UMASS AMHERST

Design and Construction Standards

Steam and Condensate System

Issue Date: January 07, 2013

Director of Physical Plant: Patrick Daly, P.E.
UNIVERSITY OF MASSACHUSETTS AMHERST MECHANICAL DESIGN & CONSTRUCTION STANDARDS
STEAM AND CONDENSATE SYSTEM

A. ADMINISTRATION

A.1. INTENT

This guideline was developed to present the University's preferences and criteria for the design, construction, and maintenance of steam and condensate distribution systems throughout the campus. It is intended for use both by installation and maintenance contractors for use on small projects as well as by design engineers to facilitate the development of contract drawings and specifications. This document is not intended to substitute as a specification. These standards are also not intended to limit input from design professionals, or prohibit the use of alternative systems, methods, or devices not specifically prescribed. The designer is required to apply sound engineering principles during the design preparation. Other materials of construction or design approaches may be approved, upon request, if a technical explanation is submitted to the University for consideration, preferably in advance of design completion. Alternate solutions shall demonstrate at least the equivalent to, or superior to, the prescribed requirements in this document with regards to performance, quality, strength, effectiveness, durability, and safety.

A.2. BACKGROUND

A.2.1. In 2008, UMass Amherst began serving its campus with a new combined heat and power Central Heating Plant (CHP) which was designed to produce up to 16 MW and 380,000 lb/hr of steam to meet the steam heating demands for the campus while maximizing the production of electricity without exceeding the power demand. Any shortfall in power production is met with power purchased from Western Massachusetts Electric Company.

A.2.2. Steam is distributed from the CHP via a pair of 20" diameter steam pipes approximately 1,600 feet to the Steam and Condensate Building (SCB), configured such that either pipe can function as high pressure steam (HPS, 200 psig) or low pressure steam (LPS, 25 psig) as required at any given time to most cost effectively meet the campus heating and power needs. Within the SCB there are two pairs of PRV's, each with its own de-superheater. The first pair of PRV's is used to reduce HPS to LPS. The SCB LPS header safety relief valve has a 40 psig set-point. The second pair of PRV's is used to reduce HPS to medium pressure steam (MPS, 90 psig). The SCB MPS header safety relief valve has a 120 psig set-point.

A.2.3. MPS and LPS are routed via a network of distribution piping across the campus from the SCB to serve both the steam heating and process steam requirements of over 200 campus buildings and nearly 10 million gross square feet of building space. Condensate return (CR) is similarly returned via distribution piping.

October 12, 2012
A.2.4. 16" and 24" LPS distribution pipes leave the SCB, however, by design these are unable to provide adequate steam flow and pressure to meet the campus peak heating load. Typical minimum building steam service pressure for adequate capacity is at least 8 to 10 psig for space heating and domestic hot water heating. Rather than a further increase in LPS distribution pipe sizes or quantities originating from the SCB, it is more cost effective to butress the LPS distribution system for peak load by injecting MPS through PRV's into the LPS distribution system at strategic locations across campus. This is because the MPS distribution piping has a significantly smaller diameter than LPS piping for an equivalent steam capacity.

A.2.5. The other significant advantage of the MPS distribution system is that it can tolerate a significant pressure drop, i.e. 90 psig to 50 psig, and still meet campus needs, while the LPS can tolerate a much smaller pressure drop, i.e. 25 psig to 10 psig, which also contributes to a larger required LPS pipe diameter relative to the MPS pipe. These LPS augmenting PRV's are located in the following Steam Manholes (STMH's), also referred to by the University as PIT's:

- STHM-38
- STHM-67A
- STHM-87A
- PIT-J
- Mullins Center
- Polymer Science
- Campus Center

In PIT J, the PRV's are set to deliver LPS at 13 psig with the LPS safety relief valves set at 20 psig. The others vary. Polymer Science has no safety relief valve.

A.2.6. The Southwest Residential Area steam distribution system functions unlike the rest of the campus. Manual valves in the SCB allow the Southwest Residential Area to be provided MPS in the winter and LPS in the summer. The following six Southwest steam manholes (SW MH's) have PRV's to reduce the MPS pressure to LPS in the winter only:

- SW MH #2
- SW MH #3
- SW MH #4
- SW MH #5
- SW MH #6
- SW MH #7

A.2.6.1. Typically, the LPS safety relief valves in the Southwest steam manholes are set at 40 psig. Although believed to be accurate, design professionals shall independently confirm all the above data; it shall not be relied upon for design purposes.

October 12, 2012
B. DESIGN

B.1. RESPONSIBILITIES OF A DESIGN PROFESSIONAL

The design professional shall meet with UMass on each project to determine the extent to which direct burial of the steam and condensate distribution piping is acceptable or whether and to what extent distribution within tunnels or vaults (aka coffins, which are just smaller tunnels) is required. Typically tunnels are only used for the larger distribution mains and are designed with at least 6'-6" vertical clearance for maintenance personnel egress. Vaults are occasionally used for building service laterals and elsewhere but do not have provisions for egress given they typically provide only 30 to 48 inches of vertical clearance. Experience has shown that when designing tunnels and vaults, cast-in-place sections are best used in local areas where existing utilities must remain and pass through the tunnel or vault and where connecting to buildings and manholes. In most other situations, precast sections are best. Provisions shall be made in tunnels and vaults for removal and replacement of all piping, support steel, expansion joints, etc. without replacing the concrete structure. Therefore, precast lids are recommended on all pre-cast sections.

Whether the steam and condensate piping is direct buried or located in tunnels or vaults, steam manholes are required to be spaced along these underground piping runs not greater than every 300 lineal feet for the purpose of installing main line drip legs and steam trap stations and wherever branch piping is necessary. Do not locate STMH's where road salt will enter because excessive corrosion of piping and concrete will result. Avoid locating STMH's in roadways or sidewalks.

Steam trap stations and isolation valves shall not be direct buried. Due to the campus topography, some of the condensate return is pumped but much of the condensate return to the CHP is by gravity drain.

In piping where the direction of steam flow cannot be positively determined, the design shall accommodate bi-directional flow.

B.1.1. The design professional's scope of work shall include a site survey of the entire area within the project boundary. The design professional shall discuss the requirements of the site survey on each project with the University prior to preparing any design and shall consult the University for any preferences in the site survey firm.

B.1.2. The design professional shall perform confined space field survey of existing steam manholes involved in the project. Survey shall be carried out by personnel trained in confined space entry and experienced in steam system design, to accurately determine existing piping conditions. Design professional shall provide necessary confined space equipment (tripod, harness, air monitor, and tools to remove manhole covers). Upon advance request, UMass Amherst will typically provide and set up ventilation fans and/or sump pumps if necessary.

B.1.3. The design professional shall review the UMass Amherst Construction Archives for information on existing conditions within the project boundary. Extensive record drawing archives are available in hard copy format at UMass Amherst and these can be provided in digital format to consultants upon written request for specific documents.
B.1.4. Based upon all available existing conditions information, the design professional shall prepare an accurate plan and profile drawings for all steam and condensate piping. As a minimum profiles shall show steam/condensate pipe elevations, steam manhole structures and mechanical room structures, and that all other utilities have been coordinated with steam/condensate system design.

B.1.5. As a minimum the design professional shall provide the University with a detailed opinion of probable construction cost for each project at the completion of bid documents.

B.1.6. The University requires AutoCAD DWG and PDF format drawing submittals from design professional for review purposes.

B.2. THERMAL STRESS ANALYSIS

B.2.1. Steam lines shall be engineered with provisions for anticipated thermal expansion and the removal of condensate. Bends or loops shall be used to absorb the pipe expansion and contraction. Expansion joints or ball joints may be used in manholes. Thermal stress analysis shall be performed for all HPS, MPS, LPS and CR above 2 inch diameter and for all pre-insulated piping.

B.2.2. Thermal stress analysis shall be performed by a Commonwealth of Massachusetts Professional Engineer using industry standard computer software to demonstrate the piping stress is in strict conformance with either ANSI/ASME Code for Pressure Piping B31.1 “Power Piping” (later referred to as ASME B31.1) or B31.9 “Building Services Piping” (later referred to as ASME B31.9), based upon the Design (Working) Pressure/Temperature requirements, with consideration given to the required hydrotest. See paragraphs below on “Code Requirements” and “Performance Requirements, Hydro-test, and Radiographic Examination” for clarification of these requirements. Stress analysis shall be performed using the corrosion allowance parameters identified later in this document for both new and existing piping. Connections to existing piping shall be in accordance with ASME B31.1 or ASME B31.9. The analysis submittal shall include detailed input and output stress analysis, a stress analysis node drawing clearly identifying piping, fittings and appurtenances, and a report interpreting the data showing stress analysis to be in compliance with ASME B31.1 or ASME B31.9. Refer to Code Requirements section below as to applicability of ASME B31.1 and ASME B31.9.

B.2.3. Design professionals shall include this task as part of their standard Scope of Services for the proposed piping depicted by their design. Restraint reaction anchor forces and moments due to piping thermal expansion from within the steam tunnels, vaults, and manholes shall be provided to the pre-insulated piping manufacturer. For piping not requiring stress analysis, installation shall follow the pipe expansion and flexibility recommendations of 2004 ASHRAE Handbook – HVAC Systems and Equipment, Chapter 41. Design professionals shall include preliminary concrete anchor sizes on bid documents for bidding purposes.

