



B-24 – STEAM SYSTEM

Table of Contents

1. GENERAL INFORMATION	2
2. SYSTEM BOUNDARIES	2
3. SAFETY RELIEF VALVES	2
4. SUPPLY PRESSURES	2
5. CONDENSATE RETURN	2
6. TIE-INS TO THE CAMPUS STEAM DISTRIBUTION SYSTEM	3
7. UNDERGROUND STEAM AND HOT WATER DISTRIBUTION CONDUIT (NON-WALKABLE)	3
8. MANHOLES.....	5
9. WALK-THROUGH TUNNELS.....	8
10. CONCRETE REINFORCING STEEL	9
11. UNDERGROUND STEAM SYSTEM ROUTING	10
12. STEAM, CONDENSATE, AND HEATING HOT WATER PIPING	10
13. THERMAL EXPANSION.....	12
14. PIPING SUPPORTS, ANCHORS, AND GUIDES.....	12
15. PIPING INSULATION	14
16. SYSTEM DRAINAGE	15
17. STEAM CONDENSATE TRAPS.....	15
18. VALVES	15
19. CONDENSATE RETURN UNITS	16
20. CONDENSATE METERS.....	16
21. STEAM METERS.....	17
22. WELDING METHODOLOGY.....	19
23. WELDER QUALIFICATIONS	19
24. WELD RECORD	20
25. WELD EXAMINATION	20
26. ACCEPTANCE TESTING	20
27. MANHOLE AND BUILDING PENETRATIONS.....	20
28. CLEANING – STEAM AND CONDENSATE PIPING	21
29. CLEANING – HEATING HOT WATER PIPING	22



1. General Information

The University owns, maintains, and operates a steam distribution system, and condensate return system serving the University campus and UNC Hospitals. All new facilities, and all expansion of existing facilities, shall utilize this district steam system for space heating, domestic hot water heating, sterilization, humidification, and other process whenever feasible. Deviation from the use of steam as the primary heat source requires analysis showing justification for the variance and written approval from the Director of Energy Services.

The University's Cogeneration Facility is located at the west end of Cameron Avenue, approximately one mile from the center of campus. Steam is provided from the central facility via a low pressure system (LPS), a medium pressure system (MPS), and a high pressure system (HPS). The LPS shall be utilized for all HVAC loads including humidification. The MPS and HPS provides steam for such process equipment as sterilizes and cage washers that require higher pressures; the MPS and HPS **shall not** be utilized for HVAC loads including humidification with un-fired steam generators.

2. System Boundaries

The steam distribution system continues up to the main pressure reducing valve (PRV) station in a building or the first isolation valve, whichever comes first. The underground design requirements shall govern the design of any such PRV station, including materials and welding requirements.

3. Safety Relief Valves

The designer may not install any safety relief valves open to the campus steam distribution system. The distribution system already has safety valves installed and the building design shall not affect these settings. Any safety relief valves installed by a project shall be downstream of a building PRV and shall affect the building systems only. The campus system safety settings are 75 psig, 95 psig, and 195 psig for the LPS, MPS, and HPS respectively. If the building is designed without a PRV, the building equipment must be such that exposure to these pressure limits will not cause harm, and will meet all applicable codes.

4. Supply Pressures

The Designer shall calculate and submit the maximum steam demand for each system for any new building, addition, or renovation to the Cogeneration Facility Engineering Representative (CFER) for determination of the adequacy of the existing steam distribution system to meet anticipated demand. The CFER will determine if modifications to the steam distribution system are required. The maximum steam demand shall be expressed in pounds of steam per hour for both the total connected load and the actual expected maximum sustained demand with an appropriate diversity factor. The CFER will provide the Designer with supply steam pressures to be expected at the project door based upon the projected design loads.

5. Condensate Return

All building equipment which uses steam and does not contaminate the condensate shall return the condensate to the pressurized condensate return system. An example of contaminated condensate that should not be returned is the drainage from a cage washing unit. The designer shall prepare a break down of returned and dumped condensate and submit a summary to the CFER for approval.

The building steam and condensate systems should be chemically cleaned and flushed after construction to remove all debris and as much silica as possible. The campus condensate return system typically has an aggregate silica level of 50 ppb or less. The condensate from a new building or renovation will not be returned to the condensate system until the silica level drops below 200 ppb at the building pumps. Cleaning of the underground mains is covered in a later section.



6. Tie-Ins to the Campus Steam Distribution System

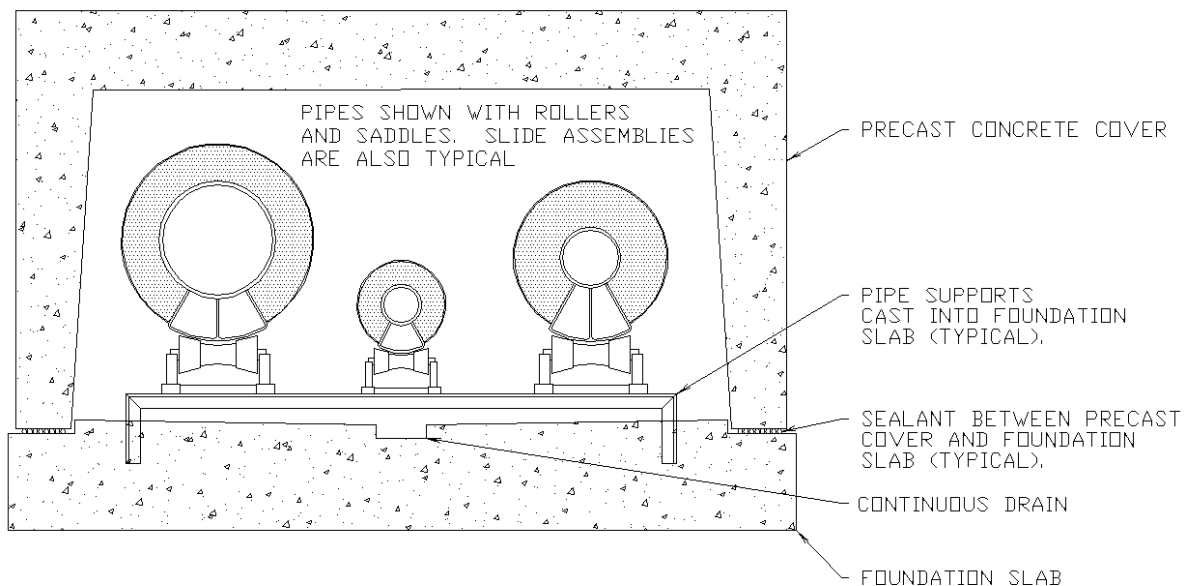
Any and all tie-in's of the project steam and condensate systems to the campus steam and condensate systems shall be supervised by, scheduled with, and coordinated with UNC Cogeneration Facility personnel. Connections to the campus steam system shall be performed by the contractor under the supervision of Cogeneration Facility personnel. The Contractor shall furnish all fittings, pipe, valves, etc., for the tie-in. The tie-in will only be made at such a time when University operations permit an outage. This will typically be when the ambient temperature is between 50 and 80 degrees F. The Contractor shall notify the Designer and the CFER a minimum of fourteen (14) calendar days in advance of a requested steam outage to perform a tie-in. The CFER has final authority on any and all scheduling for such events. Steam will not be admitted to an installation until an account has been set up for the steam usage and a meter has been installed. Steam shall only be admitted to an installation by Cogeneration Systems personnel.

7. Underground Steam and Hot Water Distribution Conduit (non-walkable)

7.1. All steam and condensate lines shall be enclosed in a continuous concrete conduit system between manholes. The conduit system has the following general appearance. The pre-cast concrete covers may also have an arched shape. The tunnel system shall be installed with 36" minimum cover, with an emphasis on going no deeper than necessary.

7.2. Foundation

7.2.1. The conduit foundation shall consist of a continuous cast-in-place monolithic concrete foundation slab with appropriate expansion joints. The foundation will be poured with concrete having a 28-



day minimum compressive strength of 4000 psi. Structural reinforcement shall be designed per the loading requirements by a licensed structural engineer, but in no case shall be less than 6 x 6 - W2 x W2.9 welded wire fabric (6 gage). The structural re-enforcing steel shall meet the requirements in the steel reinforcement section of this document. The foundation shall have a sloped floor and center drain allowing for proper drainage to the downstream manhole of any tramp water in the conduit system. The center drain shall have a minimum dimension of 1 ½"



depth by 5 ½" width. The foundation shall be keyed or notched on either side to accept the pre-cast covers ensuring proper alignment, and preventing lateral motion during backfill.

