 ft^2hrF/Btu).
3. Materials:

a. Shell: Steel.

b. Tube sheet and tube supports: Steel or brass.

c. Tubes: 20 mm (3/4 inch) OD copper.

d. Head or bonnet: Cast iron or steel.

4. Construction: In accordance with ASME Pressure Vessel Code for 861 kPa (125 psig) working pressure for shell and tubes. Provide manufacturer's certified data report, Form No. U-1.

B. Optional Heat Transfer Package: In lieu of field erected individual components, the Contractor may provide a factory or shop assembled package of heat exchangers, pumps, and other components supported on a welded steel frame.

C. Steam Pressure Reducing Valves in PRV Stations:

1. Type: Single-seated, diaphragm operated, spring-loaded, external or internal steam pilot-controlled, normally closed, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.

2. Service: Provide controlled reduced pressure to steam piping systems.

3. Pressure control shall be smooth and continuous with maximum drop of 10 percent. Maximum flow capability of each valve shall not exceed capacity of downstream safety valve(s).

4. Main valve and pilot valve shall have replaceable valve plug and seat of stainless steel, monel, or similar durable material.

a. Pressure rating for high pressure steam: Not less than 1034 kPa (150 psig) saturated steam.

b. Connections: Flanged for valves 65 mm (2-1/2 inches) and larger; flanged or threaded ends for smaller valves.

DESIGNER NOTE: Evaluate the need to provide acoustical measures for maintaining the specified noise levels in the adjoining spaces.

5. Select pressure reducing valves to develop less than 85 dbA at 1500 mm (5 feet) elevation above adjacent floor, and 1500 mm (5 feet) distance in any direction. Inlet and outlet piping for steam pressure reducing valves shall be Schedule 80 minimum for required distance to achieve required levels or sound attenuators shall be applied.

DESIGNER NOTE: Use pneumatically controlled valves for replacement of existing valves in existing facilities

where continued use of pneumatics is required by the VA

//6. Pneumatically controlled valve: May be furnished in lieu of steam-operation. All specification requirements for steam operated valves apply. Valves shall close on failure of air supply.//

D. Safety Valves and Accessories: Comply with ASME Boiler and Pressure Vessel Code, Section VIII. Capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors, maximum accumulation 10 percent. Provide lifting lever. Provide drip pan elbow where shown.

E. Steam PRV for Individual Equipment: Cast steel or bronze body, screwed or flanged ends, rated 861 kPa (125 psig), or 20% about the working pressure, whichever is greater. Single-seated, diaphragm operated, spring loaded, adjustable range, all parts renewable.

F. Flash Tanks: Horizontal or vertical vortex type, constructed of copper bearing steel, ASTM A516 or ASTM A285, for a steam working pressure of 861 kPa (125 psig) to comply with ASME Code for Unfired Pressure Vessels and stamped with "U" symbol. Perforated pipe inside tank shall be ASTM A53 Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80. Corrosion allowance of 1.6 mm (1/16 inch) may be provided in lieu of the copper bearing requirement. Provide data Form No. U-1.

G. Steam Trap: Each type of trap shall be the product of a single manufacturer. Provide trap sets at all low points and at 61 m (200 feet) intervals on the horizontal main lines.

1. Floats and linkages shall provide sufficient force to open trap valve over full operating pressure range available to the system. Unless otherwise indicated on the drawings, traps shall be sized for capacities indicated at minimum pressure drop as follows:
   a. For equipment with modulating control valve: 1.7 kPa (1/4 psig), based on a condensate leg of 300 mm (12 inches) at the trap inlet and gravity flow to the receiver.
   b. For main line drip trap sets and other trap sets at steam pressure: Up to 70 percent of design differential pressure. Condensate may be lifted to the return line.
2. Trap bodies: Bronze, cast iron, or semi-steel, constructed to permit ease of removal and servicing working parts without disturbing connecting piping,(4 bolt raised face flange). For systems without relief valve traps shall be 5. Mechanism: Brass, stainless steel

or corrosion resistant alloy rated for the pressure upstream of the PRV supplying the system.

3. Balanced pressure thermostatic elements: Phosphor bronze, stainless steel or monel metal.
4. Valves and seats: Suitable hardened corrosion resistant alloy.
6. Floats: Stainless steel.
7. Inverted bucket traps: Provide bi-metallic thermostatic element for rapid release of non-condensables.

H. Thermostatic Air Vent (Steam): Brass or iron body, balanced pressure bellows, stainless steel (renewable) valve and seat, rated 861 kPa (125 psig) working pressure, 20 mm (3/4 inch) screwed connections. Air vents shall be balanced pressure type that responds to steam pressure-temperature curve and vents air at any pressure.

DESIGNER NOTES:
1. Humidifiers should be located in the Air Handling Unit as far as possible and where mandated by the design.
2. Direct boiler plant steam can be used, provided the boiler water treatment chemicals are FDA and OSHA approved. Otherwise, an unfired clean steam generator shall be used.

I. Steam Humidifiers:

1. Steam separator type that discharges steam into the air stream through a steam jacketed distribution manifold or dispersion tube. Humidifiers shall be complete with Y-type steam supply strainer; modulating, normally closed steam control valve; normally closed condensate temperature switch; and manufacturer's standard steam trap.
2. Steam separator: Stainless steel or cast iron.
3. Distribution manifold: Stainless steel, composed of dispersion pipe and surrounding steam jacket, manifold shall span the width of duct or air handler, and shall be multiple manifold type under any of the following conditions:
   a. Duct section height exceeds 900 mm (36 inches).
   b. Duct air velocity exceeds 5.1 m/s (1000 feet per minute).
   b. If within 900 mm (3 feet) upstream of fan, damper or pre-filter.
   d. If within 3000 mm (10 feet) upstream of after-filter.

DESIGNER NOTE: Coordinate water quality requirements with manufacturer and local

water quality conditions and provide additional equipment as recommended.

J. Unfired clean steam generator

1. Provide a packaged factory assembled, pre-piped unfired steam generator consisting of stainless steel shell, stainless steel tube coil, stainless steel steam piping, valves and controls All stainless steel piping shall be type //304//316 factory-fabricated and provided as a part of the complete package.
2. Shell: Stainless steel ASME code construction with flanged piping connections. (150 psig) maximum WSP.
3. Tubes: Stainless Steel tubes suitable for (150 psig) working pressure.
4. Design: Heated fluid in shell and heating fluid (higher pressure steam) in tubes.
5. Each steam generator shall be furnished with the following accessories:
   a. Resilient insulation.
   b. Pilot operated modulating control valve with pressure controller.
   c. Control pilot to maintain constant steam output.
   d. Pressure relief valve.
   e. Vessel and tube side pressure gages.
   f. Liquid level controller with brass feed water solenoid valve, in check valve and strainer.
   g. Over-pressure limit system with auto-reset.
   h. Factory packaging.
   i. Dual F&T condensate traps.
   j. Manual blow down valve.
   k. //Time based//TDS based// automatic blow down
   l. Low water cut-off and high pressure cut-off.
   m. Fully wired control box.
   n. Automatic drain solenoid valve.
6. Provide solid state control module with LED backlit LCD display and LED pilot lights to indicate on-off, high pressure, low pressure, low water and water feed. Control module shall allow the local adjustment of pressure limits on display screen. Control module shall have alarm light and alarm horn with built in alarm silence relay. Control module shall be supplied with dry contact closure outputs to indicate to building automation controls (BAC) the

occurrence of power on, high pressure, low pressure, low water and water feed. The control module shall allow the BAC to turn the unfired steam generator on or off through a remote relay suitable for 24 VAC, 1 amp. The control module shall allow the BAC to remotely monitor the operating pressure. Control module shall be supplied with an on-off switch and shall be mounted in a NEMA 1 panel. All solenoids and limits shall be 24 VAC.

K. Steam Gun Set: Furnish for ready coupling to building steam and cold water and designed for rinsing equipment (such as carts and racks) with hot or cold water, cleaning such articles with detergent-laden hot water or steam, or alternately sanitizing the articles with only live steam.
   1. Gun: Fit gun for finger-tip release of steam. Design so siphoning action will automatically mix detergent with gun effluent. Equip gun with hardwood front and rear handgrips. Include a 25 mm (15/16-inch) diameter, double tube butyl hose reinforced with braid and designed for 1034 kPa (150 psig) pressure. Hose shall be 3600 mm (12 feet) long.
   2. Detergent Tank: Furnish 9.5 L (2-1/2 gallon) polyethylene or fiberglass storage tank and fit for wall mounting. Also provide 13 mm (1/2 inch) diameter neoprene double wall detergent hose of the same length as steam hose. Fit hose-to-tank connection with strainer. Fit other end of hose with valve to regulate amount of detergent to be mixed with steam.
   3. Steam/Water Selector: Furnish manifold for wall mounting; design manifold to deliver only steam or water, or steam and water mix to gun. Construct mounting panel of stainless steel. Valves and piping located in panel shall be brass.
   4. Accessories: Provide one pair of protective gloves and three 50 mm (2 inch) diameter brushes, one nylon and two stainless-steel.

L. Steam Hose and Accessories: Hose shall be sufficiently flexible to be placed in a 100 mm (4 feet) diameter coil.
   1. Furnish and install in the mechanical room housing each PRV station a 7500 mm (25 feet) length of 13 mm (1/2 inch) ID steam hose, rated 861 kPa (125 psig) and a hose rack. In one end of the hose install a quick-couple device, suitable for steam service, to match corresponding devices in the PRV blowdown connections.

2. Hose storage rack: Wall-mounted, steel, iron or aluminum, semi-circular shape, with capacity to store 7500 mm (25 feet) of 13 mm (1/2 inch) ID steam hose.

SPEC WRITER NOTE: Provide flow meters as shown in the design and coordinate the metering requirements with any on-going metering projects at the VA facility.

M. Steam Flow Meter/Recorder: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

SPEC WRITER NOTE: Steam exhaust head is used on steam turbines. Delete this item if not applicable.

N. Steam Exhaust Head: Cast iron, fitted with baffle plates, to trap and drain condensed water.

2.13 GAGES, PRESSURE AND COMPOUND

A. ASME B40.1, Accuracy Grade 1A, (pressure, vacuum, or compound), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.

B. Provide brass, lever handle union cock. Provide brass/bronze pressure snubber for gages in water service. Provide brass pigtail syphon for steam gages.

C. Range of Gages: For services not listed provide range equal to at least 130 percent of normal operating range:

Low pressure steam and steam condensate to 103 kPa(15 psig)	0 to 207 kPa (30 psig).
Medium pressure steam and steam condensate nominal 413 kPa (60 psig)	0 to 689 kPa (100 psig).
High pressure steam and steam condensate nominal 620 kPa to 861 kPa (90 to 125 psig)	0 to 1378 kPa (200 psig).
Pumped condensate, steam condensate, gravity or vacuum (30” HG to 30 psig)	0 to 415 kPa (60 psig)

2.14 PRESSURE/TEMPERATURE TEST PROVISIONS

A. Provide one each of the following test items to the Resident Engineer:

1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, 762 mm (30 inches) Hg to 689 kPa (100 psig) range.
3. 0 - 104 degrees C (32-220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.15 FIRESTOPPING MATERIAL

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

SPEC WRITER NOTE: Verify that the extent of freeze protection for outdoor steam, condensate, and pumped condensate piping is clearly described and that electrical drawings show power supply to heat tracing.

2.16 ELECTRICAL HEAT TRACING SYSTEMS

//A. Systems shall meet requirements of the National Electrical Code (NEC), Section 427.