October 12, 2012
B.3. CODE REVIEW

B.3.1. The design professional shall prepare a code review for each project and submit a report to the University.

B.3.2. The design professional shall incorporate the requirements of these guidelines into the Project Contract Documents.

C. PERMITTING

C.1. CODES

Steam and condensate system installations at a minimum shall comply with the requirements of the Commonwealth of Massachusetts adopted codes, a partial list below:


C.1.2. 522 CMR – Board of Boiler Rules – Department of Public Safety. 522 CMR 17 (Process Piping) requires steam and condensate systems to be constructed using ANSI/ASME B31.1 Pressure Piping 2001 Edition with 2003 Addenda (actually entitled "Power Piping").

C.1.3. ICC 2003 International Mechanical Code (IMC-2003), as required by 780 CMR 28.

C.1.4. 248 CMR: Plumbers and Gas Fitters Rules and Regulations. 248 CMR 10 is the Uniform State Plumbing Code, which was based on the BOCA National Plumbing Code 1993.

C.2. APPLICATION

C.2.1. "Boiler proper piping” and joints shall be governed by ASME Boiler and Pressure Vessel Code. "Boiler external piping and joint” shall be as defined in ASME B31.1, but is generally the piping from the factory connections up to and including the first shut-off valves, and is outside the scope of this document. “Non-boiler external piping and joint” shall be as defined in ASME B31.1, but is generally everything else that distributes to the buildings and back to the boiler. The design, materials, fabrication, erection, examination, inspection, and testing of steam and condensate “Non-boiler external piping and joint” greater than 15 psig (which includes HPS, MPS, LPS, and CR) shall be governed by ASME B31.1, except that piping within and serving only one building, and located beyond the first distribution shutoff valve inside that building, shall be governed by ASME B31.9. All underground steam and condensate piping including steam and condensate piping located within steam manholes shall be governed by ASME B31.1.

C.2.2. If the University standards exceed the minimum code requirements, the design shall comply with the University requirements.

October 12, 2012
D. TECHNICAL STANDARDS

D.1. PERFORMANCE REQUIREMENTS

Generally, LPS leaves the SCB at 15 to 19 psig and MPS at 75 to 95 psig. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

D.1.1. MPS Piping:

D.1.2. Design (Working) Pressure/ Temperature 120 psig/ 360 deg F

D.1.3. Normal Operating Pressure/ Temperature 90 psig/ 331.2 deg F

D.1.4. LPS Piping:

Design (Working) Pressure/ Temperature 40 psig/ 300 deg F
Normal Operating Pressure/ Temperature 13 psig/ 246 deg F

D.1.5. Condensate Piping:

Design (Working) Pressure/ Temperature: 50 psig/ 180 deg F
Normal Operating Pressure/ Temperature: 8 psig/ 180 deg F

D.1.6. Steam Conduit Vent and Drain Piping (for pre-insulated piping systems)

Design (Working) Pressure/ Temperature: 10 psig/ 210 deg F
Normal Operating Pressure/ Temperature: 0 psig/ 180 deg F

D.1.7. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached

D.1.8. Steam and condensate systems shall be designed to be filled with water, or shall be temporarily supported during hydrostatic tests, which are required. The University shall be notified a minimum of two full working days in advance of each hydrostatic test scheduled to be given the opportunity to witness the pressure test. Pneumatic testing of steam and condensate systems shall not be performed.

D.2. PIPING

D.2.1. Piping shall be sized to limit steam velocity to below 10,000 feet per minute at maximum design flow rate.

D.2.2. MPS Piping: ASME Schedule 40, ASTM A 53/A 53M or ASTM A106, Type S (seamless), Grade B, carbon steel pipe. Type E (Electric Resistance Welded, ERW) is acceptable for piping in ASME B31.9 service. Entire steam system shall be fully welded upstream of first gate valve for every steam trap station, blow down, pressure gage, etc.
D.2.2.1. NPS 2 and smaller: ANSI Class 300 flanges, malleable iron unions, threaded fittings, and threaded joints are allowed only between first and last gate valves for every steam trap station. Shutoff duty valves 2" and smaller shall be socket weld, 800 lb, gate valves.

D.2.2.2. NPS 3 and larger: ANSI Class 250 or 300 flanges and standard weight butt welded fittings, except extra strong weight butt welded fittings for NPS 12 and larger. Standard weight piping for NPS 12 and larger shall not be permitted. Branch connections to main lines and drip legs, with similar weight requirements as butt welded fittings, are permitted in lieu of welded fitting tees only in the following applications:

- Pressure gages, drains, vents, bypasses, traps, and blow downs.
- Where specifically indicated on the drawings.
- Where butt welded fitting size is not commercially available.
- Where pre-approved, on a case-by-case basis, in writing.

D.2.3. LPS Piping: ASME Schedule 40, ASTM A 53/A 53M or ASTM A106, Type S (seamless), Grade B, carbon steel pipe. Type E (Electric Resistance Welded, ERW) is acceptable for piping in ASME B31.9 service. Entire steam system shall be fully welded upstream of first gate valve for every steam trap station, blow down, pressure gage, etc.

D.2.3.1. NPS 2 and smaller: ANSI Class 150 flanges, malleable iron unions, threaded fittings, and threaded joints are allowed only between first and last gate valves for every steam trap station. Threaded fittings and joints are allowed only if using Schedule 80 piping. Shutoff duty valves 2" and smaller shall be socket weld, 800 lb, gate valves.

D.2.3.2. NPS 3 and larger: ANSI Class 150 flanges and standard weight butt welded fittings, except extra strong weight butt welded fittings for NPS 12 and larger. Standard weight piping for NPS 12 and larger shall not be permitted. Branch connections to main lines and drip legs, with similar weight requirements as butt welded fittings, are permitted in lieu of welded fitting tees only in the following applications:

- Pressure gages, drains, vents, bypasses, traps, and blow downs.
- Where specifically indicated on the drawings.
- Where butt welded fitting size is not commercially available.
- Where pre-approved, on a case-by-case basis, in writing.

- Drains, vents, and traps.
- Where specifically indicated on the drawings.
- Where butt welded fitting size is not commercially available.
- Where pre-approved, on a case-by-case basis, in writing.

October 12, 2012
D.2.3.3. Pipe-Flange Gasket Material

Pipe-Flange Gasket Materials shall be flat ring gasket, 304 stainless steel spiral wound type, Flexitallic Type CG with Flexicarb® filler material suitable for 900 deg F maximum temperature, or equal. Leader Gasket profile LG-13 and Teadit Style 913 are acceptable equals. Gasket shall be 0.175 in thick, fitted with 0.125 in thick solid metal centering rings. Gasket shall be manufactured in accordance with ASME B16.20 gasket standard and to suit ASME B16.5 flange designation.

D.2.4. Condensate Piping: ASME Schedule 80, ASTM A 53/A 53M or ASTM A106, Type S (seamless), Grade B, carbon steel pipe. Type E (Electric Resistance Welded, ERW) is acceptable for piping in ASME B31.9 service. Consider schedule 40 stainless steel for underground or other difficult to replace condensate piping, where not potentially exposed to salt. Entire condensate system shall be fully welded downstream of last gate valve for every steam trap station and building isolation valve.

D.3. DIRECT BURIED PRE-INSULATED PIPING

D.3.1. For direct-buried piping, pre-insulated, drainable, dryable systems are required. The following systems are currently permitted to be bid on UMass Amherst projects:

- Perma-Pipe / Ricwil Inc., Multi – Therm 500 System
- Rovanco Piping Systems, Inc. – Insul 800 System
- Tricon Piping Systems, Inc., Steel-Con Plus System
- Thermacor Process, L.P., Duotherm 505 (HDPE) System

D.3.2. Service pipe and outer conduit miters may be implemented by the contractor in accordance with the manufacturer’s recommendations but under no circumstances may the miter exceed 10 degrees.

D.3.3. The service pipe insulation for the pre-insulated direct-buried piping shall incorporate an additive which makes it water repellent and water wicking resistant. Insulation product shall be tested in affirmative compliance with the U.S. Navy’s “96 Hour Conduit Boiling Test” requirements. Each service pipe shall be in a separate steel outer conduit. The conduit shall be ASTM A ~ 139 smooth wall, spiral or ERW welded steel, of sizes 10 gauge for up to 26” diameter, 6 gauge for 28-36” diameter, and 4 gauge for 38-42” diameter.

D.3.4. The steel outer conduit shall be insulated with spray applied polyurethane foam on all straight lengths and fittings. The urethane foam shall meet ASTM C591 and have the minimum characteristics of .18 K-factor, density of 2 pcf and a closed cell content of 90 to 95% with a compressive strength of 40 psi. Quality assurance procedures for the foam insulation shall include either a visual check prior to jacketing, infrared, or radiographic (x-ray) testing to insure there are no insulation voids. Manufacturer shall provide documented test results, to include interpretation, for infrared or radiographic testing for a minimum of all the piping on the first truckload delivered to the project site. Testing shall be provided on at least one length of each size LPS, MPS, and CR.
pipe as well as at least one of each size LPS, MPS, and CR elbow and anchor. 
Additional truckloads shall not be shipped until the University has accepted the test 
results. If the test results are rejected, insulation must be corrected and new test results 
submitted. If any test is rejected, all product associated with this project must be tested 
accordingly.