7.2.2. Slab surfaces shall be screeded straight and to proper grades and pitched uniformly to drainage points. The foundation slab and drain shall extend through building and manhole walls unless noted on the drawings. The top surface of the foundation slab shall be given a hand-rubbed, wood float finish. The openings to the manhole from the conduit system shall be sealed off with 4" thick block insulation to prevent air from drafting down the conduit system. The conduit center drains shall not be blocked off from the manhole. Other methods of removable insulation will be considered.

7.3. Pre-cast Covers

7.3.1. The pre-cast concrete covers in the conduit system shall not be used as a means of piping restraint or support in any manner. At expansion loops and elbows, conduit shall be sized to allow for expansion and contraction without damaging the insulation, piping, or conduit structure.

7.3.2. The pre-cast covers shall be manufactured by an industrial/commercial manufacturer who has been manufacturing the style cover selected for a minimum of five (5) years. The manufacturer must provide a minimum of five (5) reference projects where this cover has been used. The covers shall be cast with inside clearance dimensions as shown on the drawings. Suppliers of pre-cast tunnel covers must furnish calculations to the Designer to verify structural adequacy for design loading.

7.3.3. The pre-cast covers shall be designed with interlocking ends such that the covers joined together in a method similar to tongue-and-groove or lap-joint.

7.3.4. The concrete used in the covers shall have the minimum 28 day compressive strength as required by the licensed structural engineer, but shall not be less than 4000 psi in any case. The conduit system shall be designed to withstand all of the following loading conditions.

7.3.4.1. HS-20 highway loads at 2 feet of cover, and

7.3.4.2. Soil loading assuming a soil density of 100 lbm/cuft., at the installed depth of cover, or at 10 feet of cover, whichever is greater.

7.3.5. Structural reinforcement shall be designed per the loading requirements by a licensed structural engineer, but in no case shall be less than 6 x 6 - W2 x W2.9 welded wire fabric (6 gage). The structural re-enforcing steel shall meet the requirements in the steel reinforcement section of this document.

7.4. Sealants

7.4.1. A waterproofing sealant shall be used at all joints between foundation slab and pre-cast concrete covers, and at joints between adjacent pre-cast concrete cover sections. The sealants shall be butyl resin or one part polyurethane. The polyurethane sealants shall be equal to SikaSwell S as manufactured by SIKA. The butyl resin sealants shall be equal to ConSeal as manufactured by Concrete Sealants Inc.

7.4.2. The sealant shall be installed so as to provide full coverage of all concrete joint contact surfaces per the manufacturers recommendations. Place sealant on parts to be joined prior to final positioning of the pre-cast structures.

7.5. Waterproofing mastic

7.5.1. A heavy coat of non-asphalt, rubber/resin based mastic for underground use shall be applied a minimum of 12 inches wide to all joints after the joint is made. The mastic shall be equal to Sandell Special Nuflex Mastic as manufactured by Sandell Manufacturing Co., Inc.

7.6. Waterproofing Membrane



7.6.1.A waterproofing membrane shall be installed over the entire conduit system. The membrane shall be polyvinyl chloride. The membrane shall have a nominal thickness of 20 mils, and have a minimum tensile strength of 2300 psi.

7.6.2.The membrane shall be wide enough to drape over the conduit structure and lap over the foundation on both sides in one piece. The membrane shall be extended axially along the conduit system from a large roll so as to minimize the number of joints in the membrane.

7.6.3.The PVC membrane jacket shall be overlapped a minimum of 12 inches and sealed with a non-asphalt resin based sealant at membrane joints to produce a waterproof seal. The waterproofing membrane shall be adhered to the concrete joints and to itself at overlaps. The entire conduit system shall be made waterproof. All manufacturer's installation recommendations shall be followed.

7.7. Waterproofing Backfill Protection

7.7.1.The waterproofing membrane shall be protected from backfill by a layer of non-woven polypropylene. The polypropylene protective layer shall have an approximate weight of ½ lb. per square yard. The polypropylene covering shall be equal to Terratex non-woven geotextile No. 8 as manufactured by Webtec, Inc. At wrap joints the materials shall overlap a minimum of 12 inches. The wrap joints shall not be coincident with waterproofing membrane joints. All manufacture's installation recommendations shall be followed.

7.8. Concrete Conduit Waterproofing Alternative

7.8.1.In lieu of the above membrane and mastic system, the same waterproofing system required for the manholes may be used for the entire conduit system, so long as butyl resin sealants are applied to the pre-cast joints as described in item 7.4.

8. Manholes

8.1. General Structure

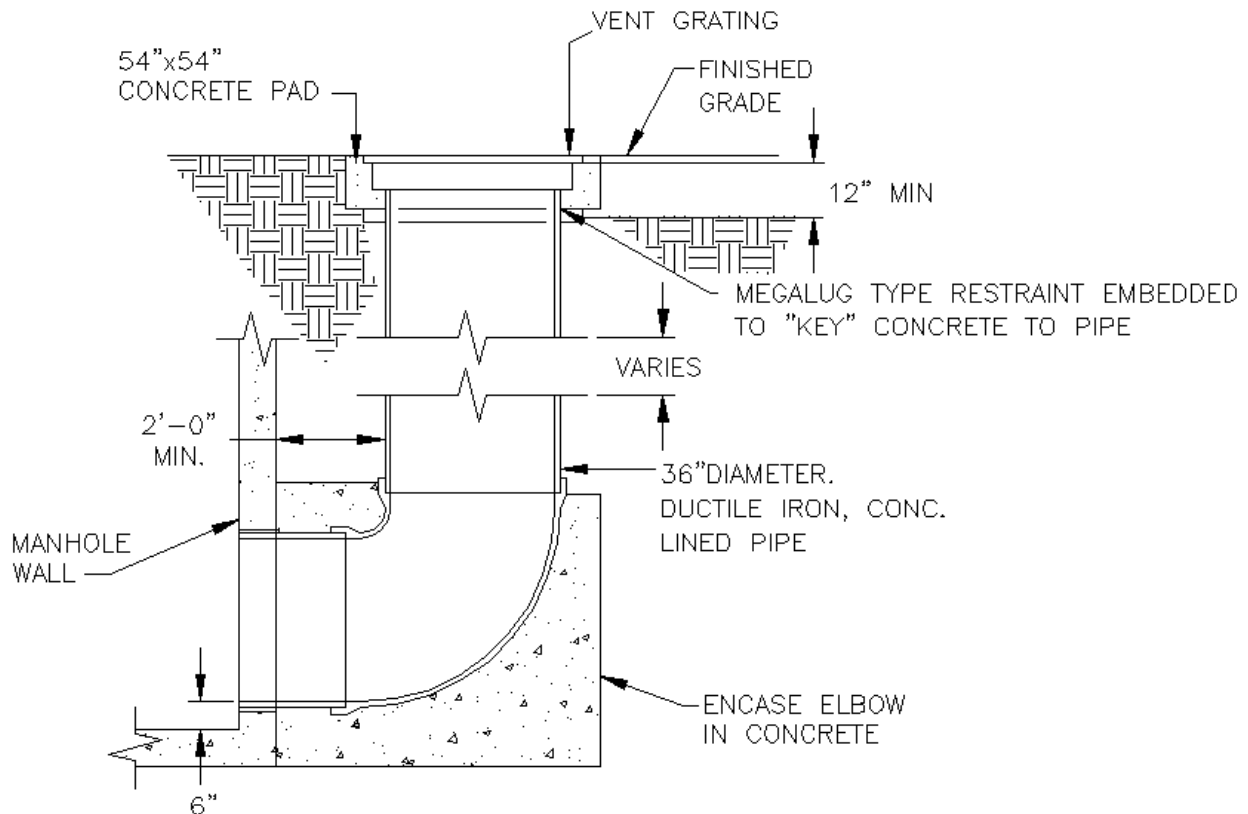
8.1.1.Steam manholes shall contain only steam related systems (steam, condensate, heating hot water, and occasionally hot domestic water). Absolutely no other utilities such as sewer, cold domestic water, electrical duct banks, chilled water, etc. shall pass through the steam manholes, or steam conduit system.

8.1.2.Minimum manhole interior dimensions shall be L=10' x W=10' x H=8'. Manholes shall be sized in excess of this as required to provide adequate and safe movement within the finished manhole including piping insulation. Free and open access to all operational components such as valves, drains, trap stations, etc. shall be provided.

8.1.3.All steam and hot water manholes shall be constructed with a minimum of two egress paths, one on each side of major obstructions such as through piping, and generally on opposite sides of the manhole. Egress paths shall be coordinated with the manhole ventilation design.

