SECTION 02551

STEAM AND CONDENSATE SYSTEMS

NOTE: This guide specification is not intended as a final construction document. The Engineer-in-Responsible-Charge for each project must review and adapt this guide specification as necessary to accommodate the unique conditions of a particular project.

The Engineer-in-Responsible-Charge shall provide the ASME B31.1 flexibility analysis and stress calculations and shall provide sufficiently detailed drawings to permit the contractor to build the piping system in compliance with ASME B31.1. The detailed drawings will show, at a minimum, the piping layout with all offsets, expansion loops and bends, expansion joints, supports, guides and anchors.

PART 1 GENERAL

1.1 APPLICABILITY

A. This specification applies to all steam and condensate utility system piping and equipment underground, in tunnels, concrete trench boxes, pre-insulated conduit systems, manholes and in building mechanical rooms.

B. The steam utility system extends from the Central Energy Facility (CEF) up to and including the pressure reducing station and main safety relief valve in each building, including the steam consumption meter.

C. The condensate utility system includes the main condensate return pump in each building and all piping and equipment downstream from the main condensate return pump back to the CEF.

1.2 RELATED DOCUMENTS

A. For Underground Piping Systems and Manholes:
   1. Section 02321: Trenching, Backfilling and Compacting
   2. Section 02950: Site Restoration and Rehabilitation
   3. MS-20 Vortex Steam Meter Installation
   4. MS-51 Conduit System Wall Penetration and Anchor
   5. MS-55 Steam Trap Assembly
   6. MS-60 Steam Pipe Powder Insulation System (for repairs only)
   7. MS-61 Concrete Wall Pipe Penetrations (for repairs only)
   8. MS-63 Pipe Supports for Pre-cast Steam Trench
9. MS-64 Pre-cast Concrete Steam Trench
10. MS-65 Pipe Anchors Supports Steam Vaults
11. MS-66 Pipe Guides for Pre-cast Steam Trench

B. For Building Mechanical Rooms:
   1. MS-20 Vortex Steam Meter
   2. MS-57 Steam Pressure Reduction Station
   3. MS-58 Electric Condensate Return Receiver and Pumps
   4. MS-59 Steam Powered Condensate Return Pump
   5. MS-55 Steam Trap Assembly
   6. MS-67 Steam Safety Valve

1.3 SYSTEM DESCRIPTION

A. Steam Distribution System: Steam is the primary heat source for a variety of heating functions throughout the University. Saturated steam is generated at the Central Energy Facility and distributed via a loop piping system which normally operates at 125 psig (353°F). (Design conditions for piping expansion and flexibility are 135 psig and 400°F). The distribution system serves most sections of the Campus as well as the Hospitals and Medical School.

B. Condensate Return System: The campus condensate return system typically operates at 180°F and 20-30 psig. Design conditions for piping expansion and flexibility are 100 psig and 212°F. Design conditions for condensate pump selection are 212°F and 10 – 40 psig.

1.4 CODE COMPLIANCE AND STANDARDS

Use current edition in effect at time of design and construction.

American Society of Mechanical Engineers (ASME) - Boiler and Pressure Vessel Code.

American National Standards Institute (ANSI)- B31.1 Power Piping

Expansion Joint Manufacturers Association (EJMA) - Standards

California Department of Transportation - Standards
1.5 QUALITY ASSURANCE

A. Material Certifications:

All materials shall be certified new from factory. Pipe, fittings, and valves shall be made in the USA or Canada to ANSI/ASME standards and suitably stamped. Piping components made in other countries shall not be used unless specifically approved by the Project Manager.

B. Welding:

1. Welder Qualifications: Welder(s) shall be qualified in accordance with ASME Section VIII, Pressure Vessels; ASME Section IX, Welding and Brazing Qualifications. Welders shall be thoroughly familiar with ANSI B31.1 requirements.