D.3.5. For competitive bid purposes, for each pre-insulated direct-buried pipe the design 
professional shall specify the following as a minimum: service pipe diameter (NPS), 
service pipe insulation thickness, outer conduit diameter, outer conduit insulation 
thickness, and jacket outside diameter. Oversized outer conduits shall be provided at 
elbows and adjacent straight runs of pipe as demonstrated necessary in the output stress 
analysis by the service pipe displacement exceeding the standard air gap between the 
service pipe insulation and the outer conduit.

D.3.6. High density polyethylene (HDPE) factory installed jackets are required for all 
preinsulated piping systems. HDPE jacket shall be a minimum of 150 mils thick for all 
pipe sizes.

D.3.7. Joint sealing system shall be CANUSA SuperCase CSC -- X joint sealing systemWhere 
service pipe and outer conduit field miters between 3 and 10 degrees are necessary and 
are permitted by the manufacturer, instead apply the CANUSA CSC-X WA wrap 
around joint sealing system over the foam. The joint sealing system shall be fully 
certified to EN 489 requirements.

D.3.8. Install direct buried, tunnel, vault, and STMH steam supply piping at a minimum 
uniform grade of 0.2% (1" in 40") downward in direction of steam flow. Piping slope 
shall be indicated on design drawings and shall be continuous slope to facilitate 
condensate removal from steam main. Installed slope shall be verified by UMASS and 
approved by the piping manufacturer prior to backfill. Where steam lines are required 
to slope upward in direction of steam flow, such as due to topography or other existing 
conditions, demonstrate to the University that condensate handling within the steam 
main has been adequately addressed. Bi-directional flow shall be discussed with the 
University and designed for in all cases where it cannot be positively ruled out.

D.3.9. Install direct buried, tunnel, vault, and STMH condensate return piping at a minimum 
uniform grade of 0.2 percent downward in direction of steam flow. Piping slope shall 
be indicated on design professional drawings. Where steam lines are required to slope 
upward in direction of steam flow, the condensate piping may follow a parallel path.

D.3.10. Early in the design of a project the design professional shall discuss with the University 
the potential need for perforated underdrain beneath each pre-insulated direct-buried 
pipe based upon existing water table level for determination. Such drains are rarely 
installed at UMass Amherst.

D.3.11. Keep the pipe system interior clean and dry at all times during installation. Grade top 
perimeter of excavations to prevent surface water run-off into excavation. Maintain 
bottom of all excavations stable, dry and free of water on a continual basis. Pipe shall be

October 12, 2012
laid in the dry trench conditions. At no time shall water in the trench be permitted to flow into the pipe system interior. Contractor shall anticipate the potential for existing water main breaks. At any time that Work is not in progress, or the trench is unattended, the end of the pipe(s) shall be suitably closed to prevent the entry of animals, earth, water etc. THE UNIVERSITY WILL NOT ACCEPT ANY PRE-INSULATED PIPING INTO WHICH WATER HAS ENTERED DURING CONSTRUCTION. DRYING PROCEDURES ARE NOT ACCEPTABLE. ALL WET PIPING SHALL BE REMOVED. Piping manufacturer shall submit a written warranty to the University, with copy to the installing contractor, for the piping to be executed upon installation by the installing contractor from the date of substantial completion for a period of ten years to repair piping systems and replace components damaged by failure. Likewise, the installing contractor shall submit a written warranty to the University for the field joints to be executed upon installation from the date of substantial completion for a period of five years to repair field joints and replace field joints damaged by failure.

D.3.12. A factory employed and certified field technician shall be required on site to provide inspection during the critical periods of installation defined as:

Unloading of the first load of material.

Inspection of the initial trench and bedding.

Initial hydrostatic test for at least one section of piping.

Cold springing of steam pipe.

Pouring of at least the first anchor blocks.

Final verification of pipe pitch.

Initial backfill of at least one area, but not necessarily all compacting.

Any other observations required by the manufacturer to provide required Warranty.

D.3.13. Provide two days of instruction on field joint construction to include both demonstration of field joint construction methods as well as observation of at least the first two field joint installations by construction staff.

D.3.14. Factory Field Technician requirements:

D.3.14.1. Technically qualified, factory trained piping system installation instructor with a minimum of five years of experience. If this instructor does not have experience installing the specified CANUSA joint sealing system, a CANUSA factory trained joint sealing system installation instructor shall also be provided for the duration of the field joint construction inspection and instruction activity described above.

D.3.14.2. A resume shall be submitted to the Owner for approval. If the Owner does not approve the proposed Technician, the Manufacturer shall submit an alternate for approval.
D.3.14.3. A substitute Technician shall not be provided unless approved in advance by the Owner. At the Owners discretion, removal of the Technician may be requested, which will require the Manufacturer to submit an alternate Technician for approval.

D.3.14.4. All costs associated with the Technician shall be included in the bid.

D.3.15. Manufacturer’s Sales

D.3.16. Representative requirements. Either the Factory Field Technician or the Manufacturer’s Sales Representative shall provide the following additional inspections:

- Unloading of remaining loads of material.
- Hydrostatic test for all other piping.
- Pouring of remaining anchor blocks.

D.3.17. A daily field report shall be required from the factory technician and sales representative detailing work observed while on site. Field reports shall be submitted to the Installing Contractor and Owners representative. Field reports shall include the condition and quality of materials used in accordance with the contract documents and manufacturer’s written instructions. Field reports shall also include any discrepancies, installation concerns, unsatisfactory work performed and the Technician’s/Representative’s recommendations for appropriate and corrective action to be taken.

D.3.18. Upon completion of the pipe installation the contractor shall deliver to the Owners Representative, a notarized certificate from the manufacturer stating that the installation has been made in accordance with the manufacturer’s recommendations and warranty requirements. Manufacturer’s Sales Representatives will not be acceptable to perform pipe installation inspections identified above as being performed by the Factory Field Technician.

D.3.19. Pre-insulated piping manufacturers shall also include Thermal Stress Analysis as part of their Scope of Services for the piping they provide. The thermal stress analysis shall be performed using industry recommended software and an accompanying report shall be submitted to the University prior to piping fabrication. Submittals shall include required concrete anchor sizes.

D.3.20. Pipe hangers, supports, anchors, alignment guides, expansion loops, expansion joints, and flexible ball joints shall be specified and shown on design drawings. In steam manholes, tunnels, and vaults it is preferred that pipe supports be attached to walls or to 4” high concrete pads, to keep them above any liquid on the floor. Pipe supports may be suspended from cast in place manhole roofs. Anchors shall be welded to the pipe, but anchor connection to the building structure must be bolted. Provide structural support for all kinetic forces including seismic and wind loads.

D.4. TEMPORARY STEAM PIPING

D.4.1. Temporary steam piping is typically utilized during a summer construction project to support a building’s domestic hot water generation and to support building heating
needs where longer periods of construction are required. Where small domestic hot water needs in a building, say due only to hand wash sinks, can be easily met with a temporary electric water heater, this shall be permitted. The University prefers temporary commercial electric water heaters by AO Smith, or equal, DuraPower model DEN with glass lined tank.

D.4.2. For temporary steam piping distribution located outside steam manholes, tunnels, vaults, and buildings the University typically prefers a shallow buried field fabricated steam and condensate piping system insulated with mineral fiber preformed pipe insulation. Six (6) mil polyethylene roll sheets are to be field applied as a jacket wrapped continuously over mineral fiber insulation to serve as moisture barrier. Polyethylene sheet shall be overlapped at joints and continuously duct tapped at seams. Consult with the University on each project, but typically a temporary condensate system is not required. Temporary piping shall be removed upon satisfactory commissioning of the permanent steam lines and areas restored to pre-existing conditions after Commissioning of permanent piping systems.

D.4.3. Occasionally, the University elects to insulate temporary shallow buried steam piping distribution located outside steam manholes, tunnels, vaults, and buildings using cellular glass insulation with Pittwrap jacket, where the temporary lines are intended to last for more than a few years. These various options, and possibly others, shall be discussed with the University early in the design of a project for determination.

D.4.4. Temporary steam hose may be used when approved by the University for use in specific situations. Steam hose shall be listed and clearly labeled for steam service at 250 psig and 450 F. Steel wire-reinforced EPDM hose may be used in sizes up to and including 3". For sizes above from 4" to 8", steel braided hose shall be used. Acceptable suppliers are Jason Industrial, Fin Mar, McGill Hose or equal approved by the University. Fittings and clamps shall be approved by the hose manufacturer for use with the specified hose at the specified operating conditions and shall be installed on the hose by the manufacturer or approved distributor at their shop, not in the field by the Contractor. Prior to installation all hoses, fittings and couplings shall be physically inspected for any sign of abrasion, kinking, cracking or deterioration by the contractor in the presence of a UMASS Physical Plant representative. Any hose not passing this inspection shall be removed from the site. Hoses to be used shall be subjected to the same hydro-test procedures as required for new steel piping prior to introduction of steam.

D.4.5. Construction fencing shall be installed around the temporary steam hose location.