8.1.4.All steam manholes shall have a high-low natural ventilation system. The ventilation system shall be designed to ventilate the manhole only, the conduit system will be blocked off with insulation from drafting with the manhole. The low vent shall be on the opposite side diagonally from the high vent if possible, or at a minimum on the opposite parallel side. The high vent can be common with a ladder access point. The high vent shall be positioned such that rain drops do not drop on top of equipment and piping. Typically, the low vent is constructed of 36" diameter ductile iron pipe adjacent to the manhole with a penetration six (6) inches above the manhole floor. Alternately the down shaft can be cast integrally with the manhole wall. The external ductile piping arrangement has proven to provide superior ventilation because the exterior shaft with separation stays coolest. In all cases the down shaft shall be exterior to the manhole, shall have a

cross-sectional area equal to or greater than a 36" diameter pipe, and shall penetrate the manhole six (6) inches above the floor. The penetration shall be sealed full wall thickness with non-shrink grout and shall be water proofed according to the manhole water proofing section of this document. The landscaping around the manhole shall prevent any surface water drainage to any manhole opening or cover. The diagram below shows a down-shaft arrangement for the low vent.



- 8.1.5. The manholes shall have a minimum of three (3) feet of cover, and the overall depth of manholes shall be kept to a minimum. Consideration shall be given to accessibility and maintainability when designing manholes.
- 8.1.6. The access points shall be a minimum of 30 inches in diameter. In non-roadways use 36" square HS-20 highway rated aluminum hinged doors. Even with such a rating, the aluminum doors are not suitable for actual roadway use (repeated traffic crossing). In an actual roadway the doors shall be standard 30" round cast iron manhole ring and covers. The accesses shall be designed for safety, accessibility to the equipment, maintainability, operability, adequate ventilation, and must be large enough to pass any equipment installed within. Regardless of installed location or type, all doors shall carry a HS-20 highway rating.
- 8.1.7. All access doors shall have an aluminum or stainless steel, welded on, tag that bears the identification number of the manhole. The letters shall be two (2) inches in height. The letters may be field "written" with a stainless or aluminum welding bead in lieu of a fabricated tag. The tag shall have the form "STM-XXX" where STM stands for steam, and XXX to be replaced with the Cogeneration Systems manhole number.



- 8.1.8. Drains shall be provided in all manholes. Open drains shall be routed to the nearest storm sewer or other suitable storm drainage location, as the purpose of these drains is simply to remove infiltrated rain water. These drains shall have a minimum diameter of four (4) inches. Where gravity drains cannot be installed, sump pumps may be utilized. The sump pumps shall be Little Giant High Temperature Sump Pumps only.
- 8.1.9. Whenever possible electrical switching equipment shall be located external to the manhole in an adjacent building. In no case shall electrical equipment be located in a non-ventilated manhole. All electrical equipment within manholes, including junction boxes, shall be suitable for continuous full load operation in a 100% relative humidity, 200 degrees F ambient condition.
- 8.1.10. All electrical conduit in manholes and in steam conduits shall be aluminum only. The only exception is naturally ventilated (with power assist) walk-able tunnels, where the conduit may be rigid galvanized.
- 8.1.11. All wiring shall be rated for a minimum of 200 degrees C and sized appropriately for the load. Referencing table 310-19 of the 1999 National Electric Code, the wiring shall be types, FEP, FEPB, or PFA.
- 8.1.12. Steps leading into manholes shall be meet OSHA standards and shall be designed to withstand a sustained temperature of 200F.
- 8.1.13. Ladders entering manholes shall be constructed of stainless steel, aluminum, or hot dipped galvanized. Fabricated ladder risers shall be 2 inch by 3/8 inch flat bar. Fabricated ladder rungs shall be 1 inch re-bar. Smooth, round rungs will not be accepted. The rungs shall rest in drilled holes and be welded in position. Similar pre-manufactured stainless steel, aluminum, or hot dipped galvanized ladders or components may be used with the owners written approval of a shop drawing. The ladders shall be anchored to the manhole wall using stainless steel only anchor bolts. Absolutely no individual step wall anchored type ladders will be allowed. No carbon steel ladders will be accepted. If hot dipped material is chosen, the ladder shall be dipped as a complete structure, not fabricated of individual pre-dipped components.
- 8.1.14. Structural reinforcement shall be designed per the loading requirements by a licensed structural engineer, but in no case shall be less than No. 4 reinforcing bar on twelve (12) inch centers. The structural reinforcing steel shall meet the requirements in the steel reinforcement section of this document.
- 8.1.15. The walls, roof, floor of the manholes shall be designed per the loading requirements by a licensed structural engineer, but in no case shall be less than eight (8) inches thick.
- 8.2. Manhole Waterproofing Materials
- 8.2.1. The primary water proofing barrier shall be constructed of a sprayed on, or rolled on material that meets or exceeds all of the following requirements.
- 8.2.1.1. Material shall be non-toxic.
- 8.2.1.2. Water based, and can be applied to green, un-cured concrete.
- 8.2.1.3. Final cure must occur within 48 hours.
- 8.2.1.4. Tensile strength shall not be less than 50 psf.
- 8.2.1.5. Elongation without failure shall be at least 1000%.
- 8.2.1.6. Resilience (elongation recovery) shall be at least 95%.
- 8.2.1.7. Moisture vapor transmission shall be no greater than 0.02 gm/sq.ft./hr.
- 8.2.1.8. Shall be impenetrable to water up to 30 psig.
- 8.2.1.9. Shall bond to the concrete with a pull off force not less than 820 psf.
- 8.2.1.10. Shall remain stable and bonded up to 240 degrees F.



8.2.2. The primary waterproofing backfill protection membrane shall be a high strength polyethylene geomembrane slip sheet, and shall meet or exceed the following requirements.

8.2.2.1. Have a minimum thickness of 10 mils.

8.2.2.2. Have a minimum puncture resistance of 70 lbs.

8.2.2.3. Have a minimum tensile strength of 25 psi.

8.2.3. An example of these types of materials can be found at www.eproserv.com in the EcoLine-R, EcoLine-S, and EcoShield-E line of products, as manufactured by EPRO Waterproofing Systems.

8.3. Manhole Waterproofing Methods

8.3.1. Manhole waterproofing shall be a three step process consisting of detailing cold joints and penetrations, applying a sprayed on / rolled on membrane to provide overall waterproofing, and the application of a backfill protection membrane.

8.3.2. The first, or detailing step consists of applying a roll on coat of the waterproofing compound to all cold joints and penetrations at least 3 inches on either side of the joints and radial out from the penetrations. While still wet, an embedding fabric shall be placed in the membrane coat. Then a second coat shall be applied to the embedding fabric until saturated.

8.3.3. The second, or membrane application step is performed by rolling or spraying membrane material to the manhole exterior surface in wet lifts until the material is not less than 60 mils thick on the concrete surface. The surface shall be fully coated, and free of gaps and cracks.

8.3.4. The third, or protection layer is a process of applying a polyethylene geomembrane slip sheet that will protect the waterproofing membrane from backfill. This membrane shall be applied such that the overlaps are not less than 12", and are sealed with a roller compressed wet layer of waterproofing material. Waterproofing seal tape shall be applied to seam overlapping 2 inches on either side of the seam.

8.3.5. In some circumstances there is a fourth process of applying a drainage membrane on the outside of the protection membrane to aid in ground water drainage away from the structure. In most cases however, the manhole is backfilled with a layer of pea-gravel which acts as the drainage mechanism.

9. Walk-Through Tunnels

9.1. Where walk through utility tunnels are applicable to the project, the walk through tunnel containing the steam systems shall be built and waterproofed to the same standards as defined in the manholes section of this document.

9.2. The only other utility that may share the tunnel space with the steam, condensate, and heating hot water is UNC Chilled Water. Standards of agreement are in place for the joint use of the tunnel for those two departments (Cogeneration Systems and Chilled Water Systems). All other utilities such as electric duct, sewer, domestic water, storm drainage, etc. are expressly forbidden.

9.3. All walk-through tunnels shall have a minimum of 8 feet of head clearance, and 3 feet of clear aisle space for walking and carrying materials.

9.4. All walk-through tunnels shall be cast-in-place.

9.5. Personnel shall have a means of egress at a maximum of 300 feet in any direction (600 feet between egress points).

9.6. The walk-through tunnel system shall have natural ventilation with fan powered assist. The fans shall be designed such that the noise emitted is not greater than 50 dbA at five feet (measured on the surface, distance from the inlet/exhaust). The fans shall have a hand/off/auto switch. In auto mode they shall be controlled by local thermostat.