B. Provide tracing for outdoor piping subject to freezing temperatures (Below 38 degrees F) as follows:

//1. Steam piping exposed to weather. //

//2. Steam condensate exposed to weather.//

//3. Pumped condensate piping exposed to weather.//

C. Heat tracing shall be provided to the extent shown on the drawings (Floor Plans and Elevations). Heat tracing shall extend below grade to below the defined frost line.

D. Heating Cable: Flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself.

1. Provide end seals at ends of circuits. Wires at the ends of the circuits are not to be tied together.

2. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 2.2 degrees C (36 degrees F) minimum during winter outdoor design temperature, but not less than the following:
   a. 75 mm (3 inch) pipe and smaller with 25 mm (1 inch) thick insulation: 4 watts per foot of pipe.
   b. 100 mm (4 inch)pipe and larger 38 mm (1-1/2 inch) thick insulation: 8 watts per feet of pipe.

SPEC WRITER NOTE: Coordinate the need for emergency power with project drawings (electric discipline).

E. Electrical Heating Tracing Accessories:
   1. Power supply connection fitting and stainless steel mounting brackets. Provide stainless steel worm gear clamp to fasten bracket to pipe.
   2. 13 mm (1/2 inch) wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 300 mm (12 inch) intervals.
   3. Pipe surface temperature control thermostat: Cast aluminum, NEMA 4 (watertight) enclosure, 13 mm (1/2 inch) NPT conduit hub, SPST switch rated 20 amps at 480 volts AC, with capillary and copper bulb sensor. Set thermostat to maintain pipe surface temperature at not less than 1.1 degrees C (34 degrees F).
   4. Signs: Manufacturer's standard (NEC Code), stamped "ELECTRIC TRACED" located on the insulation jacket at 3000 mm (10 feet) intervals along the pipe on alternating sides.

PART 3 - EXECUTION

3.1 GENERAL

A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.

C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.

G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

H. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:

   1. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

I. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, and BOILER PLANT INSULATION.

J. Where copper piping is connected to steel piping, provide dielectric connections.

K. Pipe vents to the exterior. Where a combined vent is provided, the cross sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping one inch in 40 feet (0.25

percent) in direction of flow. Provide a drip trap elbow on relief valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 0.3 M (12 inches) above the roof or through the wall minimum 2.5 M (8 feet) above grade with down turned elbow.

3.2 PIPE JOINTS

A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder’s qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

3.3 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 which 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: 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 space. 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.

3.4 STEAM TRAP PIPING

A. Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 11 kg (25 pounds) independently of connecting piping.

//3.5 SEISMIC BRACING

A. Provide is accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

3.6 LEAK TESTING

A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.

B. An operating test at design pressure, and for hot systems, design maximum temperature.

C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.

3.7 FLUSHING AND CLEANING PIPING SYSTEMS

A. Steam, Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

3.8 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Adjust red set hand on pressure gages to normal working pressure.

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SECTION 33 63 00

STEAM ENERGY DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of underground steam distribution and condensate return piping system, including manholes, outside the buildings. System shall be: // walk through concrete tunnels // concrete shallow trenches // pre-engineered direct-buried drainable-dryable-testable (DDT) // pre-engineered direct-buried water-spread-limiting (WSL) //.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.

B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. Painting exposed steel and other surfaces: Section 09 91 00, PAINTING.

E. Steel for trench and tunnel pipe supports: Section 05 50 00, METAL FABRICATIONS.

F. Cathodic Protection of DDT Pre-Engineered Direct-Buried Systems: Section 26 42 00, CATHODIC PROTECTION.

G. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

H. Metering: SECTION 25 10 10, ADVANCED UTILITY METERING SYSTEM.

I. Erosion and Sediment Controls: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 DEFINITIONS

SPEC WRITER NOTE: Add definitions as necessary for project clarity.

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. Concrete Shallow Trench: A system with removable concrete covers located at grade.

E. Walk-through Concrete Tunnels: A system located below grade with sufficient space for carrier pipes, other services, and space to walk upright along the entire length of the system.

F. Carrier Pipe: Pipe carrying the steam or condensate.

G. Encasement Pipe: Outer protective pipe on any main line pipe. Carrier pipe and insulation are within the casing.

SPEC WRITER NOTE: Verify that the project drawings include the information listed below.

H. HP Systems: High-pressure piping operating at more than 15 psi (104 kPa) as required by ASME B31.1.

I. LP Systems: Low-pressure piping operating at 15 psi (104 kPa) or less as required by ASME B31.9.

1.4 ABBREVIATIONS

A. HDPE: high-density polyethylene

B. RTRP: reinforced thermosetting resin plastic

C. RTRF: reinforced thermosetting resin fittings

D. WOG: water, oil and gas

1.5 DELIVERY, STORAGE AND HANDLING

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

B. All insulated piping systems exposed to water must be replaced prior to installation.

1.6 COORDINATION

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

1.7 QUALITY ASSURANCE:

A. Products Criteria:

1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.

2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Contractor shall restore damaged items to as-new operating condition or replace damaged items as directed by the Contracting Officer’s Representative, at no additional cost to the Government.

C. 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

SPEC WRITER NOTE: Based on project design for local conditions, delete references not applicable for project.

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 // one year // 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

SPEC WRITER NOTE: Retain this article for direct-bury piping or to describe materials for carrier pipe for conduit or cased piping. Coordinate selection of type and thickness with choices made in "Piping Application" Article.

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

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

C. Malleable-Iron, Threaded Fittings shall be ASME B16.3, // Class 150 // and // Class 300 // .

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

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

E. Steel Welding Fittings: // ASME B16.9 // and // ASTM A234 //, seamless or welded.

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

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

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

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

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

2.2 FIBERGLASS PIPE AND FITTINGS

SPEC WRITER NOTE: Retain this article for direct-bury piping or to describe materials for carrier pipe for conduit or cased piping.

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. Mineral-Wool Pipe Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, // Type I, 850 deg F (454 deg C) // Type II, 1200 deg F (649 deg C) //, Grade A.
   a. Bands shall be ASTM A666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.
2. Calcium Silicate Pipe Insulation: ASTM C533, Type 1, flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement.
   a. Bands: ASTM A666, Type 304, stainless steel, 3/4 inch (19 mm) wide, 0.020 inch (0.5 mm) thick.

3. Polyisocyanurate Foam Pipe Insulation: Unfaced, preformed, rigid cellular polyisocyanurate 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: ASTM E84, 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm).
   c. Fabricate shapes: ASTM C450 and ASTM C585.
4. 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.

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: Polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.
3. Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet (3 m).
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. Manholes: Black steel with lifting eyes.
   1. Finish: Spray-applied urethane, minimum 30 mils (0.75 mm) thick.
   2. Access: 30 inches (750 mm) with waterproof cover, gasket, ladder, and two 6 inch (150 mm) vents, one high and one low, extending above grade with rain caps.
   3. Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.
   4. Sump: 12 inches (300 mm) in diameter, 12 inches (300 mm) deep.
   5. Floatation anchor: Oversized bottom keyed into concrete base.

F. 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 LOOSE-FILL INSULATION

A. Granular, loose-fill insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.
   1. Thermal Conductivity (k-Value): 0.60 at 175 deg F (0.087 at 79 deg C) and 0.65 at 300 deg F (0.094 at 149 deg C).
   2. Application Temperature Range: 35 to 800 deg F (2 to 426 deg C).
   3. Dry Density: 40 to 42 lb/cu. ft. (640 to 672 kg/cu. m).
   4. Strength: 12,000 lb/sq. ft. (58,600 kg/sq. m).

B. Powder, loose-fill insulation: Inert, nontoxic, nonflammable, calcium carbonate particles. Include chemical treatment that renders insulation hydrophobic.
   1. Thermal Conductivity (k-Value): ASTM C177, 0.58 at 100 deg F (0.084 at 37 deg C) and 0.68 at 300 deg F (0.098 at 149 deg C).
   2. Application Temperature Range: Minus 273 to plus 480 deg F (Minus 169 to plus 250 deg C).
   3. Dry Density: Approximately 60 lb/cu. ft. (960 kg/cu.).
   4. Strength: 12,000 lb/sq. ft. (58,600 kg/sq. m).

SPEC WRITER NOTE: Drainable-Dryable-Testable (DDT) direct-buried systems are permitted at all sites (Class A, B, C, D). Water-Spread-Limiting (WSL) systems are permitted at Class B, C, and D sites. Site classifications depend on the groundwater table as per geotechnical report.

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

SPEC WRITER NOTES:

1. Increase the pressures and temperatures listed below as necessary to suit the project.

2. This type of system is allowed in Class A, B, C, D site conditions as defined in Appendix III.

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.

SPEC WRITER NOTE: Label pipe Sections A, B, etc. on the drawings to identify the locations of various steam temperatures (pressures).

2. Section A: Steam temperature is // _____deg F (_____ deg C), steam pressure is ____psi (kPa) //. Pumped condensate temperature is 300 deg F (93 deg C). Drip return temperature is 212 deg F (100 deg C).
3. Section B: Steam temperature is // _____deg F (_____deg C), steam pressure is ____psi (kPa) //. Pumped condensate temperature is 200 deg F (93 deg C). Drip return temperature is 212 deg F (100 deg C).
4. Allowable Carrier Pipe Insulation Type and Minimum Insulation Thickness:

TABLE 1
Minimum Pipe Insulation Thickness mm (inches)
For Steam 16 to 408 psi (110 to 2800 kPa) gage

Nominal Pipe Diameter Inches (mm)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp
1 (25)	2 (50)	2-1/2 (65)	4 (100)
1-1/2 (40)	2 (50)	2-1/2 (65)	4 (100)
2 (50)	2-1/2 (65)	3-1/2 (85)	4-1/2 (110)
2-1/2 (65)	2-1/2 (65)	3-1/2 (85))	4-1/2 (110)
3 (80)	3 (75)	4 (100)	5 (125)
4 (100)	3 (75)	4 (100)	5 (125)
5 (125)	3 (75)	4 (100)	5 (125)
6 (150)	3-1/2 (85)	4-1/2 (110)	5-1/2 (135)
8 (200)	3-1/2 (85)	4-1/2 (110)	5-1/2 (135)
10 (250)	4 (100)	5 (125)	6 (150)
12 (300)	4 (100)	5 (125)	6 (150)
14 (350)	4 (100)	5 (125)	6 (150)
16 (400)	4 (100)	5 (125)	6 (150)
18 (450)	4 (100)	5 (125)	6 (150)

Notes: Insulation listed has passed the 96-hour boiling water test. Pipes smaller than 1 inch (25 mm) shall have same insulation thickness as 1 inch (25 mm) pipe.

TABLE 2
Minimum Pipe Insulation Thickness inches (mm)
For Steam Less than 16 psi (110) gage, Condensate Return

Nominal Pipe Diameter inches (mm)	Nominal Pipe Diameter inches (mm)	Nominal Pipe Diameter inches (mm)	Nominal Pipe Diameter inches (mm)
1 (25)	1-1/2 (40)	2 (50)	3 (75)

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

Notes: Insulation listed has passed the 96-hour boiling water test which indicates that satisfactory performance in underground service can be expected. Pipes smaller than 1 inch (25 mm) shall have the same insulation thickness as required for 1 inch (25 mm) pipe.

E. Insulation Banding 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.

F. 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.

G. 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)

H. 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.

I. 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.

J. Gland Seals are not permitted because of the possibility of water entering the system thru the gland seal from a flooded manhole.

K. Provide continuous 1 inch (25 mm) minimum air space between carrier pipe insulation and casing.

L. 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.

M. 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.

N. 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.

O. 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.

P. 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).

Q. Manhole and building wall penetrations shall provide steel leak plates welded to wall sleeves or to casings. Where a wall sleeve is utilized, allow sufficient annular space between the sleeve and the casing and install a watertight seal, rated for 250 deg F (121 deg C) minimum. Manhole and building walls cannot be used as anchor points.