D.5. PIPE JOINT CONSTRUCTION

D.5.1. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before and after assembly. Remove all dirt, scale and other foreign matter from inside the pipe by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, equipment or fittings. UMASS shall witness and approve the pigging process.
D.5.2. Wherever tie-ins are made to existing steel piping, contractor shall first test for blockage in the existing piping, then thoroughly clean end of existing pipe as described above, and then measure existing pipe wall thickness. Corrosion allowance for all steel pipe schedules shall be 0.05" for sizes 1" and smaller, and 0.063" for pipes 1¼" and larger. Notify the University for direction where corrosion is in excess of this allowance.

D.5.2.1. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

D.5.2.1.1. Apply three wraps of Teflon tape followed by thin layer of RectorSeal® No. 5® pipe thread sealant to clean external pipe threads not more than three minutes before the joint is assembled.

D.5.2.1.2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D.5.2.1.3. Schedule 80 piping shall be used for threaded joints.

D.5.2.2. Flanged Joints: Install gasket specified, after confirming appropriate for service application. Gasket shall match ANSI Class (150, 250, or 300 lb) and size of mating flanges. Install gasket: concentrically positioned and in compliance with manufacturer's written instructions. Use suitable lubricants on bolt threads. Install new gaskets wherever reassembling or relocating flanged components, such as valves, whose joints contained pre-existing gaskets.

D.5.2.3. Bolts: Tempered alloy steel machine bolt, SAE J429, Grade 8, galvanized. Other bolt grades may be used only with UMASS written approval. Nuts: ASME B18.2.1, ASTM A563, Grade DH, Heavy Hex, galvanized carbon steel, quenched, and tempered. If these are not available in sizes ¼" and larger, acceptable alternate nuts per ASTM A194, Grade 2H.

D.5.2.4. Welding Materials: Comply with the ASME Boiler and Pressure Vessel Code: Section II, Part C, for materials appropriate for pipe being welded.

D.5.2.5. Unions (including union spuds on traps and valves): Lubricate the male union threads, the shoulder of the unthreaded part, and the corresponding surface inside the threaded ring using Permatex® Anti-seize Lubricant 133k (now manufactured by ITW Devcon) before being place in or returning to service. Unions on inlet and outlet of steam traps shall be positioned with the union ring upstream, and shall be situated to provide wrench access to both unions from the same working position.

D.6. Valves

D.6.1. Shut-off valves NPS 2 and smaller as follows shall be gate valves. Brass bodies are not acceptable. Gate valves:

D.6.1.1. NPS 2 only shall be cast steel, OS&Y, Class 300, MSS SP-70, Type I, 500 psig rating, ASTM A 216 WCB body material, cast carbon steel with bolted
bonnet, flanged or butt weld ends (threaded acceptable for condensate service if available), and steel trim.

D.6.1.2. NPS 3/4 to NPS 2 shall be forged steel, OS&Y, Class 800, API 602, ASME 31.3, and ASME B16.34 standard, 1,690 psig at 400 deg F, 1,975 psig at 100°F rating, conventional port (reduced bore), ASTM A 105 body material, forged carbon steel with bolted or welded bonnet, socket weld ends, 13% CR trim, bolted gland, and hard faced seats and solid wedge. Vogt Model # SW12111FHF (bolted bonnet) or #SW2801 (welded bonnet). Bonney Forge also manufactures an acceptable equal valve. Required for steam and condensate service, sizes NPS 3/4 to NPS 2.

D.6.1.3. Class 300 (MPS) and either Class 125 or Class 150 (LPS and condensate only) bronze gate valves are an acceptable alternate only for piping located inside buildings. Valves smaller than NPS 3/4 shall not be used, except where it is required for manufacturer standard trim on pressure reducing valves or steam meters.

D.6.1.4. Forged Steel, Socket Weld, flanges.

D.6.1.5. Threaded, class 300, malleable iron unions and fittings, only between first and last gate valves for every steam trap station.

D.6.1.6. Forged Steel, Socket Weld, ANSI Class 3000 fittings and branch connections elsewhere.

D.6.1.7. Shutoff duty valves 2" and smaller shall be socket weld, 800 lb, gate valves.

D.6.2. Shut-off valves over NPS 2 shall be rotary isolation triple offset metal seated valves as follows:

D.6.2.1. Cast carbon steel, OS&Y, Class 300 (MPS) or Class 150 (LPS and condensate return), ANSI B16.10, ASTM A 216 WCB body material, cast carbon steel, GR. 316 stainless steel seat, self-centering steel rotor, and gear actuator. Zwick Model A1 Tri-Con, or equal, (single ANSI flange full lug [API 609 Table 2] wafer body typically installed in new piping), or Zwick – Model B1 Tri-Con, or equal, (double ANSI flange [ANSI B16.10] body typically installed as a drop-in replacement for a gate valve.) Valve shall have manufacturer's written ten year, non-prorated warranty, bubble tight shut-off at full rated pressure differential without the use of energized TFE or resilient elastomer materials, and shall be tested to API 598.

D.6.2.2. Provide chainwheel valve actuation assembly with sprocket rim with chain guides, brackets, and chain attached to valve hand wheel or stem on valves NPS 8 and larger and more than 78 inches above building or manhole floor. Extend chains to 60 inches above floor.

D.6.3. Check valves shall be steel swing check valves with metal seats:

D.6.3.1. NPS 3/4 to NPS 2 shall be Class 800, ASTM B16.34-2004, 1,690 psig at 400°F, 1,975 psig at 100°F, clear or full waterway body preferred, however, reduced port (reduced bore) acceptable, ASTM A 105 body material forged carbon steel with bolted bonnet, flanged, threaded, or socket weld ends, 13% CR trim, hard

October 12, 2012
UNIVERSITY OF MASSACHUSETTS AMHERST MECHANICAL DESIGN &
CONSTRUCTION STANDARDS
STEAM AND CONDENSATE SYSTEM

faced seats, spiral wound gasket. Vogt Model #SWS701 (socket weld) or #S701 (threaded), or equal. Required for condensate service, sizes NPS ¼ to NPS 2.

D.6.4. Pressure Reducing Valves.

D.6.4.1. Spence Type ED main valves with Type D pressure reducing pilot. 300 lb flange cast steel main valves with cast steel pilots for HPS to LPS application.

D.6.4.2. Desuperheaters are required for all HPS to MPS applications. Review each installation with the University and work with the University to develop a suitable by-pass arrangement.

D.6.4.3. PRV shall be located to be accessible without the use of a ladder. All gauges shall be readable from the floor. Pressure gauges shall be selected to read the normal system operating pressure at the midpoint of the gauge.

D.6.4.4. Each regulator shall be valved so as to allow its removal from the system while the system is in operation. Give consideration to satisfactory resulting sound levels. Typically the optional muffling orifice plates are not used. Refer to accompanying illustration, Figure 7, for typical preferred parallel additive design and to Figure 8 for typical preferred single stage design.

D.6.5. Pressure Relief Valves.

D.6.5.1. Equal to Kunkle model 6252 cast iron safety relief valves. The University requests that drip pan elbows not be used inside manholes to avoid potential of relief steam entering manhole. The University does not prefer the use of pilot operated safety relief valves in manholes.

D.7. Fittings

D.7.1. Forged Steel, Socket Weld Fittings and Branch Connections (2" and smaller): ANSI B16.11, ASTM A105; Class 3000, 2000 psig, WOG (minimum) class.

D.7.2. Forged Steel, Socket Weld Unions (2" and smaller): ANSI B16.11, ASTM A105; Class 3000, 3000#, MSS-SP-83.

D.7.3. Malleable Iron Threaded Fittings (2" and smaller): ASME B16.3; Class 300, with threads according to ASME B1.20.1. Elbows shall be long radius. Cast-Iron Threaded Fittings, ASME B16.4; Class 125 (LPS and condensate) or Class 300 (MPS), with threads according to ASME B1.20.1, are acceptable alternate only where threaded fittings are permitted, and only for piping located inside buildings.

D.7.4. Seamless Forged (Wrought) Steel, Butt Weld Fittings and Branch Connections (2-1/2" to 26"): ANSI B16.9, ASTM A234, Grade B (WPB). Elbows shall be long radius. See above for weight.

D.7.5. Malleable Iron Unions (2" and smaller): ASME B16.39; Class 300, 3000#, hexagonal stock, ball and socket joints, metal-to-metal bronze seating surfaces, female threaded ends, with threads according to ASME B1.20.1. Class 150 malleable iron unions are an acceptable alternate only for piping located inside buildings.

October 12, 2012
D.7.6. Forged Steel, Socket Weld Flanges (3/4" to 2"): ANSI B16.5, ASTM A105, raised face. Class to match piping system above.

D.7.7. Forged Steel, Welding Neck or Slip On Flanges (3" to 24"): ANSI B16.5, ASTM A105, raised face. Weld inside and outside. Class to match piping system above.

D.8. EXPANSION JOINTS


D.8.1.1. Acceptable manufacturers: MetraFlex Company model MetraGator, ADSCO Single Pressure Master "PM", or equal approved by the University.