2. The Contractor shall furnish to the Project Manager all applicable Welding Procedures Specifications (WPS), Procedure Qualification Records (PQR) and Welder Performance Qualification (WPQ) records. All welding documentation (WPS, PQR and WPQs) shall be submitted for review prior to any field welding or shop welding.

3. All welding documentation shall be certified and dated by the appropriate Contractor personnel. Test reports signed by the testing lab may be attached as supporting documentation but are not acceptable in lieu of the contractor’s signature and certification.

4. Welder Performance Qualifications (WPQs) prepared by a trade union, school or previous employer will not be accepted. WPQs prepared more than 6 months prior to welding will be accepted only if accompanied with documentation to show that the welder has welded to the WPQ/WPS at least once per 6 month period since the WPQ was prepared.

5. The Contractor shall conduct new welder qualification tests and prepare new WPQs at the Contractor’s expense if all required documents (WPS, PQR and WPQs) are not submitted and approved 1 week prior to the scheduled start work.

1.6 SUBMITTALS

A. Engineering Data

The following items shall be submitted to the Project Manager for approvals:

1. The B31.3 piping stress analysis

2. Civil plans and profiles of the steam and condensate piping and trench, tunnel and manholes
3. Structural details for vaults and pipe supports

4. Mechanical details for pipe runs, steam traps, expansion joints, valves, and insulation.

B. Manufacturer's Data

Manufacturer's standard drawings, catalog cuts, specifications, and data sheets for all materials and equipment (piping, valves, expansion joints, insulation, etc.) shall be submitted to the Project Manager for approval.

C. Shop Drawings:

1. Shop drawings shall be submitted to the Project Manager for approval for all piping that is field or shop fabricated. The shop drawings shall show all anchors, guides, supports, fittings, valves and appurtenances. The shop drawings shall include sufficient detail to show compliance with the flexibility and expansion requirements of the engineer’s design.

2. Shop drawings for pre-cast concrete trench systems shall be submitted for approval. The shop drawings shall show the final layout and dimensions of each pre-cast section, reinforcement details, weld plate embed locations and weld plate attachment details.

D. Welder Submittals

Welder's performance qualification records shall be submitted to the Project Manager for approval at least 2 weeks prior to any welding in the shop or in the field.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Contractor shall be responsible for inspecting materials delivered to site for damage.

2. Contractor shall keep records of all shipping tags, mill certifications, and inspection tags.

B. Storage:

1. Materials shall be stored on-site in enclosures or under protective coverings. Materials shall not be stored directly on ground.

2. Insulation, expansion joints, joint materials, fittings, valves, and gaskets shall be stored undercover out of direct sunlight.

C. Handling:
1. Pipe, conduit sections, fittings, valves and other accessories shall be handled in such a manner as to ensure delivery to the trench in an undamaged condition.

2. The contractor shall obtain and comply with applicable handling procedures recommended by the pre-insulated conduit system manufacturer.

3. Special care shall be taken to avoid injury to coatings and linings on pipe and fittings. The Contractor shall repair damaged coatings and to the satisfaction of the Vendor and Project Manager.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Pipe:

1. ASTM A106 (seamless), Grade B, black carbon steel

2. Condensate lines: all sizes to be Schedule 80.

3. Steam lines:
   a. 2 inch and smaller: Schedule 80,
   b. 2.5 inch through 10 inch: Schedule 40,
   c. 12 inch through 14-inch, 0.375 inch wall,

B. Fittings:

1. Threaded or socket weld (2 inch and smaller): ANSI B16.11 forged carbon steel, ASTM A105, 3000# class.

2. Butt-Welded (2.5 inch and larger): ANSI B16.9, ASTM A234 WPB, schedule to match pipe. All pipe fittings that are in tunnels, trenches, and conduit systems shall be butt welded.

3. Flanged (2.5 inch and larger): ANSI B16.5, ASTM A105 forged steel, 150 or 300 pound class; weld-neck flanges shall be used to match equipment. Flange connections are used only for valves and expansion joints in manholes and mechanical rooms.