- 9.7. Repairs to the piping systems will be made within the tunnel system. Provisions must be made to provide access points where 21 foot random length piping can be lowered into to the tunnel and moved to the necessary locations. Room to make repairs to the piping shall be provided in the design.
- 9.8. Adequate lighting shall be provided through out the tunnel for egress, operation, and maintenance.
- 9.9. Walk-through tunnels are the only place in the steam distribution system where expansion joints are allowed instead of expansion loops as a means of accommodating thermal expansion. Expansion joints used in walk-through tunnel systems shall meet the following requirements:
 - 9.9.1. Expansion joints shall be designed for pressure, temperature, movement, spring rate and cycle life per Expansion Joint Manufacturers Association (EJMA) standards.
 - 9.9.2. Expansion joints shall be weld-end, packless, constructed of externally pressurized, double-ply (minimum) bellows.
 - 9.9.3. The bellows material shall be 625 stainless, with carbon steel fittings.
 - 9.9.4. Control Rings shall be constructed of cast steel, or high grade cast nickel-iron.
 - 9.9.5. Expansion joints shall be suitable for continuous operation at 200 psig and 450F.
 - 9.9.6. Provide joints with equalizing rings to reinforce the roots and walls of the corrugations against internal pressure.
 - 9.9.7. Stretching of expansion joint to correct for piping misalignment or to accommodate available end-to-end spacing shall not be allowed.
 - 9.9.8. Remove all shipping rods and spacers and clean inside of expansion joints thoroughly before putting joints into service.
 - 9.9.9. Anchors and guides shall be installed per the project documents and per the manufactures guidelines prior to conducting piping system pressure tests or putting joints into service.
 - 9.9.10. Manufacturer shall be present to instruct the Contractor and witness the installation of all expansion joints.
 - 9.9.11. Manufacturer shall be required to review and approve, in writing, the alignment and installation of all expansion joints prior to conducting piping system pressure tests, or operation of system.
 - 9.9.12. All expansion joints shall be provided with a minimum 5 year full replacement warranty.

10. Concrete Reinforcing Steel

- 10.1. All re-enforcing steel used in underground steam system structures including, but not limited to manholes, pre-cast members, tunnel slab, tunnel walls, etc. shall be epoxy coated.
- 10.2. Non-coated re-enforcing steel, bar or wire mesh, will not be accepted.
- 10.3. The epoxy coated re-enforcing steel shall be produced by a manufacturer who holds an Epoxy Coating Plant Certification issued by the Concrete Reinforcing Steel Institute (CRSI).
- 10.4. The coated re-enforcing materials shall meet or exceed the latest versions of all the following standards.
 - 10.4.1. ASTM A775: Standard specification for epoxy coated steel reinforcing bars
 - 10.4.2. ASTM A934: Standard specification for prefabricated epoxy coated steel reinforcing bars
 - 10.4.3. ASTM D3963: Standard specification for the fabrication and job site handling of epoxy coated steel reinforcing bars
 - 10.4.4. ASTM A884: Stand specification for epoxy coated steel wire and welded wire fabric for reinforcement.



11. Underground Steam System Routing

- 11.1. The Contractor shall coordinate the routing of all steam and steam condensate piping with other contractors prior to installation.
- 11.2. Furnish and install valves as required to allow for complete system venting and drain down.
- 11.3. Grade piping and piping conduit systems not less than 1/8th inch per foot in the direction indicated on the drawings.
- 11.4. Proper standoff shall be provided to protect other utilities from damage from construction, maintenance, or operating conditions. Consideration shall be given to potential damage to other utilities from high temperatures near steam lines.
- 11.5. Standoff from electrical utilities or systems shall be a minimum of 10 feet. When adequate standoff cannot be achieved, any portion of a duct bank within ten (10) feet of steam conduit in any direction shall be insulated with two (2) inches thick cellular glass on the three sides closest to the steam line, until at a point not closer than ten (10) feet.
- 11.6. Standoff from chilled water lines shall be a minimum of ten (10) feet. When adequate standoff between chilled water and steam lines and the chilled water lines cannot be achieved, the chilled water lines shall be insulated with a minimum of two (2) inches cellular glass insulation.
- 11.7. When steam and chilled water lines cannot be separated by ten (10) feet or more and they must run parallel for a distance of more than 50 feet, then consideration shall be given to a combined walk-through utility corridor, where the steam and chilled water systems share a common tunnel system.
- 11.8. Piping in non-walk-able systems shall have a locating wire and warning tape installed meeting the following requirements:
 - 11.8.1. Direct bury a bright yellow plastic warning tape buried 12 inches above the center of the steam conduit structure. The tape shall read "WARNING STEAM – WARNING STEAM – WARNING STEAM".
 - 11.8.2. Along with the warning tape 12" above the steam conduit direct bury a locating wire. The wire shall be equivalent to Annixter #6Q-1202-05 (bright Yellow), direct burial 2 conductor, 12 gage stranded copper.
 - 11.8.3. The wire shall penetrate the manholes through a one inch PVC sleeve, and be coiled on a hook inside of the manholes. The sleeve shall be sealed with a high temperature silicone sealant around the wire.
 - 11.8.4. The wire shall not continue through manholes, but shall be broken inside of each manhole. The coiled wire inside of the manholes shall be of sufficient length that it will extend out of the manhole doors 10ft.
 - 11.8.5. This wire will be used with Cogeneration Systems' locating equipment to aid in finding buried steam lines. The wire shall be clearly labeled on the hooks inside of the manholes to say "Trace Wire"

12. Steam, Condensate, and Heating Hot Water Piping

- 12.1. All piping in the steam, condensate, and heating hot water piping distribution systems shall be built in accordance with the ASME B31.1 Power Piping Code. As dictated by the specifications, the requirements may be greater than explicitly implied in the code.
- 12.2. All steam, condensate, and heating hot water piping in the distribution system shall have welded joints. No threaded, flanged, or union joints will be permitted (except at pumps, traps, and pressure control valves).



- 12.3. No steam supply pipe less than 4" nominal shall be used in the central distribution system. No pumped condensate return line less than 2" nominal shall be used in the distribution system. Avoid half sizes (e.g. 2½", 3½").
- 12.4. Piping which is sized 2" and smaller may be socket welded or butt welded. 2 ½" and larger shall be butt welded.
- 12.5. No piping smaller than 1" nominal shall be used for any service.
- 12.6. Butt-welded fittings shall be of a schedule matching the piping to which they are connected and installed in accordance with ASME B16.9.
- 12.7. Weld-o-lets and sock-o-lets may be used in lieu of tee's and saddles for branch take-offs from mains 3" or larger provided that the branch take-off is two or more sizes smaller than the main and is not larger than 4" nominal. No "stub-ins" will be permitted. Weld-o-lets and sock-o-lets outside of these guidelines are expressly forbidden.
- 12.8. Use full size isolation valves throughout the steam distribution system. Do not place reducers in distribution piping for the sole purpose of accommodating smaller isolation valves. Size control valves as appropriate and use reducers to match.
- 12.9. All piping turns shall be made with standard long radius elbows. Where turns less than 45 degrees are required, a standard long radius fitting shall be cut down and welded in position, mitered joints (offset greater than 5 degrees) are NOT acceptable.
- 12.10. All piping shall bear the continuous marking of the manufacturer, ASTM grade, and schedule number. Piping found to be defective shall be immediately removed from the site. All piping shall be cleaned of foreign matter both inside and outside before installation. All burrs shall be removed.
- 12.11. Steam piping 2 inches and smaller: Carbon steel, ASTM A53B or ASTM A106B. Schedule extra standard (XSTD), seamless.
 - 12.11.1. Fittings: ASTM A 105, forged steel, socket-weld, 3000# class, in accordance with ANSI B16.11.
 - 12.11.2. Flanges: ASTM A105 forged steel, socket weld, 300# class, in accordance with ANSI B16.5.
- 12.12. Steam piping 2 ½ inches and larger: Carbon steel, ASTM A53B or ASTM A106B. Schedule standard (STD), seamless or ERW.
 - 12.12.1. Fittings: ASTM A234-WPB, seamless or welded, butt-weld end, schedule standard. In accordance with B16.9
 - 12.12.2. Flanges: ASTM A105 forged steel, weld-neck, 300# class, in accordance with ANSI B16.5.
- 12.13. Condensate piping 2 inches and smaller: Carbon steel, ASTM A53B or ASTM A106B. Schedule extra standard (XSTD), seamless.
 - 12.13.1. Fittings: ASTM A 105, forged steel, socket-weld, 3000# class, in accordance with ANSI B16.11.
 - 12.13.2. Flanges: ASTM A105 forged steel, socket weld, 150# class, in accordance with ANSI B16.5.
- 12.14. Condensate piping 2 ½ inches and larger: Carbon steel, ASTM A53B or ASTM A106B. Schedule extra standard (XSTD), seamless or ERW.
 - 12.14.1. Fittings: ASTM A234-WPB, seamless or welded, butt-weld end, schedule standard. In accordance with B16.9
 - 12.14.2. Flanges: ASTM A105 forged steel, weld-neck, 150# class, in accordance with ANSI B16.5.
- 12.15. Heating hot water piping 2 inches and smaller: Carbon steel, ASTM A53B or ASTM A106B. Schedule extra standard (XSTD), seamless.
 - 12.15.1. Fittings: ASTM A 105, forged steel, socket-weld, 3000# class, in accordance with ANSI B16.11.
 - 12.15.2. Flanges: ASTM A105 forged steel, socket weld, 150# class, in accordance with ANSI B16.5.