D.8.1.2. Expansion joints shall utilize two-ply Type 304 stainless steel bellows with all welded construction, carbon steel flanges, heavy gauge carbon steel shroud (housing), integral guide rings, and internal liner. Minimum Pressure Rating: Suitable for hydrostatic test at 1.5 times Design (Working) Pressure and not less than 100 psig. This equates to 100 psig for LPS, 100 psig for CR, and 180 psig for MPS. Working Temperature: 700 degrees F. System line pressure to be external to the bellows to minimize squirm.

D.8.1.3. End Connections: Flanged both ends, ANSI B16.5, Class 150 lb for LPS and CR, or Class 300 lb for MPS. Flanges shall have raised faces. All joints to be provided with drain connection. Expansion joint compression (axial movement) shall be scheduled on drawings.

D.8.2. Metal-bellow expansion joints shall be ASTM F1120, circular-corrugated bellows type multiple-ply, type 321 stainless steel bellows with external tie rods.

D.8.2.1. Acceptable manufacturers are MetraFlex, Hyspan Precision Products or equal approved by the University.

D.8.2.2. Bellows shall be multiple-ply type 321 stainless steel.

D.8.2.3. Minimum pressure rating – suitable for hydrotest at 1.5 times design (working) pressure and not less than 100 psig for LPS and condensate return, 180 psig for MPS.

D.8.2.4. End connections: Butt weld, ANSI Class 150 for LPS and condensate return, 300 for MPS.

D.8.2.5. Expansion joint axial and lateral movement shall be scheduled on drawings.

D.8.3. Flexible ball joints shall be carbon-steel assembly with asbestos-free composition packing designed for 360-degree rotation and angular deflection and 300 psig at 800 F minimum pressure rating, complying with ASME Boiler and Pressure Vessel Code, Section II, "Materials and with ASME B31.1 for design of pressure-containing parts and bolting.

D.8.3.1. Acceptable Manufacturers: Advanced Thermal Systems, Hyspan Precision Products or equal approved by the University.

October 12, 2012
D.8.3.2. End connections: threaded for NPS 2 and smaller, beveled weld ends for NPS 3 and larger.

D.8.3.3. 30 degree angular deflection NPS 6 and smaller, 15 degree angular deflection for NPS 8 and larger.

D.8.3.4. Design, fabrication and testing of ball joints shall be in accordance with EJMA standards and shall meet or exceed ASTM F1298-20.

D.8.3.5. Spherical surface of ball shall be polished to surface finish of 16 RMS and plated with 2 mills of hard chrome in accordance with ASTM B-499.

D.8.3.6. Shall be provided with packing rams/cylinders for packing under full line pressure to 300 psig.

D.8.3.7. Five-year manufacturer's warrantee and service guarantee.

D.8.4. Packed slip expansion joints shall be ASTM F 1007, carbon-steel, packing type designed for repacking under pressure, rated for 225 psig at 500 F minimum.


D.8.4.3. Provided with packing rams/cylinders for packing under full pressure to 300 psig.

D.8.4.4. Drain: 1" forged steel, socket welded drain port connection, 1" seamless pipe nipple and forged socket weld cap.

D.8.4.5. Finish: Enamel paint

D.8.5. Each expansion joint system with associated guides and anchors shall be analyzed by a Professional Engineer licensed in Massachusetts to determine stress and anticipated thermal movement of steam and condensate pipes. Industry standard software shall be utilized for the calculations. Results of calculations shall be submitted to expansion system manufacturer's representative for approval.

D.8.6. Submit expansion compensation design to expansion joint manufacturer's representative for approval. Obtain written sign-off.

D.8.7. Final expansion joint, ball joint and slip joint alignment shall be field witnessed and approved by the manufacturer.

D.9. ANCHORS AND GUIDES

D.9.1. Alignment Guides shall be steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to
pipe. Typically utilize MetraFlex Company model PG-IV, Cooper B-Line B-3280 Series, or comparable product by another manufacturer approved by the University.

D.9.2. Structural steel Anchors used within steam manholes and tunnels shall be fabricated from steel shapes and plates conforming to ASTM A 36/A 36M. Welded, or bolted.


D.9.4. Nuts: ASME B18.2.1, ASTM A563, Grade DH, Heavy Hex, galvanized carbon steel, quenched, and tempered. If these are not available in sizes ¾” and larger, acceptable alternate nuts per ASTM A194, Grade 2H.

D.9.5. Guide design shall be in accordance with expansion joint manufacturer’s requirements.

D.10. DRIPLEGS, STEAM TRAPS, STRAINERS, BLOW DOWNS, AND DRAINS

D.10.1. The contractor and designer shall be aware of the danger of injury or death that might occur due to condensate induced water hammer (CIWH). Drip legs and steam trap stations should be provided for the removal of condensate from steam piping systems at designated collection points where drip legs shall be provided. Refer to accompanying illustrations, Figures 4 and 5, for typical drip leg, steam trap station, startup blowdown, and drain preferred design.

D.10.2. Drip legs and steam trap stations shall be provided at terminal ends of piping (including unit heaters, air handling coils, etc.), low points and ends of steam lines, bottoms of risers, ahead of pressure reducing valves, and control valves. Drip legs shall be provided upstream of any adjacent steam stop valves and in no case shall drip legs be less than 8 inches high. Size drip legs same pipe size as steam main. In steam mains larger than NPS 12, drip leg size can be reduced to one half the size of the steam main, but to no less than NPS 6. On straight runs with no natural drainage points, install drip legs and steam trap stations at intervals generally not exceeding 300 feet where steam mains are sloping down in the direction of flow, and generally not exceeding 150 feet where steam mains are sloping up in the direction of flow. Where practicable, slope all above grade steam and condensate piping at not less than 1/32 inch per foot down in the direction of flow; review exceptions with the University for approval. Steam traps should be installed below and close to the equipment or pipeline being drained and the steam trap should be accessible for periodic inspection. Each steam trap should serve only one collection point and shall be properly sized for both flow rate and ANSI pressure rating. Steam trap discharge lines shall be sloped for drainage into the condensate line where possible. The designer shall apply the steam trap manufacturer’s recommended safety factor when sizing steam traps but in no case shall a safety factor less than 3 be used.

D.10.3. Screwed end connection inverted bucket (IB) steam traps shall be used in trapping steam distribution mains. The continued use of IB steam traps is primarily in an effort to minimize maintenance parts storage and training. At point of steam use, designer shall propose appropriate steam trap for the University’s review. For MPS and LPS distribution system drip legs, typically the University prefers Armstrong model 881.
inverted bucket steam trap, or equal, with #38 orifice. Design professional shall confirm suitability of this trap and required size of end connections for each location.

D.10.4. Dealing with flash steam generated in MPS traps shall be provided for by installing an appropriately sized flash tank for the MPS trap discharge. This tank shall discharge the steam to adjacent LPS pipe. The lower part of the tank is provided with a steam trap station discharging the condensate to the adjacent low pressure condensate return pipe. This approach requires a safety relief near or on the flash tank to protect the LPS pipe from overpressurization in case of MPS trap failure. Where installed in buildings, this relief vent should be discharged outdoors to a safe place. When installed in manholes, this relief should be discharged to the interior of the manhole, in as safe a location as possible or preferably discharged outdoors to a safe place.

D.10.5. All blowdowns and drains shall be left plugged or capped. Y-Pattern strainers shall be as follows:

D.10.5.1. For use in LPS and MPS, in sizes NPS 1/2 to NPS 2. Body to be ASTM A126, Class B, ANSI Class 300 cast iron, with machined seats in both the body and cap to allow easy assembly and disassembly and self-aligning screen; threaded end connections; Strainer Screen: Stainless-steel, 30 mesh, 0.02” mesh strainer opening; tapped NPT blowoff outlet; non-shock steam working pressures: 250 psig @ 406 deg F; Mueller Steam Specialty, model 11M, or equal.

D.10.5.2. For use in LPS and MPS, in sizes NPS 3 to NPS 12. Body to be ASTM A126-B, ANSI Class 300 cast iron, with tapered seats in both the body and cover flange for secure screen retention; flanged end connections; Strainer Screen: 3/64 inch perforations in heavy gauge stainless-steel sheet; tapped NPT blowoff outlet; non-shock steam working pressures: 250 psig @ 450 deg F; Mueller Steam Specialty, model 752, or equal.

D.10.5.3. For use in HPS, in sizes NPS 3 to NPS 14 and up: Body to be ASTM A216 Grade WCB, ANSI Class 300 cast carbon steel, with machined seats in both the body and cap to allow easy assembly and disassembly and self-aligning screen; flanged end connections; Strainer Screen: Stainless-steel, 0.033” mesh strainer opening for NPS 3 to NPS 4, and 0.045” mesh strainer opening for NPS 4 to NPS 12; tapped NPT blowoff outlet; non-shock steam working pressures: 300 psig @ 850 deg F; Mueller Steam Specialty, model 782, or equal.

D.11. THERMOSTATIC AIR VENTS, AUTOMATIC AIR VENTS, AND VACUUM BREAKERS

D.11.1. Thermostatic Air Vents shall be provided at high points in steam system as follows:

D.11.1.1. Cast iron body and cover, stainless steel reinforced exfoliated graphite cover gasket, 3/8” NPT screwed end connections, stainless steel internals and cover gaskets, integral strainer, Spirax Sarco, model VS206, or equal. Pipe to safe drain location with air break.