5. Dielectric flange sets shall be rated for the service intended.

2.2 VALVES

A. General:
Valves shall be threaded for 2 inch and smaller piping, flanged for 2.5 inch and larger. Socket weld or butt weld valves shall not be used. Acceptable valve manufacturers for steam or condensate service are provided below; no substitutions unless approved by the Project Manager.

B. Gate Valves:

1. Threaded (2 inch and smaller): ANSI B16.34, 800 pound class, forged steel, bolted bonnet, OS&Y, conventional port gate valve Walworth, Vogt, or Edwards.

2. Flanged (2.5 inch and larger): ANSI B16.34, 150 pound class, A216 WCB cast steel body, bolted bonnet, OS&Y, stainless steel trim; Walworth or Stockham.

3. Warmup lines: All gate valves 4 inch and larger shall have bypass lines with warmup valves.

C. Globe Valves:

1. Globe valves shall not be used except where specifically shown on the Engineer’s drawings.

2. Threaded (2 inch and smaller): ANSI B16.34, 800 pound class, forged steel body, stainless steel seat ring and plug, bolted bonnet, rising steam; Walworth, Vogt, or Edwards.

3. Flanged (2.5 inch and larger): ANSI B16.34, 150 pound class, A216 WCB cast steel body, OS&Y; stainless steel trim, Walworth or Stockham.

D. Ball Valves:

1. Ball valves shall not be used except where specifically shown on the Engineer’s drawings.

2. Threaded (2 inch and smaller): 150 pound class, steam-rated, cast steel/stainless steel, Nibco or Walworth.

E. Check Valves (condensate systems only):

1. Threaded (for steam trap discharge): 800 pound class, forged steel, stainless steel disc, swing check; Vogt, Edwards, or Walworth.

2. Flanged (2.5 inch and larger): ANSI B16.34, 150 pound class, A216 WCB cast steel body, bolted flange cover, swing check; Walworth or Stockham.

3. Pressure powered condensate pump check valves: bronze or stainless steel as specified by the Engineer for the required system capacity. (Reference Standard Drawing MS-59).
F. Rotary Valves:

1. 150 pound class, carbon steel, flanged, Adams or Keystone Vanessa.

2.3 PIPING SPECIALTIES

A. Gaskets: Non-asbestos containing ring gaskets, flexitallic type "cg" Grafoil 304ss or equal, suitable for the fluids and temperatures encountered.

B. Bolting: ASTM A193, Grade B7, for bolts and studs, and ASTM A194, Grade 2H for nuts.

C. Sleeves: Sleeves for foundation wall penetrations shall be fabricated of one-eighth inch (1/8") thick steel, with two inch (2") wide collar welded in place, and the assembly hot-dip galvanized.

D. Wall Penetration Seals: High temperature elastomeric link type mechanical seals compressed with corrosion-protected bolts and compression plates; Thunderline Link-Seal, no substitution. (Reference Standard Drawing MS-52)

E. Expansion Joints:

1. Expansion joints shall be slip tube type or externally pressurized bellows type as designed for the specific location. They shall be 150 psig steam rating, flanged, and shall conform with the Standards of the Expansion Joint Manufacturers Association.

2. Bellows type joints shall have 316 ss bellows, and may be single or double bellows style as required: Hyspan, Pathway or Senior Flexonics.

3. Slip-tube type shall have external and internal high performance guides rated for 500°F, designed for packing under pressure, and may be single or double style as required: Advanced Thermal Systems or Hyspan.

F. Steam Traps for main line or building PRV assembly (see Standard Drawing MS-55): Steel body, 3/4 inch diameter, thermodynamic disc type, Nicholson TD 301, Yarway #721, or Spirax Sarco TD. Install 3-way forged steel trap test valve downstream of trap and before check valve.

G. Automatic Air Vents (for high points on condensate systems): 3/4 inch threadolet with 3/4 inch gate isolation valve is required upstream of air vent. Air vent shall be 3/4 inch 150 # rating, Sarco 13W or approved equal. Discharge of condensate air vents in vaults shall be routed to the floor.