- 12.16. Heating hot water piping 2 ½ inches and larger: Carbon steel, ASTM A53B or ASTM A106B. Schedule extra standard (XSTD), seamless or ERW.
 - 12.16.1. Fittings: ASTM A234-WPB, seamless or welded, butt-weld end, schedule standard. In accordance with B16.9
 - 12.16.2. Flanges: ASTM A105 forged steel, weld-neck, 150# class, in accordance with ANSI B16.5.

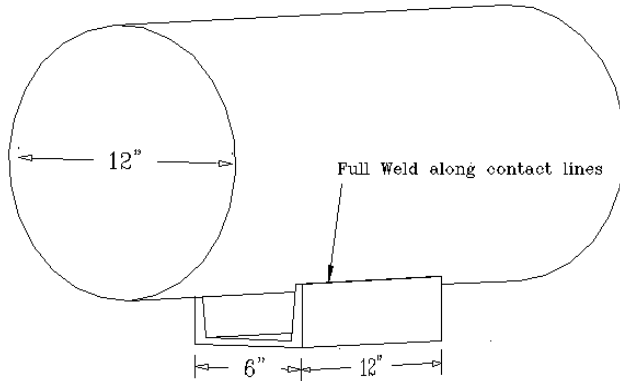
13. Thermal Expansion

- 13.1. For the purposes of calculating piping stresses, anchor loading, etc. the designer shall consider the maximum working pressure of the steam and condensate piping to be 200 psig @ 450F. Every component of the steam and condensate system from anchors, to expansion loops, expansion joints, fittings, valves, trap bodies, etc. shall be capable of continuous operation at these conditions. (NOTE: Trap orifices shall be selected based on the operating condition, not the design condition. Orifice selection is covered in the “Steam Condensate Traps” section of this document).
- 13.2. For heating hot water systems the maximum working pressure shall be considered 200 psig @ 250F.
- 13.3. Expansion loops, Z’s, and L’s are the required method for incorporating piping flexibility. Expansion joints will only be considered in walk-through tunnel systems.

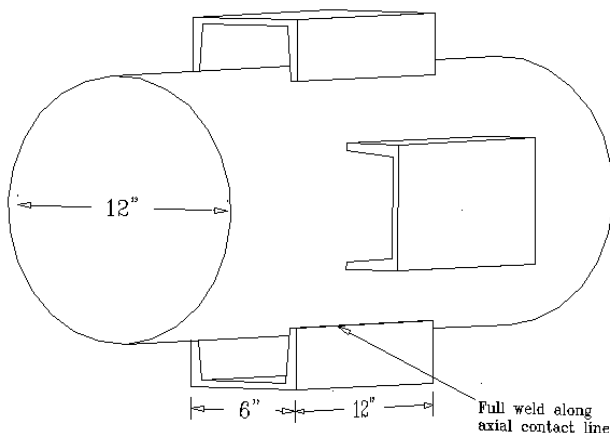
14. Piping Supports, Anchors, and Guides

- 14.1. All piping shall be supported with devices which permit the pipe to expand thermally without wear to the pipe. Slide type supports, or roller type supports may be used. When rollers are used, piping saddles matching or exceeding the insulation depth shall be used. When slides are used, a Teflon slide surface shall be integral to the slide design. All means of pipe supports shall be secured in position. Anchor and guide supports shall be cast into the base slab when it is poured. Supports providing only vertical support may be secured by stainless anchor bolts rather than cast in place.
- 14.2. All supporting and restraining devices must be selected as part of the system stress analysis. The devices shall be suitable to sustain the static and dynamic loads of the system as defined in the ASME B31.1 Power Piping Code.
- 14.3. No anchoring systems which use insulation as a means of piping restraint or support shall be allowed. Anchors shall be **welded** to piping. Saddles shall be tack **welded** to the piping. Guides structure shall be **welded** to the piping. All wear shall occur between saddles and roller, or between guides and substrate, with no wear at the piping.
- 14.4. All structural embedments and anchor bolts penetrating the concrete structures shall be stainless steel. An example would be a simple channel support where a horizontal channel is welded to two 3” pipes embedded into the concrete to create a flat support structure for an anchor, guide, support, etc. The pipes embedded in the concrete would be 304L stainless steel. The channel iron cross member would be carbon steel. Only the material penetrating the concrete needs to be stainless. In the case of 304L stainless pipe welded to carbon steel channel, SS309 filler material would be used to make the dissimilar metal weld. Carbon steel shall not be used within 2 inches of the floor of manholes or pipe conduits.
- 14.5. For piping systems in conduits with expansion loops, the piping anchors, at a minimum, shall consist of a structural steel channel welded to the pipe. The structural channel shall have a length equal the nominal diameter of the pipe, and a width equal to the ½ the nominal diameter of the pipe. For example, a 12 inch pipe will have a channel that is fully welded along the pipe axis at the contact lines not less than 12 inches, and 6 inches between the welds. A diagram of this example is shown below.

This channel is then welded to the substrate to create an anchor, or is riding on the Teflon surface to create a slide, etc. The channel could be an “H” beam, for a more heavy-duty application. The diagram is intended to show the minimum that will be allowed.



- 14.6. For systems with expansion joints instead of expansion loops (walk-through tunnels only) the anchoring system will by much more substantial to accommodate the increased loading. The piping shall be restrained in a box type restraint such that piping is restrained at all four quadrants at a minimum. This provides uniform circumferential loading on the pipe. The diagram below shows the minimum allowed attachments to the pipe, producing 8 axial welds evenly spaced around the pipe. In some cases halo rings may be required to further distribute the loading. The formula for length and width is the same as for the standard minimum anchor above.



- 14.7. Hangers or supports for steam, condensate, and heating hot water piping shall be spaced at maximum distances as shown in the following table:

Nominal Pipe Size (inches)	1 to 2	2-1/2 to 3-1/2	4 to 8	10 and over
Maximum Span (feet)	8	10	15	20



- 14.8. Hangers or supports shall be installed within two (2) feet of each change of direction, in any plane. Protect insulated steam and steam condensate piping at support points with saddles or extended slides welded to the pipe.
- 14.9. Hangers and supports shall be as manufactured by Fee & Mason, Grinnell, Modern, B-Line or an approved equal.

15. Piping Insulation

- 15.1. All insulation, coverings, and adhesives shall have a flame spread classification of 25 or less and a smoke developed rating of not more than 50.
- 15.2. All piping in the non-walk-able conduit systems and connecting manholes shall be insulated with cellular glass only. The cellular glass shall meet the following requirement:
 - 15.2.1. Nominal compressive strength of 90 psi
 - 15.2.2. Water vapor permeability of 0%
 - 15.2.3. Thermal conductivity not greater than 0.29 Btu-in/hr-ft²-°F
- 15.3. Distribution piping in building mechanical rooms, and in completely ventilated, accessible, full walk-through tunnels can be insulated with 6 lbm/cu-ft, high density fiberglass as an alternate (this does not include normal manholes). The transition from cellular glass to fiberglass shall happen within the approved areas, and shall be clearly indicated on the drawings. Any fiberglass insulation that gets wet during construction will be removed and replaced at the contractors expense.
- 15.4. For both the fiberglass and cellular glass insulating systems the insulation thickness shall be in accordance with the table below.

Nominal Pipe Size	Thickness (Steam)	Thickness (Condensate)	Thickness (Heating Hot Water)
1" to 2"	2 1/2"	1 1/2"	1 1/2"
2 1/2" to 4"	3"	2"	2"
5" or Greater	4"	3"	3"

- 15.5. Pipe surfaces shall be clean and dry prior to insulating. Insulation may be temporarily held in place with stainless steel wire or fiber re-enforced tape overlapped a minimum of 6 inches prior to the jacketing being installed. The tape and/or wire may remain on the insulation beneath the final jacket.
- 15.6. Insulate all unions, flanges, and valves with removable blanket wraps such that the insulation can be removed for maintenance and operation, and then replaced.
- 15.7. All insulated piping shall be wrapped with 20 mil aluminum or stainless steel jacket. This includes piping in the non-personnel areas such as the underground concrete piping conduits.
- 15.8. At all points where insulated hot water, steam, and condensate pipes are supported, the pipe shall be fitted with an appropriately sized pipe saddle or extended slide prior to insulating. The saddle or slide shall be left exposed at the bearing surface; the insulation shall butt neatly against the ends and sides and fill the voids of the saddle or slide.
- 15.9. Insulation shall be extended continuously through pipe sleeves.
- 15.10. Only non-asbestos insulation materials shall be used for any insulating medium.