October 12, 2012
D.11.2. Automatic Air Vents shall be provided at high points in condensate system as follows:

SG cast iron body and cover, 3/4" NTP screwed end connection (inlet), outlet varies, stainless steel internals, float and lever valve assembly, EPDM valve head, Spirax Sarco, model AE-14E, or equal. Armstrong, model 1-AV with #38 orifice, or model 2-AV with 1/8" orifice (or smaller) is acceptable. Pipe to safe drain location with air break.

D.11.3. Vacuum Breakers shall be provided as required to break vacuum, typically necessary where control valves are used to control steam flow to coils or other equipment. Vacuum breakers shall be bronze or stainless steel body; threaded end connections; stainless steel sealing ball, retainer, spring, and screen; and EPR O-ring seal.

D.12. Thermometers and Pressure Gauges

D.12.1. Locate thermometers and pressure gauges on steam lines and equipment where temperature or pressure should be identifiable for operation and maintenance. Include upstream and downstream pressure gauges and thermometers. Install pressure gauges in steam service near point of entry to a building before branch piping connection; on each side of every steam isolation valve in steam manholes and tunnels except those associated with trap stations, blow downs, drains, and vents; before and after steam pressure reducing stations and control valves; and other locations indicated on drawings. Locate pressure gauges in manholes well away from ladders to avoid potential of accidentally hitting gauges while entering manhole. Install thermometers near but not immediately adjacent to the inlet and outlet of temporary domestic hot water heater.

D.12.2. Thermometers shall be mounted in thermowell, bimetallic-actuated, 304 stainless steel case and ring, 5-inch diameter dial, glass window, complying with ASME B40.3. Thermometer scale shall be to 50 to 550°F for steam and 0 to 250 deg F for condensate. Thermowells shall be pressure-tight, socket-weld style, 304 stainless steel well with welding adapter, seal weld well, heavy duty tapered shank, metal fitting made for insertion into piping, rated for Design (Working) Pressure/Temperature 120 psig/450°F.

D.12.3. Pressure gauges shall be direct mounted, dial-type, 4-1/2-inch diameter stainless steel case and ring, liquid-filled type, Bourdon-tube pressure element assembly, glass window, complying with ASME B40.100. Pressure gauge scale shall be 0 to 200 psig for MPS, and 0 to 60 psig for LPS and CR. Refer to accompanying illustration, Figure 6, for required pressure gauge installation including pigtail syphon and gate valve. Pigtail Syphons shall be 1/2 NPT, 180 or 360 degree coil of welded 316L stainless steel, schedule 80 tubing with threaded ends, rated for 2,650 psig at 500°F (1,629 psig @ 750°F), Colonial Instruments, Inc. model 516X or approved equal. Acceptable pigtail syphons alternate in ASTM A106, Grade B, seamless carbon steel schedule 160 tubing with threaded ends, rated for 3,900 psi at 600°F, Colonial Instruments, Inc. model 5451.

D.13. Condensate Receivers and Pumps

All condensate receivers shall be sized to prevent overflow and excessive cycling. Size for a one minute run time with a maximum inflow. All condensate pump sets

October 12, 2012
shall be duplex with an alternator and high level override. Provide pressure
operated pumps in severe environments.

D.14. Pipe Hangers and Supports

Materials, design and manufacture of pipe hangers and supports shall comply with
MSS SP-58, Types 1 through 58, factory fabricated components. Selection and
application of pipe hangers and supports shall comply with ANSI MSS SP-69.
Pipe hanger installation shall comply with MSS SP-69 and MSS SP-89. Typically,
for piping 2" and smaller utilize clevis hangers and split rings. For larger
horizontal piping and those with anticipated thermal expansion, consider
supporting on pipe rolls.

D.14.1. Horizontal-Piping Hangers and Supports:

D.14.1.1. Yoke-Type Pipe Clamps (MSS Type 2): For NPS 4 to NPS 16, requiring up to
4 inches of insulation, such as Anvil International Figure 224. Use only where
minimal thermal movement expected. Typically, utilize only where there is
inadequate space for another approved support.

D.14.1.2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For
suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to
4 inches of insulation. Use only where minimal thermal movement expected.
Typically, utilize only where there is inadequate space for another approved
support. Use Double-Bolt Pipe Clamps for NPS 3/4 to NPS 4. Use Heavy
Duty Double-Bolt Pipe Clamps for NPS 6 to NPS 24.

D.14.1.3. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
Use only where minimal thermal movement expected. Typically, utilize U-
Bolts to support NPS 3/4 to NPS 2 steam trap station and blow down piping
in conjunction with custom fabricated steel angles secured to manhole wall or
to a 4" high concrete pad. Also consider use of U-Bolts loosely installed over
pipe insulation simply to prevent unexpected pipe movement from dislodging
pipe off of pipe support. Use of U-Bolts for other applications must be
approved by the University. Use of alternate support types for stream trap
station and blow down piping must be approved by the University.

D.14.1.4. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36,
with steel pipe base stanchion support and cast-iron floor flange.

D.14.1.5. Pipe Stanchion Supports: For support of pipes, NPS 4 to NPS 36, with steel
pipe base stanchion support and cast-iron floor flange.

D.14.1.6. Single Pipe Rolls (MSS Type 41): For support of pipes, NPS 3/4 to NPS 30,
from 2 rods if longitudinal movement caused by expansion and contraction
might occur. These are the most commonly used steam and condensate piping
supports in steam manholes, tunnels, and vaults.

D.14.1.7. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42,
if longitudinal movement caused by expansion and contraction might occur
but vertical adjustment is not necessary.

October 12, 2012
D.14.1.8. Pipe Slide Assembly (MSS Type 35): For support of pipes, NPS 1 to NPS 24, if longitudinal and transverse movement caused by expansion and contraction might occur. Slide assembly shall have stainless steel facing plate on tee, filled with 3/32" thick Teflon on disc. Field weld to pipe. Typically utilize Anvil International Figure 257 Type 1 Pipe Slide Assembly with structural tee and base plate for NPS 1 to NPS 3 and Figure 439 Pipe Slide Assembly with structural “H” and base plate for NPS 4 to NPS 24. Confirm exact type appropriate for each installation.

D.14.2. Vertical-Piping Clamps:

D.14.2.1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

D.14.2.2. Carbon- or Alloy-Steel Riser Clamps (IVISSType 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

D.14.3. Hanger-Rod Attachments:

D.14.3.1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

D.14.3.2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.


D.14.3.4. Nuts: Use ASME B18.2.1, ASTM A563, Grade A, Hex, hot-dip galvanized carbon steel nut only on threaded rods, sizes 1½” and smaller.

D.14.3.5. Washers: ASTM F 844, steel, hot-dip galvanized, flat washers.

D.14.4. Hangers and supports shall be galvanized or field finished. Required hangers shall be shown on design drawings, however, hanger spacing and rod size shall not be less than indicated in chart below. As stated above, steam and condensate systems shall be designed to be filled with water, or shall be temporarily supported during the required hydrotest.

D.14.4.1. Hanger Spacing and Rod Size for Straight Horizontal Runs

<table>
<thead>
<tr>
<th>NPS, in.</th>
<th>Hanger Spacing, ft</th>
<th>Rod Size, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>½</td>
<td>7</td>
<td>3/8</td>
</tr>
<tr>
<td>¼</td>
<td>7</td>
<td>3/8</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>3/8</td>
</tr>
<tr>
<td>1 1/2</td>
<td>9</td>
<td>3/8</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>3/8</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>1/2</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>5/8</td>
</tr>
<tr>
<td>6</td>
<td>17</td>
<td>3/4</td>
</tr>
<tr>
<td>8</td>
<td>19</td>
<td>7/8</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>3/4</td>
</tr>
<tr>
<td>12</td>
<td>23</td>
<td>7/8</td>
</tr>
<tr>
<td>14</td>
<td>25</td>
<td>1</td>
</tr>
</tbody>
</table>

October 12, 2012
D.14.4.2. A Commonwealth of Massachusetts Structural Professional Engineer shall specify and prepare calculations for expansion anchors used for suspending all piping inside steam manholes and buildings. Expansion anchor calculations must be prepared for each specific installation condition to demonstrate the anchor design strengths, determined using parameters set forth in The Seventh Edition, Massachusetts Basic Building Code (780 CMR, chapters 1-50; specifically 1913.0) and the ICC-ES evaluation report for the specific expansion anchor being installed. Consider specifying stainless steel expansion anchors in humid environments such as steam manholes, vaults, and tunnels. Structural engineer shall observe installations of concrete, steel, and expansion anchors for which he designed. Expansion anchors require special inspection in accordance with the provisions of the specific expansion anchor ICC-ES evaluation report and Chapter 17 of 780 CMR. According to the certification requirements of these documents, the special inspection must be completed by the structural engineer of record, which would be the engineer that stamps the expansion anchor calculations. These requirements originate from the Seventh Edition Code. The Seventh Edition Code was based on the ICC 2003 International Building Code (IBC-2003), with significant Massachusetts modifications. One such modification was a rewrite of paragraph 1913.0.

D.14.4.3. Project Engineer of Record shall perform system turn-over inspection and field verify pipe hanger installations and settings are in accordance with the Contract Documents and applicable codes.