H. Strainers (for use on steam trap stations): Y-type with cast or forged steel body, 1/16 inch mesh monel strainer elements, threaded for 2 inch and smaller piping; C.M. Bailey or Spirax Sarco IT.
I. Pipe Hangers and Supports: Pipe hangers and supports shall be designed, and located per the requirements of B31.1 and the contract drawings.

J. Pressure gauges: 4.5 inch dial, bourdon tube, 0 to 200 psig on steam mains, 0 to 50 psig on condensate mains, Ashcroft or equal. Include isolation valve and pigtail coil on steam gauges.

K. Pipe insulation in manholes, tunnels, concrete trenches, and mechanical rooms:
   1. Pipe and fittings 2.5 inch and greater shall be insulated with ASTM C533, Type I, calcium silicate; 2.5 to 6 inch steam (3 inches thick), 8 to 12 inch steam (4 inches thick), 2.5 to 6 inch condensate (2 inches thick).
   2. Insulation shall be covered with 0.016 inch smooth aluminum jackets with integral moisture barrier. Stainless steel band on 12 inch center shall hold the insulation to the pipe.
   3. Valves and expansion joints shall be insulated with removable shop-fabricated fiberglass padding rated for 500°F, with thin wire mesh lining, and covered with 18 ounce high-temperature fiberglass cloth with velcro straps.

2.4 MANHOLES

A. General Layout (see Standard Drawing CS-301)

B. All structures shall be of reinforced concrete. Concrete shall be 2500 psi minimum compressive strength after twenty-eight (28) days, for both prefabricated and field-constructed manholes.

C. Prefabricated or field-constructed manholes shall be provided with walls, floors, and roofs not less than 8 inches thick and reinforced with steel bars. Floors shall drain to sump hole (see Standard Drawing CS-301).

D. Prefabricated concrete manholes shall conform to CDT Standard Specifications, Section 70.

E. Piping - Main line junctions and service connections shall be in vaults, which require two openings. Minor assemblies such as drip legs, can be in pits, which require only one opening.

F. Waterproofing shall be provided according to CDT Standard Specifications, Section 54.

G. Ladders shall be provided at each manhole opening. Ladders shall be welded steel construction with flat, serrated rungs 1-7/8” deep and 2”x3/8” side rails. McMaster Carr #7981Txx or equal.
H. Manhole Lids - Concrete vaults, pits, covers and openings shall be vehicular traffic rated (H-20). 38-1/2 inch Neenah 1792 frames with one 40 inch solid lid and one 40 inch grate lid, both marked STEAM.

2.5 INSULATED STEEL PIPE IN PRE-CAST CONCRETE TUNNEL

A. Pre-cast concrete trenches shall be H-20 traffic rated with concrete covers and weld plate embeds at all pipe support locations. TRENWA “Road Crossing” model or approved equal.

B. Expansion loops, expansion bends and/or expansion joints shall be provided as designed by the engineer in accordance with ASME B31.1 and shown on the contract drawings.

C. Insulation:
   1. Steam and condensate piping shall be insulated with ASTM C533 calcium silicate insulation with aluminum jacketing.
   2. Steam pipe 2” to 6” – 3” thick insulation
   3. Steam pipe 8” to 12” – 4” thick insulation
   4. Condensate pipe – 2” thick insulation.

D. Pipe Supports: Pipe supports and guides in pre-cast trench systems shall be Tolco 421/426/431 or approved equal. Pipe anchors for pre-cast trench systems shall be constructed as shown on the contract drawings.

2.6 BURIED PRE-INSULATED STEEL PIPE CONDUIT SYSTEMS

A. Conduit Casing: The outer conduit casing shall be a drainable/dryable and pressure-testable system with an annular air space. Casing systems shall be fiberglass or extruded HDPE jacket with polyurethane foam insulation.