R. Provide sacrificial anode type cathodic protection system with dielectric isolation devices and test stations for all systems. Design system for 25 years service, assume two percent bare metal. System shall comply with NACE SP0169.

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.

T. All branch piping connections must be located in manholes.

Manholes

SPEC WRITER NOTE: In all cases and subject to VAMC management approval, the manholes need to reduce confined space access requirements. This includes easy access, and may include open or semi-open tops.

U. Reinforced concrete manholes: Not less than 8 inches (200 mm) thick. Pour monolithically where possible. Place waterproof membrane between mud slab and bottom concrete slab, and continue up sides to top of sidewalls. Joints between manhole walls and conduit casings or concrete trench sections shall be watertight. Steel manholes or prefabricated concrete manholes are not permitted.

V. Accessories for Manholes: Cast iron manhole frames and solid covers, not less than 28 inch (700 mm) clear openings. Unless otherwise shown on the drawings, frames and covers shall be as follows:

1. For non traffic applications:

a. Fed Spec. A-A-60005 NOT1, Frame Type IV, Size 28

b. Fed Spec. A-A-60005 NOT1, Cover Type E, Size 28, cast identification “STEAM”.

2. For traffic applications:
   a. Fed Spec. A-A-60005 NOT1, Frame Type I, Style A, Size 27A
   b. Fed Spec. A-A-60005 NOT1, Cover Type A, Size 27A, cast identification “STEAM”.
3. Manhole steps shall be standard, cast iron.

W. Manhole ventilation: As indicated on Drawings. Construct ventilation ducts of galvanized steel sheet metal and in accordance with ASHRAE Handbook recommendations for low pressure ducts. Gravity ventilators shall be factory fabricated of aluminum or galvanized steel and arranged as indicated on drawings. Ventilating pipes shall be standard weight black steel and installed as shown on drawings.

X. Drainage as shown on drawings. Provide a 24 inch (610 mm) square by 24 inch (610 mm) deep sump pit in each manhole where indicated on drawings. Provide larger sump pit if necessary to accommodate required electric sump pumps.

Y. Electric Sump Pumps with Automatic Controls and High Water Alarm:
1. Type: High temperature submersible duplex pumps and automatic controls.
2. Service: Continuous operation at required flows and pressures while completely submerged at 200 deg F (93 deg C). All pumps and pump controls shall have demonstrated 200,000 cycles of operation at 200 deg F (93 deg C) and 100% relative humidity while totally submerged in water.
3. Capacity and pressure: Pumps shall be capable of passing 0.375 inch (10 mm) spheres. Pumps and motors shall be capable of operating continuously without damage when not submerged.
4. Pumps: Epoxy-coated cast iron casing, cast iron impeller, stainless steel shaft, carbon/ceramic shaft seal, stainless steel hardware, permanently lubricated bearings, screened inlets. Schedule 80 discharge pipe protected from corrosion.
5. Motors: Non-overloading at all points on the pump performance curve. Include overload protection.
6. Controls: Automatic alternating lead-lag, with damp-proof electrical service.
7. High water alarm switch: Set at level below lowest steam or condensate pipe in the manhole. Switch shall activate weatherproof

red alarm light mounted above grade as shown. Provide contacts // and connect to // for future connection // to engineering control center.

2.6 TUNNELS (WALK THRU)

SPEC WRITER NOTE: Use A or B, or combination of both. If both are used, show locations on Drawings.

A. Reinforced concrete tunnel: Place waterproof membrane between mud slab and bottom concrete slab and continue up sides and over top of tunnel roof slab.

B. Precast concrete tunnel: ASTM C655. Construct precast concrete pipe tunnel with straight runs of tunnel. Provide cast-in-place concrete tunnel sections at each bend and at each change in grade of the tunnel. Mortar shall be as recommended by the precast concrete tunnel manufacturer.

C. Ventilation ducts: Galvanized sheet steel constructed in accordance with ASHRAE Handbook recommendations. Gravity ventilators shall be factory fabricated of aluminum or galvanized steel.

D. Provide drainage system at all low points of tunnel systems as shown on the drawings.

E. Waterproof manholes and below grade ventilation ducts.

2.7 CONCRETE SHALLOW TRENCHES

SPEC WRITER NOTE: Select cast in place or precast trenches.

A. Reinforced Cast-in-Place Trench: Reinforced concrete with minimum thickness 8 inches (200 mm).

1. Trench covers: Precast reinforced concrete sections, set to existing grade, flat and true at all points of contact on trench wall; trench and cover to form a watertight envelope when assembled.
2. Waterproofing: Apply to all below grade portions of the trench.
3. Gaskets and sealants: ASTM C920, 1/4 inch (6 mm) thick neoprene pads with a minimum width of 2 inches (50 mm) between covers and tops of walls; 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.

2.8 STEAM CARRIER PIPING

A. Pipe: // ASTM A53, steel, seamless, Grade B // or // ASTM A106, Grade B, electric resistance welded // or // ASTM A53, Grade B, Schedule 40 // .

Standard weight permitted for pipe sizes 12 inches (300 mm) and above. Grade F, furnace butt-welded pipe, is not permitted.

B. Joints:

1. In trenches and direct-buried systems: Butt-weld; socket weld for pipe sizes 2 inches (DN 50) and below. Manufacturer’s standard sliding gasketed joints are permitted between sections of WSL pre-engineered 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.
2. In tunnels, manholes and open areas: Butt weld pipe sizes 2-1/2 inches (65 mm) and above; thread or socket weld pipe sized 2 inches (50 mm) and below.

C. Fittings:

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

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

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

2.9 STEAM CONDENSATE CARRIER PIPING

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

B. Joints:

1. In Trenches and direct-buried systems: Butt weld joints. Socket weld is required for pipe sizes 2 inches (50 mm) and below. Manufacturer's standard sliding, gasketed joints are permitted between factory-fabricated sections of direct buried WSL system. No joints are allowed in factory-fabricated straight sections of pre-engineered direct-buried systems. Factory-fabricated direct-buried piping systems that are a portion of expansion loops or bends shall have all welded joints 100% radiograph inspected. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. Dye penetrant testing may be utilized for pipe sizes 2 inches (50 mm) and below.
2. In tunnels, manholes and open areas: Butt weld pipe sizes 2-1/2 inches (65 mm) and above; thread or socket weld pipe sizes 2 inches (50 mm) and below.

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

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

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

SPEC WRITER NOTE: Increase pressures and temperatures listed below if necessary to suit project conditions.

2.10 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).

2.11 EXPANSION JOINTS

A. 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 5-30 psi (35-200 kPa): Rated 50 psi (345 kPa) at 298 deg F (148 deg C)
   b. Steam Service 31-125 psi (214-850 kPa): Rated 150 psi (1025 kPa) at 366 deg F (186 deg C)
   c. Steam Service 126-150 psi (869-1025 kPa): Rated 200 psi (1375 kPa) at 382 deg F (194 deg C)
   d. Condensate Service: Rated 100 psi (690 kPa) at 310 deg F (154 deg C)
2. Number of Full Reverse Cycles without failure: Minimum 1000
3. Movement: Allowed as recommended safety factor of the manufacturer.

C. Internally pressurized bellows shall have:

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

D. Externally pressurized bellows shall have:

1. ASTM A240, multiple corrugations, 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. Include threaded connection at bottom, 1 inch (25 mm) minimum, for drain or drip point and integral external cover and internal sleeve.

E. Slip Type Joints shall include:

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, 1 inch (25 mm) minimum, for drain or drip point.

SPEC WRITER NOTE: The following requirement adds considerable cost and may be proprietary.

//2. Bolted packing gland permitting replacement of all packing and all sealing rings without removing joint from the line. //

F. Expansion Compensators are:
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.

G. Stamped brass or stainless steel nameplate: Indicating on each expansion joint 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.

H. 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.

2.12 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 shall be rated 250 psi (1725 kPa), 450 deg F (232 deg C), continuous on steam and condensate.

C. Submit independent certification that similar units have passed the following tests with no leaks.

1. Low Pressure Leakage Test: Minimum 6 psi (40 kPa) saturated steam for 60 days.
2. Life Cycle Flex Test: Minimum 8000 flex cycles at 250 psi (1725 kPa) 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: MIL S 901.
5. Vibration Test: Test for 170 hours on each of three mutually perpendicular axes at 25 to 125 HZ; 0.05 to 0.10 inch (1 to 2 mm) double amplitude on a single ball joint and on a three ball joint offset.

D. Joints: ASME B31.1:

1. Cast or forged carbon steel with welded ends.
2. Standard weight pipe wall thickness.
3. Minimum angular movement capability: 15 degrees and 360 degrees rotational movement.
4. Gaskets: Non asbestos.
5. Packing injection devices, if provided: Allow injection under full line pressure. Provide one year supply of packing.

2.13 VALVES

A. Gate Valves (ASTM A126):

1. Type 101 shall have:
   a. Cast steel body, rated 150 psi (1025 kPa) at 500 deg F (260 deg C), 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 150 psi (1025 kPa) flanged ends, OS&Y, rising stem, bolted bonnet.
   b. Factory installed globe valved bypass on all steam valves larger than 3 inches (80 mm).
   c. Drill and tap bosses for connection of drains where shown.
2. Type 102 is not used.
3. Type 103 shall have:
   a. Cast iron body, Class B, rated for 125 psi (850 kPa) saturated steam, 200 psi (1375 kPa) WOG, bronze or bronze faced wedge and

seats, 125 psi (850 kPa) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.

4. Type 104 shall have:
   a. Bronze body, rated for 200 psi (1375 kPa) saturated steam, 400 psi (2750 kPa) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.
5. Type 105 is not used.
6. Type 106 shall have:
   a. Forged steel body, rated for 300 psi (2050 kPa) at 420 deg F (216 deg C) minimum Class 600 psi (4130 kPa) or Class 800 psi (5500 kPa), hardened stainless steel or satellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.

B. Globe Valves (ASTM A126):
1. Type 201 shall have:
   a. Cast steel body, rated 150 psi (1025 kPa) at 500 deg F (260 deg C), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 150 psi (1025 kPa) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains.
2. Type 202 is not used.
3. Type 203:
   a. Cast iron body, rated for 125 psi (850 kPa) saturated steam, 200 psi (1375 kPa) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 125 psi (850 kPa) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
4. Type 204:
   a. ASTM B61, bronze body, rated for 200 psi (1375 kPa) saturated steam, 400 psi (2750 kPa) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.

C. Check valves (ASTM A126):
1. Type 401 shall have:
   a. Cast steel body, swing-type, rated for 150 psi (1025 kPa) at 500 deg F (260 deg C), stainless steel or stainless steel - faced disc and seat, 150 psi (1025 kPa) ASME flanged ends, bolted cover, renewable disc.
2. Type 402 is not used.

3. Type 403 shall have:
   a. Cast iron body, Class B, swing-type, rated for 125 psi (850 kPa) saturated steam, 200 psi (1375 kPa) WOG, bronze or bronze-faced disc and seat, 125 psi (850 kPa) ASME flanged ends, bolted cover, renewable disc and seat.
4. Type 404 shall have:
   a. Bronze body, swing-type, rated for 200 psi (1375 kPa) saturated steam, 400 psi (2750 kPa) WOG, bronze disc, threaded ends, regrinding disc.

D. Ball valves (ASTM A126):

SPEC WRITER NOTE: Reduced port is permitted for bypass (throttling) service, full port required for all other services, one-fourth turn to open.