D.15. Sleeves and Mechanical Sleeve Seals

D.15.1. Mechanical sleeve seals for pipe penetrations through building equipment room walls and floors, areawall walls and all walls below grade shall be one of the following assemblies: "LINK-SEAL" by Thunderline Corp., "Innerlynx" by Advance Products & Systems, Inc., or "Metra Seals" by Metraflex. Utilize Standard Service EPDM seals with preinsulated piping and High Temperature Silicone seals with temporary steam pipes since seal will be in direct contact with hot temporary pipe surface.

D.15.2. Sleeves in steam manhole walls shall be steel "wall pipes" constructed by continuously welding both sides of water stop plate to center of sleeve, followed by hot dipped galvanizing the assembly. Sleeves in building walls shall be cast iron construction with water stop. Install water stop at center of wall. Select sleeve size in accordance with mechanical sleeve seal manufacturer's published recommendations to allow for annular clear space between pre-insulated pipe.
system and sleeve for installing mechanical sleeve seals. Both sleeve-to-wall and sleeve-to-pipe junctions shall be watertight.

D.15.3. The Mechanical Contractor shall be fully responsible for sizing and providing the sleeve and mechanical sleeve seal model number at each penetration point in a submittal to be approved by the engineer of record and the University.

D.16. Insulation

D.16.1. Use Cellular Glass insulation with field applied aluminum jacket and aluminum bands for all field insulated steam and condensate piping systems, except temporary installations located outside steam manholes, tunnels, vaults, and buildings.

Thermal conductivity: 0.29 BTU-in/hr-deg F at 75 F

Maximum service temperature: 900 deg. F

Dry Density: 7.5 lbs/cu.ft

Compressive strength: 90 psi at 10% deformation per ASTM C240

Thickness: Meet or exceed requirements of current Massachusetts Energy Code.

D.16.2. For each pressure reducing valve, flanged and lug isolation valve, and expansion joint provide non-box type removable, reusable, one-piece, insulating cover.

D.16.3. For each inverted bucket and F&T steam traps provide box-type removable, one-piece insulating cover.

D.16.4. Box Type insulating cover shall be insulated with hydrophobic silica aerogel blanket reinforced with glass-fiber batting. Jacket shall be PTFE – Fiberglass composite jacketing, 16.5 oz./sq. Yd. minimum. Maximum temperature 600 Deg. F. Insulation thickness designed to limit surface temperature to 120 Deg. F.

D.16.5. Non-Box Type insulating cover shall be insulated with glass matt, type E needlel fiber. Density shall be 9 lb./cu. Ft. for ¼” and ½” and 11.3 lb/cu. Ft. for 1”.

Jacket shall be PTFE – Fiberglass composite jacketing, 16.5 oz/sq. Yd. minimum. Maximum temperature 600 Deg. F. Insulation thickness designed to limit surface temperature to 120 Deg. F.

D.16.6. Jacket shall be fastened using Velcro straps and 1” slide buckles. Provide a stainless steel grommet at the low point of each cover for drainage. Provide a permanently attached stainless steel nameplate to identify location, size and tag number of insulated item.

D.17. Piping Identification

Piping within buildings, steam manholes, tunnels and vaults shall be permanently identified with preprinted, color-coded, manufactured pipe labels with lettering indicating service, and showing flow direction. Labels shall be manufactured in accordance with ASME A13.1-1996 “Scheme for the Identification of Piping Systems”. Each valve in each piping system shall be tagged with a brass or aluminum

October 12, 2012
tag numbered consecutively for each system and attached to the valve with a brass or aluminum chain. Valve tags shall have stamped abbreviations of the system in addition to the valve number. A valve schedule with tag numbers shall be installed and located in a conspicuous place preferably in a mechanical room.

E. CONSTRUCTION

E.1. QUALIFICATIONS

E.1.1. Pipefitters shall be licensed per Commonwealth of Massachusetts, M.G.L. c. 146, Section 84.

E.1.2. Heating and process piping system installing contractor shall be licensed in the Commonwealth of Massachusetts per 780 CMR 28. This shall apply to all piping on this project.

E.2. HYDROTEST, AND RADIOGRAPHIC EXAMINATION

E.2.1. Isolate hydrostatic pressure test from live steam. Where a steam shutdown is not feasible and a single valve is used to isolate the hydrostatic pressure test from live steam on the opposite side of the valve, its closure shall be capable of sealing against test pressure without damage to valve. Install a blind (also referred to as a blank, pancake blind, slip blind, or frying pan) between the pair of flanges on the side of the valve to be hydrostatically tested. Blinds shall be of adequate thickness to prevent deformation under anticipated pressures, typically not less than 3/8" thick plate steel. Utilize equation in ASME B31.1 to calculate minimum required thickness of blank based upon allowable stress of blank material.

E.2.2. For steam and condensate systems governed by ASME B31.1, the hydrostatic test pressure at any point in the system shall not be less than 1.5 times the Design (Working) Pressure (90psig), but shall not exceed the maximum allowable test pressure of any non-isolated components, such as vessels, pumps, or valves, nor shall either the piping circumferential (hoop) or longitudinal stresses exceed 90% of the yield strength at test temperature. Hydrostatic test pressure shall not be less than 100 psig, per ICC 2003 International Mechanical Code (IMC-2003), Article 1208.1. The test pressure shall be continuously maintained for a minimum time of 2 hours and then conduct the examination for leakage. Examinations for leakage shall be made of all piping, joints, and connections. If second attempt of hydrostatic test for any section being tested fails, the University reserves the right to require Contractor to conduct radiographic examination (x-ray) of five percent (5%) of entire project service pipe welds and dye test all other service pipe welds. Each joint shall have 100% of the circumference of the weld examined. The University will select welds to be radiographed. Contractor shall bear all costs associated with radiography and dye testing in compliance with the University requirements, including necessary repairs, barricades, etc.

E.2.3. Pre-insulated piping assembly manufacturer shall provide radiographic examination of all factory service pipe welds. Radiographic examination shall be conducted by a third party testing laboratory regularly engaged in such examinations. Each joint shall have 100% of the circumference of the weld examined.

October 12, 2012
E.3. PERMIT-REQUIRED CONFINED SPACE

E.3.1. All entries in permit-required confined spaces (PRCS) shall comply with OSHA 29 CFR 1910.146 and the entrant’s employer’s PRCS/OSHA policy. A confined space permit must be applied for with UMass EH&S Department. Refer to specification section 01010 for additional requirements. UMass EH&S Department and this contractor shall jointly be responsible for determining if a particular space is a permit required confined space. This evaluation shall occur as a minimum each time the space egress or configuration changes.

E.4. STEAM METERS

Steam meters shall be provided to measure the steam main flow in each building with remote reporting to the Campus energy management system. Temperature sensors shall be provided in selected building condensate mains with similar remotely reporting. Meters should be sized to handle the expected maximum and minimum flows. Flow meters and temperature sensors shall be interfaced with the Metasys Building Automation System (BAS). Preferred manufacturer of the orifice plate steam meter is Rosemount.

E.4.1. Steam meter shall be and orifice plate meter sized for an 80 in. wg pressure drop at peak flow, installed in 300 lb. tapped flanges. Plate shall be provided with weep holes at six o’clock and piping to provide for condensate removal on either side of orifice plate. Provide flanges with jacking bolts to facilitate inspection.

E.4.2. Manufacturer’s recommendations for straight runs before and after orifice plate shall be observed. Typical straight run requirements are six (6) pipe diameters upstream and three (3) downstream.

E.4.3. Transmitter shall include a temperature probe and send to the BAS a 4-20 ma signal, scaled to the meter range. Rosemount 3095MA.

E.4.4. Impulse pipes from the flanges shall be stainless steel tubing pitched down to the transmitter to avoid air pockets.

E.4.5. Meter set-up and calibration manufacturer’s representative or designated instrument technician proficient in these types of meters. Calibration shall include offsets for flange tap orientation and impulse line water head.

E.5. STEAM MANHOLES, VAULTS AND TUNNELS

Steam manholes shall have two means of egress. Dead end tunnels, such as to a building foundation wall, shall be provided with an egress manhole or access door into the building if dead end is otherwise more than 50 feet from egress to outside. Manhole covers shall be 30” diameter with 4 - one inch holes for lifting and ventilation. Manholes shall be staggered and located near opposite corners of rectangular vaults. The number of the manhole shall be welded to the cover. Manhole covers shall be 2” above grade. Where possible, keep manhole covers out of roads and walkways to minimize disruption to pedestrian and road traffic and to avoid accelerated pipe and concrete corrosion due to road salt entering manhole. Drains shall be provided in all steam manhole structures and tunnels, and shall be by gravity drain. Design engineer Scope of Services shall include this gravity drainage design for steam system designs which involve new steam manhole.

October 12, 2012
structures or tunnels. Per state plumbing code, steam manhole structure, tunnel, and vault drainage inlets shall discharge into the sanitary sewer. Drains shall be not less than 6" ductile iron CL 52 with approved backflow preventer and sweep elbow where possible. Where required, provide design for completely new drain systems. Provide for up to 12” deep structure sump where gravity drain allows. Permanently installed sump pumps in steam manholes shall be avoided.