B. Conduit End Seals: Conduit end seals shall be fixed type where there is no thermal pipe expansion through the end seal, and shall be slip type where there is thermal pipe expansion through the end seal. One-half inch (1/2”) threaded pipe ports at top and bottom of each end seal shall be provided for draining, venting, and pressure testing of conduit casings.

C. Pipe Insulation: ASTM C533, Type I, calcium silicate, mineral fiber, or C552 cellular glass, three inch (3”) for steam, and two inch (2”) for condensate.

D. Piping and Fittings: ANSI B31.1, factory fabricated with pre-installed internal supports and insulation. Fabricated materials shall be shipped to the job site in maximum feasible size sections to minimize number of field joints.
E. Pipe Supports: Anchors shall be located as shown on the approved manufacturer’s shop drawings. Sizing of the concrete anchor block and reinforcing steel shall be in accordance with the manufacturer’s recommendations and approved by the engineer.

PART 3 EXECUTION

3.1 TRENCHING, BACKFILLING, AND COMPACTING

A. Pre-insulated conduit systems:

1. Ditch bedding shall be accurately graded with a minimum of six inches (6") of sand. Sand shall pass a 1/4 inch screen with not more than fifteen percent (15%) passing a No.200 sieve. Sand shall be backfilled to a minimum of six inches (6") above the pipe casing. Bedding shall be laid to firmly support the piping along its entire length.

B. Pre-cast concrete trench systems:

1. Pre-cast concrete sections shall be set to grade on concrete dobies. Bedding shall be concrete slurry and shall be thoroughly vibrated to ensure all spaces beneath the pre-cast sections are filled. Concrete slurry shall be brought to approximately ½ the height of the pre-cast sections. The Contractor shall weight the pre-cast sections as needed to prevent floating.

2. Prior to backfilling, all joints shall be filled with non-shrink grout and the pre-cast trench covered with 10mil HPDE plastic sheeting. The HDPE shall overlap the sides of the trench a minimum of 12” on each side. Joints in the HDPE shall overlap a minimum of two feet.

C. Earthwork shall be in accordance with FDG Section 02321: Trenching, Backfilling and Compacting.

D. Damage Repair: Utilities, walls, piping, and other improvements damaged during the course of work shall be repaired to their original condition or replaced by the Contractor.

E. Excess Material: Excess material and debris shall be removed and disposed of, at an approved disposal site, within one week after final approval of installation.

3.2 PIPING INSTALLATION

A. General:

1. Piping and pipe systems shall be fabricated, assembled, welded, supported and tested in accordance with ASME B31.1. and the approved shop drawings.

2. Piping shall be cut accurately to field measurements and worked into place without springing or forcing, except where cold-springing is specified. Piping shall not be buried, concealed, or insulated until it has been inspected, tested, and approved.
3. Pipe runs underground between vaults shall be welded.

4. Flanged and threaded joints shall not be buried. Gaskets, packing, and thread compounds shall be suitable for the service. Joint compound or thread tape shall be applied to male threads only.

5. Arrangement of all piping shall be shown on the approved shop drawings. During installation, care shall be taken to avoid interference with other piping, conduit, and equipment.

6. Steam lines shall be trapped where shown on the drawings.

7. Reducing fittings shall be used for changes in pipe sizes. Bushings shall not be used.

8. In horizontal lines two inches (2") and larger, reducing fittings of the eccentric type shall be used to maintain the bottoms of the lines in the same plane for steam, and the tops of the lines in the same plane for condensate.

B. Cleaning:

1. Each section of pipe, fittings, and valves shall be thoroughly cleaned free of all foreign matter before erection. Interior of piping shall be cleaned thoroughly as described in Article 3.07 (below) before final connections are made.

2. Open ends of mains shall be plugged or capped during shutdown periods. Lines shall not be left open at any place where foreign matter might accidentally enter pipe.

C. Pipe Expansion: Expansion of pipes shall be accommodated by expansion loops, L-bends, Z-bends in buried locations, or by slip or bellows expansion joints in manholes, tunnels and buildings. Expansion joints shall be set to ensure proper function and movement during system operation.