1. Type 501 is not used.
2. Type 502 shall have:
   a. Bronze body, rated for 150 psi (1025 kPa) at 365 deg F (185 deg C), 250 psi (1725 kPa) at 250 deg F (121 deg C); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, one-fourth turn to open.
3. Type 503 is not used.
4. Type 504 shall have:
   a. Carbon steel or ductile iron body, saturated steam service, rated for 150 psi (1030 kPa), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, 150 psi (1025 kPa) ASME flanged ends. Manufacturer: American, Worcester, or equal.

E. Butterfly valves (ASTM A126):

1. Type 601 shall have:
   a. Ductile iron body, wafer style, rated for 125 psi (850 kPa), 212 deg F (100 deg C), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, geared handwheel operator for valves 4 inch (100 mm) pipe size and larger, ratchet handle operator for smaller pipe sizes.
2. Type 602:
   a. Triple-offset, lug or flanged type, carbon steel body, steam service, rated for 150 psi (1025 kPa) at 500 deg F (260 deg C), stainless steel nitrided disc, stellite seat, stainless steel shaft, stainless steel/graphite-laminated seal ring, neck

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

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

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

2.14 STEAM PRESSURE REDUCING VALVES

A. Valves: 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. Controlled reduced pressure to steam piping systems: Design for saturated steam at pressures shown on drawings.

C. Pressure control: 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 2 inches (50 mm) and under: Cast iron body rated for 250 psi (1725 kPa), threaded ends. Valve plug and seat shall be replaceable, Type 316 stainless steel and include stainless steel stem.

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

2.15 STEAM TRAPS

A. Apply at steam line drip points.

B. Construct inverted bucket type with thermostatic vent in bucket, except closed-float-thermostatic on discharge side of pressure reducing stations. Each type furnished by a single manufacturer. Select the traps for pressures and capacities as shown or required. Fixed orifice or venturi type traps are not permitted.

C. Traps: // Cast iron // or // stainless steel // bodies. Construction shall permit ease of removal and servicing working parts without disturbing connecting piping. Include stainless steel floats, hardened chrome steel valves, stainless steel mechanisms and bi-metallic air vent on inverted bucket traps.

SPEC WRITER NOTE: Insert details of the existing trap monitoring system in //_____//.

D. Provide electronic trap performance monitoring devices that are compatible with the existing monitoring system. Trap malfunctions shall be automatically transmitted to and properly interpreted by the existing monitoring system. Provide all necessary power sources, transmitting and retransmitting devices and batteries to achieve a properly operating system. The existing monitoring system is // _____ //.

E. 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.

F. 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.

2.16 STRAINERS, Y TYPE

A. Provide as shown on steam and condensate piping systems.

B. Include open end removable cylindrical screen and threaded blow off connection.

C. For steam service up to 150 psi (1025 kPa) and at drip traps, strainer shall be rated for minimum 150 psi (1025 kPa) saturated steam; rated for 150 psi (1025 kPa), flanged ends, cast steel, for pipe sizes above 2 inches (50 mm). Use cast iron or bronze, rated for 250 psi (1725 kPa) saturated steam, threaded ends, for pipe sizes 2 inches (50 mm) and under.

D. For condensate service, strainer shall be rated for 125 psi (850 kPa) saturated steam, 175 psi (1200 kPa) WOG. Provide 125 psi (850 kPa), flanged ends, cast iron, for pipe sizes above 2 inches (50 mm). Provide cast iron or bronze, threaded ends, for pipe sizes 2 inches (50 mm) and under.

E. Strainer screen shall be stainless steel, with a free area not less than 2 1/2 times flow area of pipe. Diameter of openings shall be 0.05 inch (1.3 mm) or less on steam service and 0.06 inch (1.5 mm) or less on water service.

F. Include gate type valve and quick couple hose connection on all blowoff connections.

2.17 SAFETY VALVES AND VENT CONNECTORS

A. Safety valves: 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: Not 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 15 psi (100 kPa). Drip pan ells not allowed in tunnels or constricted spaces because of “blow-back” of steam from the drip pan ell openings.

2.18 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. Gages: ASME B40.100

1. Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.

2. Non corrosive, 4-1/2 inch (110 mm) diameter face with black markings on white background.
3. Bourdon tube measuring element designed for service. Provide bellows for pressure ranges under 15 psi (100 kPa).
4. Stainless steel, rotary movement.
5. Micrometer adjustable, black color pointer.
6. Plastic window.
7. Provide liquid filled gages at outlet of all pumps.

C. Accuracy: 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. Include:

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.

SPEC WRITER NOTE: Verify with Facility personnel the preference for English or metric gage measurement units and edit accordingly.

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

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

2.19 THERMOMETERS, PIPE OR TANK MOUNTED

A. Thermometer locations are shown on the drawings.

B. Thermometers:

1. Industrial type, separable well and socket, union connected.
2. Red reading mercury combination Fahrenheit/Celsius scale, 9 inches (220 mm) long.
3. Corrosion resistant case with glass or plastic front.
4. Straight or back form except those located more than 7 feet (2100 mm) above floor shall be adjustable angle.

5. Wells sized to suit pipe diameter without restricting flow, or provide oversized pipe at well location. Snug sliding fit between socket and well.
6. Accuracy shall be one percent of scale range.
7. 30 to 300 deg F (0 to 150 deg C).

2.20 PIPE HANGERS AND SUPPORTS

A. Requirements: MSS SP 58 and ASME B31.1.

B. Applies to all piping not in factory-fabricated direct-buried system. All systems shall be completely supported. Arrange supports so that all loads due to weight, thermal expansion, 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.

C. Manufacturer Certification: Factory built products of a manufacturer whose principle business is pipe supports for // 5 // 10 // Insert number // years. All components must have published load ratings. For concrete trenches, non-factory built products that comply with details may be utilized.

SPEC WRITER NOTE: Confirm that the drawings conform to the following paragraph and all information as shown. Once verification that Drawings are accurate is complete, delete Paragraph D.

D. Drawings:

1. Types, sizes, locations, and spacing of all hangers and supports.
2. Roller or slider supports for all horizontal steam and condensate piping.
3. Special supports including anchors, guides and braces.
4. If equipment and piping arrangement differs from that shown on the drawings, support locations and types shall be revised at no cost to the government.
5. Supports to permit removal of valves and strainers from pipelines without disturbing supports.
6. Spring hangers on all systems subject to vertical movement.
7. Roller hangers and sliding supports on all systems subject to horizontal movement.

8. If vertical angle of hanger rod exceeds four degrees, rollers or sliders are required.
9. Loads for all supports. On systems utilizing variable spring supports; show the loads at each support by calculating the forces and moments throughout the system. // Seismic restraint calculations shall utilize the applicable shock spectra for the type of structure, type of supported system, and the locality. //
10. Vertical deflection: Shall not exceed 0.1 inch (2.5 mm) between supports when system is filled with fluid normally carried. // Deflections due to seismic shock shall be restrained as necessary to prevent overstressing the supported system or the connected equipment. Seismic restraints shall permit movement due to thermal expansion. //
11. Individual drawing for each hanger assembly showing all components, sizes, calculated loadings. Provide identification tags, on each hanger part, keyed to the layout drawings.

E. Components:
1. Roller supports: MSS SP 58, Type // 41 // 43 // and // 46 // . Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
2. Variable spring support assembly: MSS SP 58, // Type 51 variable spring // Type 3 pipe clamp // or // Type 1 clevis // Type 53 variable spring trapeze // . Locate Type 51 variable spring within 1 foot (300 mm) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.

F. Spring Cushion Support Assembly: MSS SP 58.
1. Double rod assembly: Type 41 and 49.
2. Single rod assembly: // Type 48 spring cushion // Type 3 pipe clamp or // Type 1 clevis // . Locate spring cushion within 1 foot (300 mm) above pipe attachment.

G. Clevis supports: MSS SP 58, Type 1.

H. Wall brackets: MSS SP 58, Type // 31 // 32 // or 33 // .

I. Pipe stands: MSS SP 58, Type 38.

J. Riser clamp: MSS SP 58, Type 42.

K. Alignment guides: Welded steel as shown to restrain movement perpendicular to the long axis of the piping. If not welded, provide steel spider clamped to pipe, enclosed within steel sleeve that is //

bolted // or // welded // to structural support. Must provide lateral force equal to minimum of 15 percent of anchor loading.

L. Trapeze supports: MSS SP 58, may be used where pipes are close together and parallel, structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with “U” bolts.

M. 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.

N. 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.

O. Pipe racks and miscellaneous supports: ASTM A36, structural steel shapes. Manufactured strut systems are acceptable if they have the required load carrying ability.

P. Supports, including all structural steel, in trenches and manholes: Hot-dip galvanized.

Q. Seismic Restraints:

1. Provide bracing as required. Refer to details on drawings.
2. Shock Absorbers: MSS SP 58, Type 50. Mechanical or hydraulic type rated for shock loads. Pipe attachments shall be MSS SP 58, Type 3.
3. Insulation Materials (In Manholes, Tunnels, Concrete Trenches, Open Areas)

R. 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, Type II Grade GU, and Type III, premolded fitted covering 0.020 inches (0.5 mm) thick.

S. Fiberglass Insulation:

1. Preformed piping insulation: ASTM C547, 450 deg F (230 deg C).
2. Fitting insulation: ASTM C547, 450 deg F (230 deg C), with polyvinyl chloride, Type II Grade GU, and Type III, premolded fitted covering 0.020 inches (0.5 mm) thick.

T. Rigid closed cell phenolic foam: ASTM C1126, Type III, Grade 1, 250 deg F (121 deg C).

U. Cellular glass insulation: ASTM C552.

V. Insulating and finishing cements: ASTM C449, as recommended by the manufacturer for the type of insulation system and service conditions.

W. Insulation bands: ASTM A167, minimum of 1/2 inch (12 mm) wide by 0.015 inch (0.4 mm) thick stainless steel.

X. Aluminum jackets: Minimum of 0.016 inch (0.4 mm) thick aluminum, 3003 alloy, H-14 temper, with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory fabricated to match material and construction of the straight run jackets. Factory fabricated stainless steel bands shall be furnished and installed on all circumferential joints. Bands shall be 0.75 inch (20 mm) wide on 18 inch (450 mm) centers. Bands shall be applied with manufacturers recommended sealant. Entire system shall be watertight.

Y. Service jackets: ASTM C1136, white kraft bonded to 0.001 inch (0.025 mm) thick aluminum foil, fiberglass reinforced, pressure sensitive adhesive closure, beach puncture tested to 50 units, suitable for painting without sizing. Jackets shall have a minimum 1-1/2 inch (40 mm) lap on longitudinal joints and not less than 4 inch (100 mm) 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.

Z. Glass cloth jacket: A minimum 7.8 ounces per square yard (0.24 kg per square meter), 300 psi (2000 kPa) bursting strength, weathertight for outside service. Beach puncture test to 50 units.

AA. Pipe covering protection saddles: MSS SP 58, Type 39 at all hanger points except where Type 3 pipe clamps are provided.

BB. Fire and smoke ratings of assembled insulation systems: ASTM C411 and NFPA 255, flame spread (25) and smoke developed (50) ratings.

2.21 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

SPEC WRITER NOTE: Verify work under A below. Provide specification to cover work to be done by re-writing Paragraph A.

A. If the carrier pipe insulation has failed (disintegrated) in an existing buried piping system, but the system is otherwise sound, there is an alternative to total replacement of injecting foam insulation into the existing system from above grade.

B. Connect new work to existing work in a neat and workmanlike manner. Where an existing structure must be cut or existing utilities interfere, such obstruction shall be bypassed, removed, replaced or relocated, patched and repaired. Piping connections shall be made only in manholes, tunnels or buildings.