16. System Drainage

- 16.1. The steam distribution system shall have a drip leg and trap station at every low point in the system. The condensate return system, and hot water systems shall have drains at every low point, and shall have vents at every high point.
- 16.2. The steam distribution system shall have a drip and trap station at least every 450 lineal feet of piping run.
- 16.3. For every main line isolation valve in the steam system. Closing the valve creates a dead leg in the system with a high point and a low point. The side of the valve creating a low point (side that holds water) shall have a drip leg and trap station. The side draining away from the valve shall have a 2 inch full port manual drain. For valves with supply pressure on both sides, and where the valve is the low point relative to both sides, a trap station shall be installed on both sides of the valve.
- 16.4. The drip legs shall be full size through 8 inch piping and shall be at least $\frac{1}{2}$ the size of the main line for lines larger than 8 inch. (i.e. 10" drip leg on a 20" main). The legs shall be of sufficient depth to hold temporary condensate surges until the traps can remove the condensate.
- 16.5. The traps shall be located sufficiently above the bottom of the leg so as to prevent dirt from entering the trap line.
- 16.6. All blow down drain and vent valves shall be 2 inch 600# class, full port, socket welded gate valves. The drains shall have welded construction with the end of each drain terminating in a Sch. 80 threaded pipe nipple. The entrance end of the nipple shall have its threads cut off, prepped, and welded in position. A threaded cap shall be placed on the exit end of the nipple.

17. Steam Condensate Traps

- 17.1. All steam traps installed in the campus distribution system shall be of the inverted bucket type.
- 17.2. All steam traps in the distribution system will be standardized to one trap. The Armstrong inverted bucket model 813 with a 1" connection size. For the campus LPS system the orifice size shall be 5/16". For the campus MPS system the orifice size shall be 1/4". For the campus HPS system the orifice size shall be 7/32". These orifices are matched to the model 813 trap for the pressure differential in the systems.
- 17.3. The model 813 trap is 12 inches tall, and must be positioned below the steam line to effect proper drainage. This shall be taken into account in the design of the system.
- 17.4. Traps shall be installed with isolation valves, unions, check valves, and strainer. Blow down valves shall be provided on the strainers. Trap discharge shall be routed to an atmospherically vented flash tank, and then to a condensate return pump set, preferably in the closest building mechanical room. Injecting trap discharge into a condensate return main is not permitted.

18. Valves

- 18.1. All valves shall be brand new, un-refurbished, first quality.
- 18.2. All isolation valves 2 $\frac{1}{2}$ " and above in the steam distribution system, up to and including the first valve inside of a building, shall be full port, butt-weld-end 300# class, gate valves suitable for operation at 450F. No brass or copper shall be permitted.
- 18.3. All isolation valves 2" and below shall be full port, socket weld 600# class, gate valves suitable for operation at 450F. No brass or copper shall be permitted.
- 18.4. Where possible, a project shall provide valves from one manufacturer in the underground steam, condensate, and hot water systems.
- 18.5. The acceptable isolation valve manufactures are (in no order):
 - 18.5.1. Crane



- 18.5.2. Edwards
- 18.5.3. Jenkins
- 18.5.4. Lunkenheimer
- 18.5.5. Milwaukee
- 18.5.6. Powell
- 18.5.7. Walworth
- 18.5.8. Williams

19. Condensate Return Units

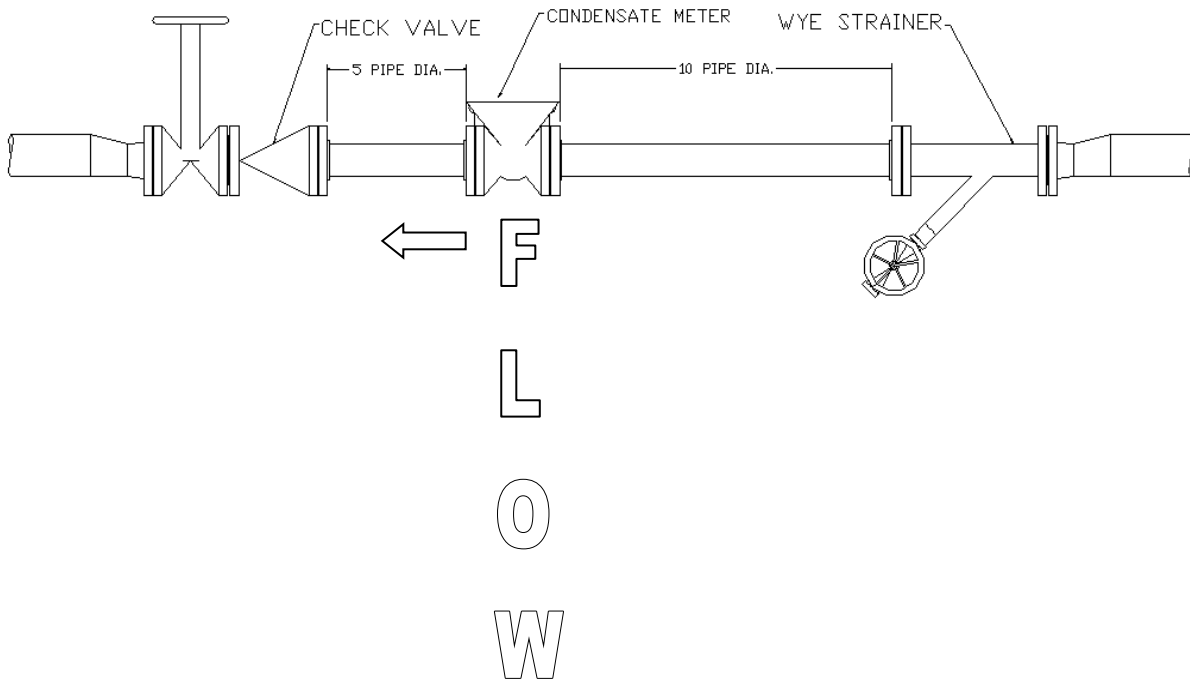
- 19.1. All building and trap condensate shall be routed to an atmospherically vented flash tank prior to entering the condensate receiver.
- 19.2. Condensate return pump/tank sets shall be duplex type provided with a float-operated mechanical alternating switch, sight glass, and check and gate valves on each pump discharge line.
- 19.3. The pump set must utilize “off the shelf” electric motors that can be purchased from any typical motor supplier. The motors cannot be custom to the design of the pump or manufacturer.
- 19.4. The pump set must be rated for continuous operation while pumping 212°F water at a back pressure 75 psig.
- 19.5. The pump set shall be provided with integral back pressure regulators for the pumps.
- 19.6. The pump set must come standard with a tank that is elevated 2 feet above the pumps as a pre-manufactured set.
- 19.7. The unit shall be installed such that the motors are not less than one foot above floor level, with two feet preferred in manholes and pits.
- 19.8. The pump set should be as manufactured by SHIPCO Pumps, type PEC (Propeller Elevated Condensate) or equivalent.

20. Condensate Meters

- 20.1. The contractor shall provide and install a condensate meter for every building to measure the condensate returned from the building.
- 20.2. Condensate meters shall be Niagara hot water meters of type MTX or WPX as sizing dictates, with local mechanical totalizers and integrated dry contact closures. Dry contacts should not be confused with a pulse output, the contacts provide momentary contact closure once per block unit of total. It does not provide rate as a pulse transmitter does. The contacts shall be left disconnected, they will be connected at a later date by Cogeneration Systems. The engineering specifications and cut sheets can be found at www.niagarameters.com.
- 20.3. The meter shall be sized to handle the full pumping rate of the condensate return unit, with both pumps running in a high-high tank level condition.
- 20.4. Strainers shall be provided upstream of each meter with mesh sizing per the meter manufacturer’s recommendation.
- 20.5. An isolation gate valve shall be provided on the discharge side of the meter, isolating the meter from the campus condensate system.
- 20.6. A check valve shall be provided in the meter discharge line downstream of the meter and installed according to the manufacturer’s recommendations.
- 20.7. The meter shall be installed in a horizontal pipe with the dial facing up, and shall be easily accessible. The reader shall not have to climb a ladder, or enter a pit to read the meter.