D. Connections: Locations of capped outlets for future connections shall be shown on the Drawings. Weldolets or welding fittings (welding tees) shall be used for tapping existing systems.

E. Steam Line Drainage: Steam lines shall be pitched to allow for condensate drainage to the low point steam pots. For steam pipes in tunnels sloped down in the direction of steam flow, a minimum of three inches per one-hundred feet (3" per 100') of length is required. Where counterflow of condensate must be accommodated in steam tunnels, lines shall be pitched up in the direction of steam flow six inches per one-hundred (6" per 100') feet of length. Buried steam lines shall be pitched to accommodate the worst case of 6" per 100 feet. Final pipe elevations must be recorded on the as-built drawings.

F. Welding:

1. Electric Fusion Welding: Contractor shall be responsible for submitting all required welding documentation for approval at least 2 weeks prior to any shop or field
welding. Contractor shall be responsible for the quality of all welding. Contractor shall determine the suitability of welding procedures used to ensure that welds meet the requirements specified herein.

2. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done after flame cutting, surfaces shall be ground and thoroughly cleaned of scale and oxidation just prior to welding. Beveling shall conform with ANSI standards.

3. Butt welds: All butt welds shall be open root, multi-pass welds, 6010 or 6011 root with 7018 filler caps (SMAW welding process).

4. Electrodes: Electrodes shall be stored in a dry, warm area and kept free of moisture during fabrication operations. Electrodes that have lost part of their coatings shall be discarded.

5. Inspections: Welds shall be inspected in accordance with ANSI B31.1 requirements. The Owner may radiograph 5 to 10% of the welds. If any welds are found to be defective, the Contractor shall be responsible for full 100% radiograph testing of all the welds. Repair of defective welds by adding weld material over the defect, or by peening shall not be permitted. Welders responsible for defective welds shall be re-qualified before performing more welding on the job.

6. Any welds made prior to approval of all required welding documentation shall be cut out and re-welded. The contractor may, at the contractor’s expense, elect to do 100% radiography of these welds.

7. All finished weld joints shall be painted with high temperature black paint.

G. Anchor Blocks:

1. Concrete anchor blocks shall be provided for pipe anchorage not less than five feet (5') from building or manhole walls (except where fabricated structural anchors are shown on Contract Drawings).

2. Size and position of anchor blocks shall be as shown on Standard Drawings MS-51 and MS-52. Anchor blocks shall be cast against undisturbed earth using concrete that conforms to ASTM C-94 and has a minimum compressive strength of 2,500 psi at twenty-eight (28) days.

3. Fabricated structural anchors shall be provided if necessary in vaults, tunnels, and mechanical rooms as described in the Contract Drawings.

H. Wall Penetrations: Galvanized steel sleeves shall be provided for penetrations in concrete walls six inches (6") or less in thickness, and masonry walls. Existing concrete walls thicker than six inches (6") shall be core drilled or equipped with galvanized steel
sleeves. High temperature elastomeric link type seals shall be acceptable for use in all locations.

I. Insulation and Jackets:

1. Insulation shall be continuous through pipe hangers with calcium silicate inserts to prevent crushing of insulation.

2. Steam and condensate valves and equipment in manholes and buildings shall be insulated and covered with removable jackets. Insulation shall stop short of bolts/studs at flanges to allow their removal without damage of permanent insulation.

3. Trap sections between unions in steam trap manifolds shall not be insulated.

4. No exposed insulation will be permitted. Aluminum or PVC end caps that match the insulation jackets shall be used to cover the ends of insulation runs.

5. Steam and condensate lines in manholes, tunnels, and buildings shall be color coded as follows:
   a. High pressure steam - RED (darker shade)
   b. Reduced pressure steam - RED (lighter shade)
   c. Condensate Return (building) - Orange (lighter shade)
   d. Condensate Return (steam system traps) - Orange (darker shade)

3.3 VALVE INSTALLATION

A. Valves shall be installed in accordance with ANSI B31.1 and ASME Section VIII. Valves shall be installed as shown on the drawings and as required for proper functioning of the system.