C. 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.

D. 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 DEMOLITION

A. Perform work in accordance with requirements for phasing and the Drawings.

B. Completely remove all pipe, valves, fittings, insulation, and all hangers including the connection to the structure and any fastenings.

C. Seal all openings in manhole or building walls after removal of piping.

D. All material and equipment removed shall become the property of the Contractor and shall be removed from Government property and shall not be stored in operating areas.

E. All flame cutting shall be performed with adequate fire protection facilities available as required by safety codes and Contracting Officer’s Representative.

3.3 PIPING APPLICATION

SPEC WRITER NOTES:

1. Retain at least one pipe material in paragraphs below for each service required for Project. Services are specified separately to allow different pipe materials and joining methods for each. If materials and methods are the same for all services, combine the requirements by revising the paragraph titles. Pipe materials and joining methods in this article, in general, are as listed in the 2004 ASHRAE HANDBOOK - "HVAC Systems and Equipment," Ch. 41, "Pipes, Tubes, and Fittings." The change point for pipe materials and joining methods is specified, in this section of the Specifications, where the pipe size changes from NPS 2 to NPS 2-1/2 (DN 50 to DN 65). Revise this change point as required for project.

2. If Project includes steam and condensate piping with pressure ranges both higher and lower than 15 psi (104 kPa), retain this article and "HP Steam Piping" Paragraph and identify the pressure range of steam piping on Drawings; use similar designations. If pressure range for systems on Project is limited to 15 psi (104 kPa) and lower, or is limited to higher than 15 psi (104 kPa), retain only the appropriate paragraph and omit pressure designations on Drawings.

A. LP Steam Piping:

1. // NPS 2 (DN 50) and Smaller // : // Schedule 40 // Schedule 80 // , Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. // NPS 2-1/2 through NPS 12 (DN 65 through DN 300) // : // Schedule 40 // Schedule 80 // , Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. // NPS 14 through NPS 18 (DN 350 through DN 450) // : Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

4. // NPS 20 (DN 500) and Larger // : Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Conduit piping shall be // Standard weight // Schedule 40 // Schedule 80 // steel carrier pipe, with // mineral-wool // calcium silicate // polyisocyanurate // carrier-pipe insulation and with // coated // coated and insulated // conduit.
   a. Piping Insulation Thickness shall be // 1 inch (25 mm) // 2 inches (50 mm) //.

SPEC WRITER NOTE: If conduit piping is to be installed, retain "Conduit Insulation Thickness" subparagraphs below.

   b. Conduit Insulation Thickness shall be // 1 inch (25 mm) // 2 inches (50 mm) //.
   c. Insulation shall be // Polyisocyanurate // Polyurethane //.
6. Piping with // granular // powder //, loose-fill insulation.

B. HP Steam Piping:

1. // NPS 2 (DN 50) and Smaller // : // Schedule 40 // Schedule 80 // , Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. // NPS 2-1/2 through NPS 12 (DN 65 through DN 300) // : // Schedule 40 // Schedule 80 // , Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. // NPS 14 through NPS 18 (DN 350 through DN 450) // : Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. // NPS 20 (DN 500) and Larger // : Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Conduit Piping shall be // Standard weight // Schedule 40 // Schedule 80 // steel carrier pipe, with // mineral-wool // calcium silicate // polyisocyanurate // carrier-pipe insulation and with // coated // coated and insulated // conduit.
   a. Piping insulation thickness shall be // 1 inch (25 mm) // 2 inches (50 mm) //.

SPEC WRITER NOTE: If conduit piping is to be installed, retain "Conduit Insulation Thickness" subparagraphs below.

b. Conduit insulation thickness shall be // 1 inch (25 mm) // 2 inches (50 mm) //.

c. Insulation shall be // Polyisocyanurate // Polyurethane //.

6. Piping with // granular // powder //, loose-fill insulation.

C. Condensate Piping:

1. // NPS 2 (DN 50) // Insert pipe size // and smaller shall be the following:

SPEC WRITER NOTE: If conduit piping is to be installed, retain "Conduit Insulation Thickness" subparagraphs below.

a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

b. RTRP and RTRF with adhesive or flanged joints.

2. // NPS 2-1/2 (DN 65) // and larger shall be // either of // the following:

SPEC WRITER NOTE: If conduit piping is to be installed, retain "Conduit Insulation Thickness" subparagraphs below.

a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

b. RTRP and RTRF with adhesive or flanged joints.

3. Conduit Piping: // Standard-weight, steel pipe and fittings // Schedule 40, steel pipe and fittings // Schedule 80, steel pipe and fittings // Fiberglass pipe and fittings // with // mineral-wool // calcium silicate // polyisocyanurate // polyurethane // carrier-pipe insulation and with // coated // coated and insulated // conduit.

a. Piping insulation thickness shall be // 1 inch (25 mm) // 2 inches (50 mm) //.

SPEC WRITER NOTE: If conduit piping is to be installed, retain "Conduit Insulation Thickness" subparagraphs below.

b. Conduit insulation thickness shall be // 1 inch (25 mm) // 2 inches (50 mm) //.

4. Piping with // granular // powder //, loose-fill insulation.

3.4 PIPING INSTALLATION

A. Drawings indicate general location and arrangement of piping systems. Install piping insulation as indicated.

B. Standing water in the bottom of trench: Remove all water.

C. Pipe Bedding: Minimum 6 inch (150 mm) layer of sand.

D. Clearance: Minimum 6 inch (150 mm) clearance between the pipes.

E. Testing: Do not insulate piping or backfill piping trench until field quality-control testing has been completed and results approved.

F. Grade:

1. Install condensate piping at uniform grade of 0.4 percent downward in direction of flow.
2. Install 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.

SPEC WRITER NOTE: Retain this article for bare pipe installation requiring insulation.

M. Loose-Fill Insulation Installation:

1. Form insulation trench by excavation or by installing drywall side forms to establish the required height and width of the insulation.
2. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after back filling with insulation.
3. Place insulation and backfill after field quality-control testing has been completed and results approved.
4. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors.
5. Wrap piping at expansion loops and offsets with mineral-wool insulation of thickness appropriate for calculated expansion amount.
6. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.
7. Remove temporary hangers and supports.
8. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils (0.10 mm) thick, and empty loose-fill insulation bags on top.

9. Manually backfill with 6 inch (150 mm) lifts of clean backfill. If mechanical compaction is required, manually backfill with 12 inch (300 mm) lifts.

3.5 DRAIN VALVES AND VENT VALVES

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

3.6 PIPE SUPPORT INSTALLATION (IN TRENCHES, TUNNELS, MANHOLES)

A. Coordinate support locations prior to erection of piping. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site during construction.

B. Upper Attachments to Structure:

1. New reinforced concrete construction shall have concrete inserts.
2. For existing reinforced concrete construction, upper attachment shall be welded or clamped to steel clip angles (or other construction shown on the drawings) that are expansion bolted to the concrete. Expansion bolting shall be located so that loads place bolts in shear.
3. For steel deck and structural framing, upper attachments shall be welded or clamped to structural steel members.

C. In existing concrete construction, expansion fasteners may be used for hanger loads up to one third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.

D. Special Supports:

1. Secure horizontal pipes where necessary to prevent vibration or excess sway.
2. Where hangers cannot be adequately secured as specified, make special provisions for hanging and supporting pipe as approved by the Contracting Officer’s Representative.
3. Do not attach pipe supports, hangers, clamps or anchors to equipment unless specified for that equipment or unless the Contracting Officer’s Representative gives written permission.

E. Locate spring hangar units within 1 foot (300 mm) of the pipe attachment, except in locations where spring assemblies interfere with pipe insulation.

SPEC WRITER NOTE: Delete paragraph if not required on Project.

//F. Seismic Braces and Restraints: Do not insulate piping within 1 foot (300 mm) of device until device has been inspected by Contracting Officer's Representative. //

G. Minimum Clearances in Tunnels and Trenches:

1. Floor to bottom of pipe support beam: 2 inches (50 mm)
2. Floor to bottom of pipe insulation jacket: 6 inches (150 mm)
3. Wall to side of pipe insulation jacket: 3 inches (75 mm)
4. Ceiling to top of pipe insulation jacket: 1 inch (25 mm)

3.7 PAINTING EXPOSED STEEL SURFACES IN MANHOLES, TUNNELS AND CONCRETE SHALLOW TRENCHES

A. For manholes and walk-through tunnels, provide surface cleaning and preparation and apply prime coat of rust resistant metal primer.

B. For concrete shallow trenches, provide surface cleaning and preparation, apply primer and finish coat of zinc-rich paint.

3.8 DIRECT-BURIED SYSTEM INSTALLATION

A. The Contractor shall oversee the 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. Printed instructions must be available on site prior to delivery of system components. Any changes required to the design and layout of the system due to site conditions must be approved in writing by the Contracting Officer's Representative. All branch piping connections, valves and drip traps must be located within manholes.

B. Excavation, Trenching, and Backfilling: Perform all excavation, trenching, and backfilling as required by the system manufacturer's design. Beach sand or any sand with large amounts of chlorides is not permitted. Place system on a 6 inch (150 mm) thick sand bed and backfill on all sides with 6 inch (150 mm) thick sand as measured from outside the carrier pipe/insulation. Foundation for system must be firm and stable. Foundation and backfill must be free from rocks. Concrete anchor and thrust blocks must be installed in undisturbed earth. Backfilling must not commence until elevations have been surveyed and accepted and

system has been satisfactorily pressure tested including hydrostatic testing of carrier pipes and air testing of casings.

C. Maintain constant slope of carrier pipes as shown or specified. Prior to backfilling over the top of the casing, but after removal of temporary supports, Contractor shall measure and record elevations of top of casing in the trench. Elevations shall be taken at every field joint, 1/3 points along each pipe section, and at tops of elbows. These measurements shall be checked against contract drawings and shall confirm that the conduit system has been installed to the elevations shown on the contract drawings unless approved by the Contracting Officer’s Representative. Slope shall be uniform within 0.1 percent. Measurements shall be recorded by the Contractor, included in the direct buried system manufacturer representative’s daily report, and given to the Contracting Officer’s Representative prior to covering the top of the casing with backfill.

D. Provide cathodic protection for all steel casing systems and all buried exposed metal. Provide dielectric pipe flanges and unions and isolation devices at all points necessary. Provide test stations at grade on each section of the piping system. Isolation flanges and unions shall be rated for the carrier pipe service temperature and pressure.

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

G. 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.

H. Provide reports to the Contracting Officer’s Representative that include:

   1. Daily written report: Prepared daily and signed by the Contractor. Submit the original report to the Contracting Officer’s Representative on the same day it is prepared. Provide one set of field pictures of work daily.

2. Report Contents: State whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the manufacturer’s recommendations, changes to drawings and specifications, any corrective action that was taken of the system, identify any conditions that could result in an unsatisfactory installation.
3. Report Certification: Daily reports are to be reviewed, signed and sealed by the Professional Engineer responsible for the system installation.
4. Report Submittals and Stop Order: Daily reports shall be submitted with the payment requests. All work must stop if daily reports are not furnished and requests for payments shall be denied if the daily reports are not furnished.
5. Certification of Compliance: Upon completion of the work and 30 days prior to final acceptance, deliver to Contracting Officer’s Representative a notarized Certificate of Compliance signed by principal officers of Contractor, stating that the installation is satisfactory and in accordance with plans, specifications, and manufacturer’s instructions.
6. The Contractor shall retain copies of all the daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.

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

J. 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 through the tops of the manholes or 1 foot (300 mm) above the conduit in buildings. Terminate the outside vents in 180-degree bends.