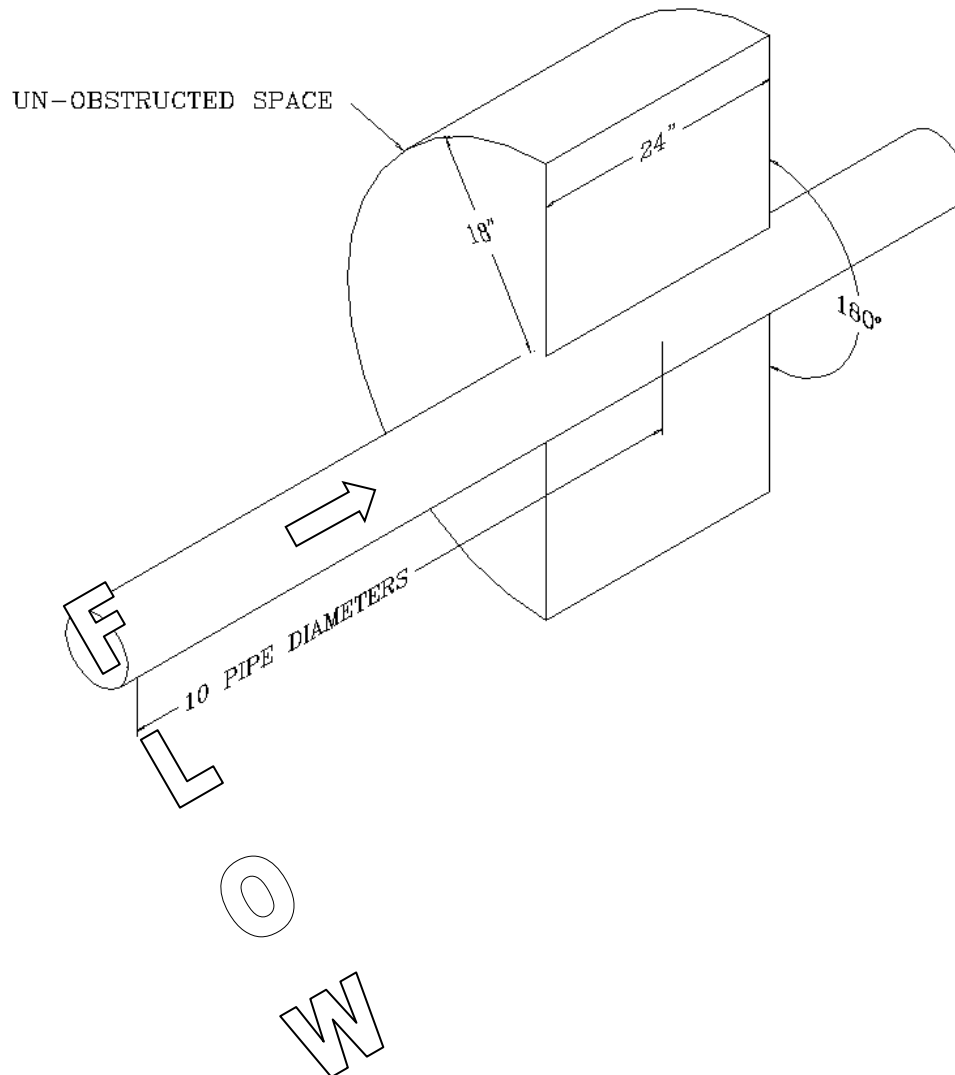


- 20.8. The meter shall be installed with no obstructions of any kind for a distance of ten (10) pipe diameters upstream of the meter, and 5 pipe diameters downstream of the meter. A general installation diagram is shown below.



21. Steam Meters

- 21.1. UNC Cogeneration Systems will provide, install, and commission a steam meter to monitor building steam usage for each feed to the building. The project shall provide a monetary reserve in the amount of \$7,500 payable to UNC Cogeneration Systems to cover the cost of the equipment and installation. If the building has dual feeds (high and low pressure) the reserve shall be \$10,000.
- 21.2. The project shall leave a 15 pipe diameter, horizontal, accessible pipe run inside of the building for the meter placement. Within the 15 pipe diameter run, a 180 degree section (left or right, not top or bottom), two feet long, shall be left completely unobstructed for a radius of 18 inches away from the pipe. This unobstructed section shall be centered 10 pipe diameters from the inlet of the pipe section. There shall be no other instruments in this section. See the diagram below.



- 21.3. The meter section location shall be indicated on the design drawings. The drawings shall indicate this section of piping is reserved for UNC Cogeneration Systems, and that nothing can be placed in this section of piping.
- 21.4. Meter section placement can be upstream or downstream of the building PRV. However, the meter section shall always be placed upstream of any building use points or branch lines. The designer shall coordinate the meter placement with the CFER so the proper elements can be purchased.
- 21.5. The electronics for the meter will be housed in a 20x20x10 inch deep control enclosure. UNC Cogeneration Systems will provide this enclosure, and turn it over to the contractor for mounting so that he has a termination point for the required wiring.
- 21.6. The enclosure shall be mounted such that the bottom face is 56" above finished floor elevation.
- 21.7. The enclosure shall be mounted in an area as close to the meter piping section as feasible, but where the ambient air temperature will not exceed 100°F. The designer shall show the appropriate location on the contract drawings, and the contractor shall confirm with the CFER when taking delivery of the enclosure.



- 21.8. The project shall provide a dedicated 115V circuit for the steam meter with conduit and wiring brought to the meter control enclosure. The power conduit shall not be less than ¾" and shall enter the enclosure at the top right corner. This circuit shall have a dedicated 15 amp breaker, and nothing else shall connect to this circuit.
- 21.9. The project shall provide a data connection running from the building main data switch to the meter control enclosure. The data conduit shall not be less than ¾" and shall enter the enclosure at the top left corner. The data cable shall be connected to the Steam V-LAN at the building switch, and be labeled as such. The data cable shall terminate in a surface mount RJ-45 receptacle in the enclosure. The data connection shall meet UNC Telecomm standards for the building.

22. Welding Methodology

- 22.1.1. Welding shall be done using only the following processes:
 - 22.1.1.1. Shielded Metal Arc Welding (SMAW), also known as "stick" welding
 - 22.1.1.2. Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding
 - 22.1.1.3. Metal Inert Gas Welding (MIG)
 - 22.1.1.4. Submerged Arc Welding (SAW)
- 22.1.2. For stainless steel piping, root passes must be applied by the GTAW process with argon gas purge, only.
- 22.1.3. Fabrication, installation, inspection, examination and testing shall be in accordance with B31.1, and further as the project documents require.
- 22.1.4. Backing rings (chill rings) or consumable inserts are not allowed.
- 22.1.5. All completed welds shall be wire brushed a minimum of 2 inches on either side and coated with rust inhibitive primer prior to being insulated.

23. Welder Qualifications

- 23.1. All welding shall be performed by qualified welders who are regularly engaged in welding of piping systems. The welders' certifications shall cover the exact procedure(s) to be used on the project piping systems.
- 23.2. All Welding Procedure Specifications (WPS's) and their supporting Procedure Qualification Records (PQR's) shall be submitted to Engineer of Record for review and approval prior to performing any welding. These documents shall meet requirements of ASME B31.1. Submit a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests as required by Section IX of ASME Boiler and Pressure Vessel Code for all welding procedures to be performed by the welding operator.
- 23.3. The qualifying test segment shall be 2" nominal pipe size with wall thickness within range of WPS for each pipe material specified in this Section. Test position shall be arranged in "6G position".
- 23.4. Welders shall be qualified in accordance with ASME B31.1. The welding qualification tests shall have an independent witness. The witness shall be a representative of independent testing laboratory, Authorized (Code) Inspector, or consultant approved by National Certified Pipe Welding Bureau.
- 23.5. Welder qualifications must be current. If qualification test is more than 6 months old, provide record of welding continuity for each welder. Record of welding continuity shall include, at a minimum, the following:
 - 23.5.1. Welder's employer name and address
 - 23.5.2. Date Welder Qualification Test was passed
 - 23.5.3. Dates of work performed and type indicating welding continuity.



- 23.5.4. If the continuity record is not satisfactory to the Engineer or the owner, the welder shall re-qualify before performing any work.

24. Weld record

- 24.1. For all pipe welding the contractors shall submit to the Engineer for approval an administrative procedure for recording, locating, monitoring and maintaining the quality of all welds to be performed on the project. This quality control document record shall include but not be limited to:
- 24.2. Drawings and schedules identifying location of each weld by individual number, identification of welder who performed each weld by individual welder's name, stamp number, date, and WPS used.
- 24.3. Once the procedure is approved, the Contractor shall carry out the procedure and the Engineer shall review the weld record documents monthly.
- 24.4. A finalized copy of the weld record shall be turned over to the CFER at the completion of the project.