B. Handwheels shall be installed in locations accessible from floor level, preferably with vertical stems, for operation and repair.

C. All flange bolts shall be lubricated with a high temperature bolt lubricant approved by the Project Manager. Flanged bolt torquing shall be in a incremental staggered pattern to assure even compression of the gasket.

3.4 PIPING SPECIALTIES INSTALLATION

A. Traps and Manifolds: Steam drip and mud legs, guard and blow-down valves, and piping shall be as shown on Standard Drawing MS-55. Dual traps stations shall be installed at all mud legs unless otherwise indicated on the drawings. Multiple trap manifolds at one location shall be in the same horizontal plane.
B. Hangers and Supports:
   1. Hangers shall be sized to allow for continuous pipe insulation through the hangers. Hangers shall not be permitted to touch steam pipe.
   2. Expansion bolts shall be acceptable for use in wall or ceiling construction.

3.5 PRE-CAST TRENCH SYSTEM INSTALLATION
A. Installation as per Manufacturer's specifications and the contract drawings.
B. Piping shall by hydro-tested prior to installing insulation and covers.

3.6 PRE-INSULATED CONDUIT INSTALLATION
A. Conduit Field Joints:
   1. Conduit sections shall be joined after leak testing of carrier pipe. Conduit joining materials provided or specified by the system manufacturer shall be used.
   2. Pipe shall be insulated and casing joined to provide field joint equal to factory fabricated section on conduit system. Connections to existing conduit systems of a different manufacturer or type shall be made only in manholes or buildings and never in buried locations.
   3. Conduit casing shall be leak tested in accordance with the manufacturer’s instructions.
B. Conduit End Seals: Conduit end seals in manholes or tunnels shall be provided with gooseneck vents on the top and drain valves on the bottom. In buildings, conduit end seals shall be provided with threaded brass plugs. Refer also to Standard Drawing MS-51.

3.7 FIELD QUALITY CONTROL
A. General: The Project Manager or his representative will conduct field inspections and shall witness all field tests specified in this Section. The Contractor shall perform field tests and provide labor and equipment required for testing.
B. Piping Hydrostatic Pressure Tests:
   1. All anchor blocks and restraints shall be complete prior to testing. Concrete supports shall be fully cured.
   2. Test pressure gauges for a specific test shall have dials indicating not less than one and one-half (1-1/2) times nor more than two (2) times the test pressure.
3. Prior to installation of insulation, pre-cast trench covers or pre-insulated conduit closures, hydrostatic pressure shall be applied to 200 psig and allowed to stabilize to ground temperature while maintaining 200 psig, +/- 10 psi. After stabilization, pressure source shall be removed. Piping must hold 200 psig, +/- 10 psi, for at least four (4) hours.

4. Leaks shall be repaired and the test repeated if the pressure does not hold. The Contractor shall ensure the test pressure does not exceed 300psi at any time due to heating of the pipeline or other reasons.

C. Conduit Casing Pressure Tests:

1. Before backfilling, conduit casing shall be pressurized to fifteen (15) psig air pressure and allowed to stabilize. After stabilization the pressure source shall be removed.

2. Casing must hold fifteen (15) psig air pressure, +/-2 psi, for at least four (4) hours. Leaks shall be repaired and the test repeated if the pressure does not hold.

3. Pressure test shall be repeated after backfilling.

D. Cleaning: After pressure and hydrostatic testing, the pipe system shall be flushed with a water/chemical solution. The procedure, cleaning solutions, and disposal methods shall be approved by the Project Manager.

E. Operational Tests: After completion of the work, the system shall be operated for not less than six (6) hours at operational temperatures and pressures to demonstrate satisfactory function. The movement of each expansion joint shall be checked, and each valve shall be operated in both cold and hot conditions.

END OF SECTION