3.9 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded joints: ASME B1.20.1, tapered pipe threads. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Joints made with oil and graphite pipe joint compound shall have compound applied to male threads only.
2. Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
3. Pipe threads shall be cut to give proper engagement in threaded fittings. Clean pipe and fittings before installation and ream pipe after cutting threads. Threaded pipe shall have clean-cut threads; dull or damaged pipe dies shall not be used.

D. Construct welded joints: AWS D10.12, using qualified processes and welding operators according to "Quality Assurance" Article. Branch connections shall be made with either welding tees or welding outlet fittings. Welding outlet fittings shall be forged, integrally reinforced to provide 100 percent pipe strength, beveled for full penetration welding and funneled at inlet for full fluid flow.

E. Flanged joints: Select gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.

F. Location, spacing and cold set of ball joints: 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.

G. Expansion Joints (Bellows And Slip Type):
1. Type, quantity and spacing of anchors and guides 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.
2. Cold setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
3. Prepare for service by cleaning all sliding surfaces, add packing as necessary. Remove all apparatus provided to restrain joint during shipping or installation.

4. 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.

H. Conduit piping joints shall be assembled in sections and finished with pourable or split insulation, exterior jacket sleeve, and apply shrink-wrap seals.

I. All pipe intersections and changes in direction shall be made with factory-built-reinforced fittings. Field-fabricated fittings and miters are not permitted.

3.10 INSTALLATION - SAFETY VALVES

A. Valves must be upright and oriented so that lifting levers are accessible from nearest walkway.

B. Provide special flexible connector on each safety valve that is designed to avoid blow-back of steam into the tunnel or manhole. Slip joint to be 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. Provide union or flanged connection at safety valve outlet to allow removal of safety valves without disassembling vents.

3.11 INSTALLATION - PRESSURE GAGES

A. 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 siphon on steam service. Provide liquid filled gages on pump discharge.

3.12 INSTALLATION – THERMOMETERS

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

3.13 INSTALLATION – VALVES

A. Do not locate valve stems below the horizontal centerline of the pipe.

B. Locate valves to permit access for operation, maintenance, and replacement.

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

D. Provide 3/4 inch (19 mm) gate or ball-valved drains at each side of steam gate and butterfly valves where condensate could collect, due to the slope of the pipeline, when the main valve is shut.

3.14 THERMAL INSULATION

A. Steam, condensate and drip return piping, other than in pre-engineered direct buried systems, shall be insulated as follows:

1. Piping in concrete trenches and manholes: Insulated with calcium silicate, fiberglass, or cellular glass pipe insulation, glass cloth or aluminum jacket.
2. Exposed piping in walk through tunnels: 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: 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 minimum nominal thickness.

TABLE 5

Minimum Pipe Insulation Thickness inches (mm)
For Steam 16 to 250 psi (110 to 1724 kPa) gage

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

TABLE 6

Minimum Pipe Insulation Thickness inches (mm)
For Steam less than 16 psi (110 kPa) gage, Condensate Return

Nominal Pipe	MPT-PC MPT-	Delta	Foamglas	Insul-phen

Diameter inches (mm)	PF		Thermo-12 Super Caltemp	
1 (25) and under	1-1/2 (35)	2 (50)	3 (75)	1 (25)
1-1/2 (40)	1-1/2 (35)	2 (50)	3 (75)	1 (25)
2 (50)	1-1/2 (35)	2 (50)	3 (75)	1 (25)
2-1/2 (65)	1-1/2 (35)	2 (50)	3 (75)	1 (25)
3 (80)	2 (50)	2-1/2 (63)	3-1/2 (85)	1 (25)
4 (100)	2 (50)	2-1/2 (63)	3-1/2 (85)	1-1/2 (38)
5 (125)	2 (50)	2-1/2 (63)	3-1/2 (85)	1-1/2 (38)
6 (150)	2-1/2 (63)	3 (76)	4-1/2 (110)	1-1/2 (38)
8 (200)	2-1/2 (63)	3 (76)	4-1/2 (110)	1-1/2 (38)

Parts not to be insulated are:

a. Threaded valves
b. Steam traps
c. Check valves
d. Unions
e. Threaded strainers
f. Strainer basket removal cover and bolting
g. Dielectric flanges and unions
h. Expansion joints
i. Flexible connectors
j. Ball joints except piping between joints

5. Installation of insulation:
   a. Pressure Tests: Complete all pressure tests before installing.
   b. Insulation material: New, clean, dry and stored in a clean dry environment; jacketing materials to be clean and unmarred; store adhesives in original containers. Materials shall not have exceeded the predicted shelf life as set by manufacturer.
   c. Identify all materials incorporated in the job on manufacturer’s container by name, type and description.
   d. Apply materials on clean, dry surfaces from which all dirt, loose scale, construction debris has been removed by wire brushing.
   e. The installation shall be neat, thermally and structurally tight without sag, neatly finished at all hanger or other penetrations and shall provide a smooth finished surface primed as required to receive specified painting.
   f. Do not use scrap insulation. Repair any work damaged by welding, burning, compressing due to concentrated construction loads.
   g. Apply pipe covering protection saddles, MSS SP 58, Type 39, at all hanger points. Fill space between saddle and piping with high

density insulation, thoroughly packed. Terminate jacket clear of saddle bearing area.

h. Insulation and jacket shall terminate hard and tight at all anchor points.

i. Insulation termination at piping facilities not to be insulated shall stop short, and be finished with 45 degree chamfered section of insulating and finishing cement, and covered with jacket.

j. Flanged fittings and valves shall be insulated with sections of pipe insulation cut, fitted and arranged neatly, and firmly wired in place. Insulating cement shall fill all cracks, voids and outer surface 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 2 inches (50 mm) 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 2 inches (50 mm) 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 2 inches (50 mm) 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.

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

A. The Contractor is entirely responsible for the quality of the welding and shall:

1. Conduct tests of the welding procedures used on the project, verify the suitability of the procedures used, verify that the welds made will meet the required tests, and also verify that the welding operators have the ability to make sound welds under standard conditions.

2. Perform all welding operations required for construction and installation of the distribution system.

B. Welder Qualifications: All welders shall be qualified as per ASME B31.1 and AWS B2.1-B2.1M-BMG.

C. Field bevels and shop bevels: Done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.

D. Utilize split welding rings or approved alternate method for field joints on all carrier pipes above 2 inches (50 mm) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe. Make field joints 2 inches (50 mm) and smaller with welding sockets.

E. Piping shall not be split, bent, flattened, or otherwise damaged either before, during, or after installation. Where the pipe temperature falls to 32 deg F (0 deg C) or lower, the pipe shall be heated to approximately 100 deg F (38 deg C) for a distance of 1 foot (300 mm) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 32 deg F (0 deg C).

F. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be requalified.

G. Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

H. An approved independent testing firm regularly engaged in radiographic testing shall perform radiographic examination of all field welds in the carrier piping of the systems, in manholes 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 Contracting Officer’s Representative reserves the right to review all inspection records, and if any welds inspected are

found unacceptable they shall be removed, rewelded, and radiographically reexamined at no cost to the Government.

3.16 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.

3.17 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.

3.18 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.

3.19 FIELD QUALITY CONTROL

A. Demonstrate leak-tightness of all piping systems by performing hydrostatic and operational tests. All labor, material and test instruments must be furnished by the Contractor. All instruments must be approved by the Contracting Officer’s Representative.

B. Pressure test direct-buried systems in conformance with requirements stated in this specification and in printed instructions for the system supplied. Tests must include carrier piping and casing.

C. Holiday testing of direct-buried system steel casings: Test entire surface of casings for faults in 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 Contracting Officer’s Representative.

E. Steam and condensate carrier piping shall be tested hydrostatically before insulation is applied at field joints and shall be proved tight

at a pressure 1 1/2 times distribution supply pressure for a period not less than 2 hours with no pressure decay.

1. Test piping located in concrete trenches prior to installing trench covers. Test direct-buried systems prior to backfilling.
2. Remove or isolate any elements of the system such as expansion joints, which are not designed for the test pressure.
3. Prior to acceptance of installation, Contractor shall subject system to operating tests as may be required by Contracting Officer’s Representative to demonstrate satisfactory functional and operating efficiency. These operating tests shall cover a period of not less than six hours for each portion of system tested. Conduct tests at times as the Contracting Officer’s Representative may direct.
4. Provide calibrated instruments, equipment, facilities and labor, at no additional cost to the Government. Test gage shall read in increments not exceeding 0.1 psi (1 kPa).
5. Repeat tests when failures occur.
6. After completion of satisfactory test, replace all elements that have been removed prior to testing.

F. Pneumatic Testing of DDT System Casings:

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

G. NACE-accredited corrosion specialist shall test cathodic protection systems and demonstrate proper operation and protection in accordance with the recommendations and criteria in NACE SP0169.

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

SPEC WRITER NOTE: Retain paragraph below to identify who shall perform tests and inspections.

I. // Owner will engage // Contractor will engage // a qualified testing agency to perform tests and inspections.

SPEC WRITER NOTE: Retain paragraph below to require a factory-authorized service representative to perform inspections, tests, and adjustments of all equipment and systems.

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

SPEC WRITER NOTE: Retain subparagraph below to require a factory-authorized service representative to assist Contractor with inspections, tests, and adjustments.

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

SPEC WRITER NOTE: Retain paragraph below to describe tests and inspections to be performed.

L. 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.

M. Prepare test and inspection reports.

SPEC WRITER NOTE: The following paragraphs are provided for design direction of the system. Delete from this section and design the project system to meet the site conditions.

3.20 APPENDIX I – ALLOWABLE SITE CHARACTERISTICS FOR CONCRETE SHALLOW TRENCH APPLICATION

APPENDIX I			
ALLOWABLE SITE CHARACTERISTICS FOR CONCRETE SHALLOW TRENCH APPLICATION (SEE NOTE 1)			
SITE CONDITION	GENERAL CONDITIONS OF GROUND WATER DURING THE WETTEST PERIOD OF THE YEAR	SURFACE WATER ACCUMULATION RAINFALL/ IRRIGATION	TRENCH CONSTRUCTION
A. Fine grained impervious or semipervious and coarse grained impervious	Water table generally 1 foot (300 mm) below lowest point of water entry (See Note 5) with not more than 25% of the length of the proposed concrete trench system showing water within 1 foot (300 mm) of the lowest point of water entry.	5 year - 7 day rainfall equal to or less than 10 inches (250 mm). (See Note 2)	Continuous wall and bottom.
B. Coarse grained semipervious and pervious (See Note 2)	Same as for A. above.	5 year - 7 day rainfall equal to or less than 10 inches (250 mm).	Same as for A. above
	Water table generally 2 feet (600 mm) or more below point of water entry with not more than 10% of the length of trench system showing water within 2 feet (600 mm) but not closer than 1 foot (300 mm) to lowest point of water entry.	5 year - 7 day rainfall equal to or less than 8 inches (200 mm). (See Note 2)	Continuous wall; openings may be provided in trench bottom to provide drainage.
C. Swelling soils (See Note	Same as for A. above.	Same as for A. above.	Same as for A. above plus design

3)			of joint spacing and joint details to accommodate movement.

NOTES:

1. Shallow concrete trench system shall not be used if any conditions defined by these criteria are exceeded.
2. As shown in U. S. Weather Bureau (USWB) Technical Paper 40 and confirmed with local data and local weather patterns
3. Swelling soils are materials with high swell potential when subjected to an increase in moisture content.
4. Precipitation rates for a specific site should be used to design drainage systems and select sump pumps.
5. Lowest point of water entry is defined as the joint between trench wall and trench bottom.