25. Weld Examination

- 25.1. 100% of the welds in the steam, condensate, and heating hot water distribution system will be inspected and tested by non-destructive examination.
- 25.2. All tests shall be performed by an AWS-CWI (American Welding Society Certified Welding Inspector). The firm providing these services shall be agreed upon by the mechanical engineer and the owner.
- 25.3. All butt welds shall be tested by means of radiography. The criterion for pass/fail of this test will be as defined in the latest edition of the ASME B31.1 Power Piping code.
- 25.4. All socket weld connections shall be tested by means of dye penetrate or magnetic particle analysis. The criterion for pass/fail of this test will be as defined in the latest edition of the ASME B31.1 Power Piping code.
- 25.5. In the rare occurrence where radiography cannot be used to test a weld due to site restrictions the weld may be visually inspected by an AWS certified welding inspector provided that all the following conditions are met.
- 25.5.1. The CFER and design engineer must agree that a radiographic test cannot be reasonably achieved.
- 25.5.2. The pipe joint fit up must be inspected prior to welding by an AWS-CWI.
- 25.5.3. All welding passes must be inspected by an AWS-CWI including the root pass, hot pass, and all fill and cover passes.
- 25.5.4. If any of these steps are bypassed, and radiography cannot be utilized to verify the joint integrity, then the joint will be rejected outright and it will be replaced at the contractors expense. The replacement joint will be subject to the same testing requirements.
- 25.6. All initial testing will be funded by the owner through the project testing funds.
- 25.7. All repairs, and re-examination of repaired welds will be at the contractors expense

26. Acceptance Testing

All steam and steam condensate piping systems shall be tested at a hydrostatic pressure of 300 psig. The test shall be for a period not less than four hours with no pressure drop and shall be performed in the presence of the Designer. After any leaks are found and corrected the test shall be repeated.

27. Manhole and Building Penetrations

- 27.1. Where feasible the concrete steam conduit shall penetrate the manhole wall or building wall through the wall thickness and end flush with the inside wall face.



- 27.2. The wall shall either be integrally cast around the conduit to create a true cold joint, or if the conduit is placed through a pre-cut opening, the opening shall be “walled up” with masonry, concrete, and non-shrink grout as needed to provide a seal around the conduit.
- 27.3. The air space between the piping and conduit walls shall be blocked insulation to prevent drafting of the conduit system into the manholes or buildings.
- 27.4. Where lines must penetrate through walls, floors, and ceilings where there is no conduit, sleeves must be furnished and installed. The sleeves shall be schedule 40 black steel pipe and large enough to provide clear design movement of the pipe without damaging the piping insulation. Sleeves through walls and ceilings shall be flush, sleeves through floors shall extend 1" above the finished floor. Sleeves in the floor and in exterior walls shall be sealed with "Chase Foam" by Chase Foam Technologies, or equivalent. The contractor shall be responsible for the accurate placement of all sleeves.

28. Cleaning – Steam and Condensate Piping

- 28.1. All steam and condensate piping in the distribution system shall be cleaned prior to its connection to the University’s district energy system.
- 28.2. The steam and condensate piping shall be cleaned by means of steam blow only.
- 28.3. The contractor shall procure the services of qualified company to perform the steam blow(s) or may elect to have the University self perform the work.
- 28.4. The required steam blows may be completed by the University’s Cogeneration Systems Group or by a qualified industrial cleaning service contractor meeting the requirements of this specification. The Contractor can contact the CFER at UNC Cogeneration Systems for details and pricing related to the steam blow. If the Contractor wishes to use an external company rather than proceeding with the University, then it is highly recommended that he request “an approved equal” status for the cleaning contractor prior to the bid.
- 28.5. All in-line instruments and devices shall be removed prior flushing and steam blowing, and replaced with spool pieces if necessary. After the completion of the cleaning, the Contractor shall reinstall all instruments.
- 28.6. All permanent piping shall have passed its hydrostatic test and be flushed with water to remove loose debris prior to any steam blow.
- 28.7. All steam and condensate lines shall be blown three separate times with cool down periods between each blow to cause thermal cycling of the piping. This is to facilitate the release of welding slag and other bonded debris.
- 28.8. During the final blow for each pipe, the process shall generate not less than 250 feet per second of steam flow velocity in all sections of the permanent piping, and maintain this velocity for period not less than one hour. The blow shall continue until the piping is deemed clean enough to connect to the University’s district energy system by the CFER.
- 28.9. The steam blow shall be witnessed by the CFER and the mechanical design engineer of record, or their designated representatives.
- 28.10. The steam blow shall not be conducted when the ambient air temperature is less than 50 degrees F or greater than 80 degrees F. Any such event shall be scheduled with Cogeneration Systems personnel. The scheduling of such events will be dependent on campus load, and steam availability, and outages required. Cogeneration Systems has final authority on the scheduling of all such events.
- 28.11. The steam blow shall minimize stress to the system components caused by excessive temperature and/or pressure changes.



- 28.12. The arrangement of the temporary piping shall be designed in accordance with ASME B31.1. The piping arrangement and steam blow shall not cause the stress levels in any permanent or temporary piping component to exceed the allowable levels listed in ASME B31.1.
- 28.13. Any low points created as a result of the temporary piping arrangement shall have manual drains installed for proper drainage during the blow. If the drains are installed in permanent piping they shall be installed in accordance with the permanent piping standards for this project, and shall remain. If they are temporary to be removed after the steam blow, they may be of suitable temporary construction, such as threaded brass or bronze valves.
- 28.14. The exhaust end of the line(s) being blown shall be muffled and/or quenched as required to maintain 85 dBA or less at a distance of 50 feet from the steam discharge point.
- 28.15. Steam discharge shall not produce shock waves or air born particulate which could settle on parked cars, people, buildings, etc. This includes small material which may soil clothing, buildings, cars, etc.
- 28.16. Modifications to any permanent fixtures or systems to accommodate the steam blow shall be repaired and or replaced at the completion of the event to the satisfaction of the University and the designer of record.
- 28.17. The contractor shall provide barricades, warning tapes, and signage as necessary to secure the immediate area during the steam blow.
- 28.18. The contractor and his cleaning sub-contractor shall provide all necessary temporary piping, valves, mufflers, etc. needed to accomplish the steam blow(s) safely and within the guidelines of this specification.
- 28.19. If a cleaning contractor other than the University is selected, that contractor shall submit the following for approval by the designer and the CFER prior to any cleaning equipment coming onsite:
 - 28.19.1. Only firms experienced in performing steam blows in noise sensitive areas for similar projects shall be considered. The proposed service company shall submit a list of projects where they have performed steam blows in noise sensitive areas for projects of similar size and flow requirements to this project. The list shall include five projects where distribution lines have been blow within the past ten years. This list shall include a brief description of the scope of work for each project, including the size of the piping blown, the name and location of the facility generating the steam, and a contact name and telephone number for each facility. For each project provide a brief description of the noise sensitive issues, what was done to satisfy the requirements, and the general results of those actions. Failure to provide qualifications in this format will result in rejection of the proposed service company.
 - 28.19.2. Steam blow procedure indicating pressure required, quantity of flow, and duration.
 - 28.19.3. An description of how much temporary piping is going to be installed, and what size.
 - 28.19.4. Acceptance criterion for each blow.
 - 28.19.5. Process flow diagram showing steam flow direction through the temporary and permanent piping.
 - 28.19.6. Layout drawings depicting the setup of the temporary equipment and its connection to the piping to be cleaned.
 - 28.19.7. Maximum noise levels that will be emitted during the cleaning process.
 - 28.19.8. MSDS of all chemicals used, if any. Include a description of the proper disposal method for any waste.

29. Cleaning – Heating Hot Water Piping

- 29.1. All heating hot water piping in the distribution system shall be cleaned by means of chemical flush and filter.



- 29.2. The chemical flush shall be performed by a qualified contractor who has performed this type of work for industrial systems continuously for a period not less than five (5) years.
- 29.3. The cleaning contractor shall provide in writing the acceptance criterion for the cleaning process per the cleaning contractors standards as part of the submittal process.
- 29.4. The submittals shall include MSDS of all chemicals used, including a description of the proper disposal method for any waste.
- 29.5. Temporary filters shall be used during the flush to remove debris loosened by the cleaning process.
- 29.6. The supply and return lines shall be tied together on each end and the cleaning solution shall be circulated by temporary cleaning pump until filter checks show the fluid is clean, or twenty-four (24) hours, whichever is longer.
- 29.7. All instrumentation, and any system component not compatible with the cleaning process shall be removed before the cleaning agent is applied.
- 29.8. The system shall be flushed and circulated with clean water after the cleaning process until the system is free of the cleaning solution, and is in a neutral pH state.
- 29.9. Proper disposal of any contaminated fluids shall be the responsibility of the contractor.