3.21 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:

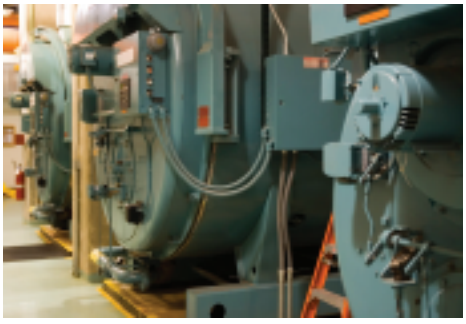
1. If there is any reason to suspect that the soil pH will be less than 5.0 anywhere along the proposed path of the system, pH measurements should be made at pipeline depth at close intervals along the proposed route, and all locations at which the pH is less than 5.0 should be indicated in the contract 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.

---- E N D ---

VA

U.S. Department of Veterans Affairs

Office of Construction & Facilities Management



Steam, Heating Hot Water, and Outside Distribution Systems design manual

September 2016

Volume 3
Outside Steam and Heating Hot Water
DISTRIBUTION SYSTEMS

Volume 3
Outside Steam and Heating Hot Water DISTRIBUTION SYSTEMS
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1.0 GENERAL:

1.1 Outside heat distribution work includes all heating hot water (HHW), steam supply and steam condensate piping and equipment located underground, in tunnel, or aboveground outside of buildings. Systems located 5 feet outside the building exterior wall are considered site (or outside) distribution.

1.2 Design the outside heat distribution systems to comply with this design manual, and the current editions of VA design guides, VA design and construction procedures, and the VA master specifications. The design shall also comply with the provisions of the current edition of ASME B31.1 Code for Pressure Piping. If state or local codes are more stringent than the above requirements, discuss with the Office of Capital Assets Management, Engineering and Support (OCAMES) healthcare engineering staff.

1.3 Show outside heat distribution plot plans on drawings using a minimum scale of 1:250 (1”= 20’). Manhole piping plans and sections shall be drawn with a minimum scale of 1:30 (3/8" = 1').

1.3.1 Existing work shall be identified in a way which easily distinguishes this work from the new work. Points of connection between new and existing work shall be identified.

1.4 Outside steam and heating hot water distribution systems shall be designed to provide the required flow and pressure at the point of use as defined herein. All condensate shall be returned to the boiler plant unless the design of steam-using equipment prevents this, for very small loads, or when it is not economical.

2.0 GENERAL VA STANDARDS:

2.1 Outside heat distribution work shall only be indicated on "MS"-series drawings (see VA Design and Construction Procedure, “Drawings”).

2.1.1 “MS"-series drawings shall include symbols and schedules, details, plot plans and profiles with interference from other utilities located and identified, manhole plans and sections, tunnel and trench plans and sections, location of expansion loops and anchors, demolition plans, other work as necessary.

2.1.2 Only symbols and abbreviations shown on VA Standard Details (PG-18-4) division 00 and 23 may be used on the drawings.

2.1.3 Pipe sizes shall be indicated on plot plans and on manhole plans and sections.

2.1.4 Equipment and piping systems shown on the drawings shall be generic and not the configuration of a particular manufacturer.

2.2 Major options and alternatives shall be evaluated utilizing the life cycle cost analysis methods using Department of Energy mandated discount factors.

3.0 TYPES OF SYSTEMS:

3.1 Pre-engineered, factory-fabricated, direct buried distribution systems: These are systems of various manufacturers which include the carrier pipes, pipe insulation, protective enclosures,

and accessories. The systems may be "drainable-dryable-testable" or "water-spread-limiting" as defined in the VA master specification. The "drainable-dryable-testable" system specified is an enhancement of the standard products of manufacturers. The enhancements include thicker casings, type and thickness of insulation, superior coating, thicker end plates, and cathodic protection.

Caution: ***The design of direct buried systems shall adhere strictly to the VA Master Specification, Section 33 63 00. Numerous failures of manufacturer's standard systems have been experienced.***

3.2 Concrete Shallow Trench Distribution Systems: These are either precast or field-built systems designed specifically for each project. The tops of the trench covers are slightly below or at grade and the trenches are sized only for pipe, insulation, and pipe supports with no provision for personnel access other than the removable covers. These systems can be applied only where site conditions (such as water table below maximum trench depth, lack of surface water, level or continuous grades) permit. Refer to Master Specification Section 33 63 00, Appendix I for acceptable conditions for application of shallow trenches.

3.3 Concrete Tunnel Systems: These are either precast or field-built systems designed specifically for each project and are sized to permit personnel walk-thru. They can often be justified on the basis of life cycle costs when other utilities, such as chilled water, share the tunnel.

4.0 SELECTION OF TYPE OF SYSTEM:

4.1 The design engineer shall recommend the type of system primarily based on a comparison of the life cycle costs of the types of systems.

4.2 The analysis shall also include an environmental impact (potentially NEPA) as applicable to the past work on the site. Life cycle cost analysis shall include removal of any portion of an existing system that may pose an environmental hazard if left abandoned in place.

4.3 In making the selection, the engineer shall also consider the service record of existing types of systems at the site. Consideration shall be given to the extent of the new systems, the ability to combine various utility services into one trench or tunnel, and maintenance requirements.

5.0 SYSTEM DESIGN

5.1 Steam and HHW load calculations:

5.1.1 Loads may include HVAC, domestic hot water, kitchen, laundry, sterilizers, other process loads, and line losses.

5.1.2 Load profiles shall include diversity factors and credits for heat recovery systems which are in operation during the peak load conditions.

5.1.3 Existing loads should be determined by reviewing boiler steam flow rate data for winter periods when the outside temperature approaches ASHRAE design conditions. Loads may be apportioned among separate buildings by analysis of major steam-using equipment and comparing building floor areas, whichever is most accurate.

5.1.4 Consider future loads for new or upgrade construction projects which are programmed. A minimum of 10% additional capacity shall be provided in the sizing of the distribution

system piping.

5.2 Steam/heating hot water distribution pressure:

5.2.1 Distribution shall be the same as the plant header pressure unless existing conditions make this impractical.

5.2.2 It is recommended that operational pressure not be increased on existing distribution systems. Pressures on existing systems may be increased only if a complete engineering analysis of the system is performed and stamped by a registered engineer and is deemed appropriate to increased thermal expansion, increased pressures in fittings, valves and joints as well as temperatures.

5.3 Connecting to existing steam/heating hot water distribution systems:

5.3.1 Calculate steam flows and pressure drops on the portions of the existing system which are affected by the new steam loads. The new steam loads shall not impose excessive pressure drops or velocities (velocity shall be below 7000 fpm) on the existing systems.

5.3.2 Calculate water flows and pressure drops on the portions of the existing system which are affected by the new loads. The new loads shall not impose excessive pressure drops or velocities (velocity should be below 7 fps or 1psi/100ft) on the existing systems.

5.4 Sloping and dripping of steam lines:

5.4.1 Steam lines shall pitch down 50 mm in 12 meters (two inches in 40 feet) in the direction of flow. Provide drip pockets and steam traps at all risers and immediately ahead of all isolation valves that would collect condensate if the valves are closed. Distance between drip pockets shall not exceed 150 meters (500 feet) and should be less if possible. Locate all drip pockets and steam traps in manholes or buildings. Provide oversized drip pockets (refer to standard detail). Steam drip traps shall discharge into a drip return line which is separate from other types of condensate return lines such as pumped returns and vacuum returns.

Caution: ***Water hammer is dangerous and must be prevented. It can occur when condensate is not properly removed from steam lines. Steam lines shall be properly sloped and drained.***

5.4.2 Steam traps for steam line drip service shall handle normal steady state radiation and convection heat loss condensate and also high levels of condensate and air flow when the steam line is being warmed-up. The preferred trap type is the inverted bucket type with thermal vent (for air release on warm-up) in the bucket. This type is resistant to water hammer and wire drawing of the valve and seat. Caution must be exercised when sizing the traps because oversized traps can “blow-through” (fail open) and lose their prime.

5.4.3 Trap monitoring shall be supplied in critical locations on all mains and major traps.

5.4.4 Provide adequate access to all traps and other appurtenances for maintenance and inspection. See also para 5.11.11

Note: ***Fixed orifice steam traps with no operating mechanism are prohibited due to the small diameter orifices that become plugged with dirt and cause the trap to fail shut. This will cause build-up of condensate in the steam main and dangerous water hammer may occur.***

5.5 Condensate Return:

5.5.1 Generally, all condensate should be collected at condensate return pump sets and then be pumped to the boiler plant. Exceptions include existing systems being replaced which have other types of condensate returns such as vacuum or gravity. Also drip returns from the steam line drip traps may be returned directly to the boiler plant if practical.

5.6 Installation of HHW Lines

5.6.1 Indicate piping slopes on drawings. Piping shall be installed free of sags and bends. Design for fittings for changes in direction and branch connections. Design and installation of piping shall allow application of insulation. Groups of pipes shall be parallel to each other, spaced to permit applying insulation and servicing of valves.

5.6.2 Reduce pipe sizes using eccentric reducer fitting installed with level side up.

5.6.3 Indicate branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

5.6.4 Show shutoff valve immediately upstream of each dielectric fitting.

5.6.5 Indicate sleeves and/or seals for piping penetrations of concrete walls and slabs with specific detail as to design and construction requirements.

5.7 Thermal Expansion:

5.7.1 Locate and design the anchors and the expansion joints, bends and loops so that piping will not be overstressed. The locations shall be shown on drawings. Sizes of bends and loops need not be shown on direct buried systems because the system manufacturer is responsible for loop and bend sizing. Expansion loops shall be used instead of expansion joints unless not physically possible. The use of expansion joints shall be approved by OCAMES if absolutely required to accommodate the installation.

5.7.2 Pipe anchors shall be provided within 0.6 to 1.5 meters (two to five feet) outside of manhole and building walls to minimize pipe movement through the manhole and/or Building. For piping passing through the manhole, do not anchor on both sides of the manhole unless the piping within the manhole has sufficient offset to avoid overstress. Thermal expansion stress calculations shall be conducted by the Engineer of record to ensure proper anchor locations throughout the system. Those calculations shall also account for the pipe expansion in the manholes.

5.7.3 All anchoring and expansion joints, bends and loops shall be completely designed including the civil structural component and specified in the contract documents except for anchors and expansion loops and bends being furnished as part of a direct buried system. These are the responsibility of the manufacturer of the direct buried system to design.

5.7.3.1 Specific support, anchor and hanger information/data shall be provided on the design drawings by the engineer of record that created the drawings, including, but not limited to, the following:

5.7.3.1.1 Types, sizes, locations, and spacing of all hangers and supports.

5.7.3.1.2 Roller or slider supports for all horizontal steam and condensate piping.

5.7.3.1.3 Special supports including anchors, guides and braces.

5.7.3.1.4 Supports to permit removal of valves and strainers from pipelines without disturbing supports.

5.7.3.1.5 Spring hangers on all systems subject to vertical movement.

5.7.3.1.6 Roller hangers and sliding supports on all systems subject to horizontal movement.

5.7.3.1.7 Loads for all supports. On systems utilizing variable spring supports, show the loads at each support by calculating the forces and moments throughout the system. Seismic restraint calculations shall utilize the applicable shock spectra for the type of structure, type of supported system, and the locality.

5.7.3.1.8 Individual detail for each hanger, anchor and support assembly showing all components, sizes, and calculated loadings. Provide identification tags on each keyed to the layout drawings.

5.7.4 Design steam systems for boiler plant header pressure and temperature (150 psig, 370 °F) minimum, and design condensate systems for (100 psig, 200 °F) minimum. Pipe stresses must not exceed allowable stresses calculated in accordance with ASME B31.1, ASME Code for Pressure Piping, Power Piping.

5.7.5 Vertical deflection shall not exceed 2.5 mm (0.1 inch) between supports when system is filled with fluid normally carried. Deflections due to seismic shock shall be restrained as necessary to prevent overstressing the supported system or the connected equipment. Seismic restraints shall permit movement due to thermal expansion

5.7.6 If vertical angle of hanger rod exceeds four degrees, rollers or sliders are required.

5.8 Fiberglass Reinforced Plastic (FRP) Pipe for Condensate is prohibited.

5.9 Pipe Material

5.9.1 The following table reflects acceptable carrier pipe material. Outside HHW distribution, including distribution in tunnels and/or shallow trenches shall be all welded construction. Alternate systems may be considered based on specific needs and characteristics of a given site, but will require prior approval by OCAMES :

Utility	Minimum Size	Material
Steam / HHW	≥ 150 mm (6”)	Seamless carbon steel schedule 40, butt weld
Steam / HHW	< 150 mm (6”)	Carbon Steel Schedule 40, socket weld joint 2” and smaller, butt weld larger
Condensate	< 150 mm (6”)	Seamless Carbon Steel Schedule 80, socket weld 2” and smaller, butt weld larger
High Pressure Drip	N/A	Seamless Carbon Steel Schedule 80, socket weld 2” and smaller, butt weld larger.

5.10 Insulation:

Comply with EPA and VA specification requirements.

5.10.1 Factory Applied Insulation:
Prefabricated pipe and fittings shall be insulated in the factory. Foam insulation for prefabricated insulated pipe and fittings shall be polyurethane (polyisocyanurate) foam meeting the requirements of ASTM C591 having a density not less than 2 pounds per cubic foot (pcf). The polyurethane (polyisocyanurate) foam shall completely fill the annular space between the carrier pipe and the casing. Insulation thickness shall be a minimum of one inch. The insulation thermal conductivity factor shall not exceed the numerical value of 0.15 Btu-inch/square foot-degrees F-hour at 75 degrees F, when tested in accordance with ASTM C518. Manufacturer shall certify that the insulated pipe is free of insulation voids.

5.10.2 Field Applied Insulation:
Steam Systems: Field applied insulation for fittings, and field casing closures, if required, and other piping system accessories shall be polyurethane (polyisocyanurate) matching the pipe insulation. Thickness shall match adjacent piping insulation thickness. Buried fittings and accessories shall have field applied polyurethane (polyisocyanurate) insulation to match adjacent piping and shall be protected with a covering matching the pipe casing. Shrink sleeves with a minimum thickness of 50 mils shall be provided over casing connection joints.
HHW Systems: Field applied insulation shall follow the requirements of VA specifications Section 23 07 11 “HVAC and Boiler Plant Insulation”. Tunnel piping insulation shall adhere to this specification requirement for “above ground insulation”. Shallow trench and underground piping insulation shall adhere to the requirements “for Exterior Locations”.

5.11 Underground warning tape:

Design for the provision of underground warning tape to be buried above the piping during the trench backfilling and shall be buried approximately 12 inches below grade. Tape shall be polyethylene tape with metallic core. Tape shall be six inches wide and be printed with repetitive caution warnings along its length. Tape shall be yellow in color with black letters. Tape color and lettering shall not be affected by moisture or other substances contained in the backfill material.

5.12 Manholes:

5.12.1 In direct buried systems and in concrete trench systems all devices requiring access for operation and maintenance shall be located in manholes. These devices include valves, steam traps, expansion joints, flanged and threaded joints, unions.

5.12.2 Manholes shall be cast-in-place reinforced concrete. Prefabricated manholes are prohibited due to difficulty of properly locating underground pipe openings in the manhole walls. Concrete floor slabs shall be of sufficient weight to prevent floatation in high water table areas.

5.12.3 Do not locate manholes in roads or parking areas because of access and ventilation problems.

5.12.4 Manhole structure and mechanical layout shall be completely designed by the A/E. Allow adequate working access and headroom.

5.12.5 Provide a minimum of two separate entrances from grade with full-size manhole covers dependent on safety/operational requirements. One shall be for access with grab-bars or ladder set in the manhole wall, the other shall be for ventilation while working in the manhole. Locate the ventilation access directly above the sump.

5.12.6 Provide 760 mm (30 inch) square (minimum) by 915 mm (36 inch) deep sump in floor and slope manhole floor to the sump. Provide duplex submersible sump pumps when electricity is available otherwise a drop-down pump shall be used. Where feasible, provide gravity drainage to a storm sewer.

5.12.7 The designer shall review the "confined space" regulations of the facility and design the manholes to allow maximum possible access convenience. The designs shall be reviewed and approved by the appropriate facility officials regarding these regulations. A possible design feature to ease the "confined space" limitations may be the use of sidewalk-type access doors instead of manhole covers.

5.12.8 Show all pipe supports on drawing. Completely design all pipe anchors to withstand the applied forces.

5.12.9 Place waterproof membranes in or below the concrete bottom slabs and continue them up the outer sides to the top of the sidewalls.

5.12.10 Provide ventilation pipes through the top of the manhole. Terminate one, 12" above grade and the other 12" below the bottom of ceiling slab. Both pipes shall terminate 18" above finish grade in a gooseneck configuration.

5.12.11 All piping, fittings, valves, etc., in the valve manholes shall be insulated. Insulation shall be pre-molded, precut, or job fabricated to fit and shall be removable and reusable. Thickness of insulation shall be in accordance with VA specifications Section 23 07 11 "HVAC and Boiler Plant Insulation". Insulation jackets shall be provided for all pipe and fittings insulation. Insulation for all piping, fittings, and valves shall be molded calcium silicate conforming to ASTM C533, type I, or molded mineral fiber insulation conforming to ASTM C547, Class 2, or cellular glass insulation conforming to ASTM C552. All insulation shall be asbestos free. Laminated construction shall not be used unless the thickness exceeds four inches. Flanges, couplings, unions, valves, fittings, and other pipe accessories, unless otherwise shown or approved, shall be insulated with removable and reusable factory pre-molded, prefabricated, or field fabricated insulation. For accessories in valve manholes, aluminum sheet shall be applied over the insulation.

5.12.12 Site Investigations:

5.12.13 The designer shall determine the most economical and practical locations for the system and accessories. In addition, the determination of soil conditions is necessary when direct buried systems are selected.

5.12.14 The designer shall perform the following:

5.12.14.1 Land surveys to determine routing, grades, and location of any interference.

5.12.14.2 Testing to determine water table depth

5.12.14.3 Soil corrosiveness, soil type, moisture content, and pH if direct buried

systems are to be used. This shall be performed by a licensed professional geotechnical engineer. Test samples shall be taken every 30 meters (100 feet) (minimum) along the routes of the systems.

5.12.14.4 Review "as-built" drawings and interview VAMC maintenance personnel to locate underground interferences. When sufficient information is not available, acquire services to perform utility locating in addition to local utilities, to determine location and depth of existing underground systems in the area.

5.12.15 Field work by the A/E or their consultant shall be administered under the terms of the contract between VA and the A/E.

5.13 Design of Direct Buried Systems:

5.13.1 The manufacturer is responsible for the design of the system within the parameters of the VA specification. This responsibility includes insulation types, pipe guides and anchors, end seals, corrosion protection, expansion bends and loops, and carrier pipes. The designer is responsible for all other aspects of the design including manhole structure and piping, system locations, profiles, pipe type and sizing and anchor locations. The contract drawings should include no details of the elements of the system for which the manufacturer is responsible.

5.13.2 The condensate return piping shall not be included in the same conduit as the steam piping. This will prevent condensate piping failures from affecting the steam piping. Typically, condensate pipes have a much higher failure rate than the steam pipes due to the acidic and corrosive content that can occur if water treatment is not properly applied.

5.13.3 Depth of burial of the systems shall be 0.6 to 1.5 meters (two to five feet) to top of conduit casing.

5.13.4 The designer shall be completely responsible for the manhole design including manhole structure, ventilation, and piping.

5.13.5 Provide cathodic protection for all steel casing systems and all buried exposed metal. Assume that a minimum of 25 percent of the exterior of the system is exposed metal. Submit design life calculations for the cathodic protection system, stamped by a qualified corrosion engineer. Cathodic protection systems shall have a minimum design life of 25 years. Dielectric pipe flanges and waterways, and isolation devices shall be provided at all points as necessary. Test stations at grade shall be provided on each section of the piping system. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match the connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals.

5.14 Design of Concrete Shallow Trench Systems:

5.14.1 The designer shall be completely responsible for the entire design including concrete trenches, pipe anchors, sizing of expansion loops and bends, sizes of expansion joints, pipe supports and guides, manhole structure and piping, system locations, profiles and

pipe sizing and insulation. Provide access points (manholes or handholes) every 350 feet and/or change of trench direction and point of connection to buildings where main valves are to be located. Pipe insulation shall conform to the requirements of para 5.9.2.

5.15 Design of Concrete Tunnel Systems:

5.15.1 The designer shall be completely responsible for the entire design including concrete tunnel, pipe anchors, sizing of expansion loops and bends, sizes of expansion joints, pipe supports and guides, tunnel structure and piping, system locations, profiles and pipe sizing and insulation. Insulation shall conform to the requirements of para 5.9.2.

5.15.2 The tunnel shall include ample walking space with height for persons to stand erect, and drain system to handle ground water and piping leaks.

5.15.3 Tunnel access shall be provided every 350 feet of tunnel length and every change of direction. Provide a minimum of two separate entrances from grade and at least one every 350 feet of tunnel with full-size manhole covers. Access entrance shall have grab-bars or ladder set in the tunnel wall.

5.15.4 Provide ample lighting and electrical receptacles designed for high temperatures per OSHA 1926.56 and NFPA 101. Lights must be connected to Life Safety branch of the EES, if it is practical or feasible (or have 1-1/2 hour-emergency power packs integral with the lights. The power packs will require periodic maintenance/testing per code).

5.15.5 Provide ventilation systems to allow personnel to work safely. A minimum 6 air changes per hour (ACH) are recommended or as required by IBC/IMC, whichever is more stringent for tunnel ventilation. Provide ventilation (exhaust) fans every 700 feet For shorter tunnels one fan shall be provided by the end with the fresh air intake at the opposite end.

5.16 Design Details:

5.16.1 Provide pressure gages at the outlet side of all main steam valves so that personnel can observe the gages while warming-up the steam line.

5.16.2 Provide steam drip traps and manual drains on steam lines at all low points and upstream of all valves and pressure reducing stations. Spacing shall not exceed 150 meters (500 feet).

5.16.3 Provide HHW air vents, vacuum breakers and drains to allow the system to be purged of air and drained if required. The vents and vacuum breakers shall be placed at all high points and sized to accommodate the calculated drain rate and anticipated air entrainment. Drains shall be located at all low points and trapped areas to ensure that the system can be drained.

5.16.4 Provide isolation valves (gate valves) on all branch connections to the main piping runs.

5.16.5 Provide gravity drainage along the length of the tunnel and to the storm sewer in the vicinity. When not possible to drain by gravity provide 760 mm (30 inch) square (minimum) by 915 mm (36 inch) deep sump in floor and slop tunnel floor to the sump. Provide duplex submersible sump(s) in number and location as required by the tunnel layout and elevation.

5.16.6 The designer shall furnish thermal expansion calculations for the supply and return

piping using the following design characteristics and installation temperature. The system design conditions supply and/or return shall be a temperature of 450 degrees F and a pressure of 665 psig. For calculation purposes, the installation temperature shall not be higher than the ambient temperature at the site of installation.

5.16.7 Assure that proper chemical treatment for the site distribution system is provided and included with the design of systems and equipment in the Heating Power Plant (refer to Volumes 1 and 2 of this manual). If not, make provisions for a chemical feeder connection to the piping system for such service and in close proximity to the Heating Power Plant.