Steam tunnels shall be provided with an engineered ventilation system. Steam tunnels shall be provided with removable covers where appropriate for maintenance.

Steam vaults, manholes and tunnels shall be designed to withstand H-20 axle load.

E.5.1. Provide tunnels and manholes with 12” wide steel ladders at all points of access. Side rails shall be continuous ½ by 2-1/2 inch flat bars. Bar rungs shall be 1 – inch diameter steel bars spaced 12” on center, set into the centerline of the bars and plug welded. Provide non-slip surfaces on top rungs. Galvanize all ladders, including brackets and fasteners to Coating Grade100 – 3.94 mils minimum.

E.5.2. Vaults shall be designed to accommodate future expansion in terms of future additional branch connections. Provide for access to and continuation of piping from tees provided for that purpose. Make provision for temporary connections steam and condensate mains and provide clearances necessary for routing temporary piping in and out of vault.

E.5.3. All vaults and tunnels shall be insulated or vented to maintain working temperature of less than 130 degrees unless approved by the University. All system components including waterproofing components and sealants shall be designed for the appropriate temperature range.

E.6. ADDITIONAL STANDARD CONTRACTOR WORK PROCEDURES

E.6.1. In advance of any work being performed the responsible agency (whether outside contractor or in-house unit of the University) shall perform a comprehensive survey of the proposed job to determine what work will be done, what services must be interrupted prior to or during the work, whether asbestos is present, and whether any existing work has become deficient (e.g. reversed pitch, missing or collapsed hangers, etc.) and will have to be renewed to meet codes or University policy. At this time the University Physical Plant Plumbing Shop will be consulted to ensure that the University steam trap station numbering system is observed in numbering the steam traps in the proposed work area, and that the required records of the work are kept according to the standard then current. Forms for such record-keeping will be provided by the University Physical Plant.

E.6.2. All material and equipment shall be of the proper size, type and capacity to perform the function intended, and shall be installed according to generally accepted standards of good craftsmanship (where more stringent University of Massachusetts policy standards do not apply) to ensure maintainability, durability and safe and proper function.

E.6.3. Where practicable, replacement equipment shall be of uniform manufacture and model number within each building. Where partial replacement or repair occurs,
replacement equipment shall be of the same manufacturer and model number as existing equipment.

E.6.4. Old equipment shall be removed using techniques of good workmanship to ensure safe and clean removal without harm to building occupants, employees (whether of the contractor, the University or any other employer), or University property. This requirement specifically includes (but is not limited to) excessive noise, dust or fumes, obstruction of public ways, and any hazard offered to passers-by, as by improper disposition of waste materials, creation of slipping or tripping hazards or improper parking of vehicles.

E.6.5. Any unfinished work to be left unattended shall be capped or plugged on both the steam and return sides. It should be noted that a closed valve does not satisfy this requirement.

E.6.6. All valve handles for each steam trap shall be positioned so as to be reached from a single ladder position without reaching around, through or under obstructions or piping. No installation which does not allow enough clearance for a full and secure grip on the valve handle shall be acceptable.

E.7. SCHEDULING AND NOTIFICATION:

All work shall be scheduled using University scheduling and notification protocol.
Note: there should be at least three (3) customer notices given:

E.7.1. Job planning notification:
Advises customer of work being planned in their area, building and/or room and its likely impact on their normal routine. It should spell out the scope of the work in some detail, giving particulars in layman's terms about what will work and what will not work during the job, where the noise, mess and nuisance will be and how long the work will probably take. This notice is normally to be given at the time of the survey.

E.7.2. Work imminent notice:
Advises customers that materials and tools necessary to complete the job will be arriving at job-site at a date certain. This notice is to be given when the work is definitely scheduled, but work will not begin in the customer's space until preliminary preparation of materials has been performed. Where possible at least several days advance notice should be given before work commences in the customer's space.

E.7.3. Floor/room notice:
Advises customer's sub-unit that work will begin in their immediate area within 24 to 48 hours.

E.7.4. For (7.2) and (7.3) above, prominent notices not less than 8 ½" x 11" (bearing the name of the contractor or agency, the location and scope of the work, probable duration and a telephone number at which the agency performing the work can be contacted by the customer if problems arise) should be posted at each entrance to the affected area so as to be visible to the persons concerned at the start of the

October 12, 2012
normal workday, and should also be delivered verbally to the building or area coordinator and/or directly to the first few persons affected by the work.

E.7.5. It cannot be over-emphasized that a successful operation depends upon well-established and frequently employed lines of communication. Customers are usually willing to be accommodating as long as they are kept updated with information regarding work progress and plan deviation.

E.7.6. The timing of all these notices has to be discussed and coordinated among the customer, the Physical Plant and the contractor.

E.7.7. Work with customer and appropriate University agents to establish needed space within, or adjacent to, work site to accommodate such things as workshop space, wash-up area, storage, lunch room, trailer siting, parking, etc.

E.7.8. SERVICE INTERRUPTION

Steam service interruption notices shall be coordinated with University Physical Plant Mechanical Utilities Department and issued a minimum of ten (10) working days prior to the planned service interruption.

E.8. UNIT PREPARATION:

E.8.1. Radiator valves:

E.8.1.1. New valves shall be disassembled, pre-lubed with Permatex® Anti-seize Lubricant 133k according to the accompanying illustration, Figure 2, before installation.

E.8.1.2. Valves to be rebuilt shall have packing, spring and valve disc replaced. Valve will be thoroughly pre-lubed with Permatex® Anti-seize Lubricant 133k according to accompanying illustration, Figure 2, before being re-installed.

E.8.2. Thermostatic steam traps:

E.8.2.1. New traps shall have the covers and union spuds dismantled. Union spuds shall be lubed as described herein for unions, and cover threads shall be lubed for their full circumference, as in the accompanying illustration, Figure 1.

E.8.2.2. Traps to be rebuilt shall have trap bowl thoroughly cleaned and rendered free of old gasket material, sediment, debris or other substances which might hinder proper sealing or operation. Cover threads and union spuds shall be lubricated as for new traps, as in the accompanying illustration, Figure 1. A new service package, including new trap seat (old traps with integral seats shall be replaced, not repaired) shall be properly installed before the rebuilt trap is put back into service.

E.8.2.3. Care should be used in both cases above to ensure that the trap outlet and inlet are free of any restriction or stoppage. Such conditions, if found, shall be remedied before the trap is installed or re-installed.

E.8.3. F&T, bucket, inverted bucket and similar steam traps:

E.8.3.1. New traps shall have any plugs removed (whether or not those openings are to be used now or ever) and treated according to Section 8.2.1 above. Traps shall
be fitted with unions on the inlet and outlet side installed according to Section 8.2.1 above. All such traps shall be provided with a positive means of testing to atmosphere and valves to isolate them from the steam and return lines.

E.8.3.2. Traps to be rebuilt shall have trap body thoroughly cleaned and rendered free of old gasket material, sediment, debris, or other substances which might hinder proper sealing or operation. The face of the trap body, both sides of the gasket, the face of the service package or cover and any bolts and nuts used to secure the cover shall be thoroughly lubricated with Permatex® Anti-seize Lubricant 133k before assembly.

E.8.3.3. Care should be used in both cases above to ensure that the trap outlet and inlet are free of any restriction or stoppage. Such conditions, if found, shall be remedied before the trap is installed or re-installed.

E.8.3.4. Refer to the accompanying illustration, Figure 3, for alternate F&T trap installations.

E.8.4. STEAM TRAP SERVICE RECORDS:

E.8.4.1. There shall be affixed to each station immediately upstream of the trap inlet union a permanent metal tag with the station number and building number stamped or engraved thereon. Any service to a trap station shall be tagged at the station and recorded as provided by University of Massachusetts Physical Plant policy. The tag shall list at minimum date of service, building number, payment authorization number, room and location of station, station number, equipment that the station serves, service performed on station, name of contractor, name of service person.

E.8.4.2. A written copy of station data for all traps serviced, installed, repaired or removed under a given contract, project, etc. shall be kept according to the University Plumbing Shop protocol for such records then current, and a fair copy provided to the University Plumbing Shop at the completion of the contract, project, etc. It should be noted that this is more comprehensive data than the station tag data given above. Forms for the recording of such data shall be provided by the Physical Plant.

E.9. OPERATIONS:

E.9.1. Service interruption: Whenever building or area service will be interrupted notice shall be filed according to University of Massachusetts policy and all valves fitted with appropriate “lock-out” tags and (where appropriate) lockout devices.

E.9.2. Unit Preparation: All furniture, molding, woodwork, covers or other obstructions shall be removed with due care and in a craftsman-like manner. Drop cloths or other means shall be used to ensure finished surfaces remain clean and undamaged. All stations serviced shall be vacuumed or otherwise cleaned and left free of dirt and dust (including fins, radiators, coils and their enclosures). At the completion of service the furniture, moldings, woodwork and covers that were moved or removed shall be replaced and the area left clean of service-related debris or dirt. Work performed shall be tested and free of leaks before returning unit to service.

October 12, 2012
E.9.3. Record keeping: In addition to trap service records described previously, a daily record will be kept indicating:

E.9.3.1. Service interruptions (utility, date and times off and on).

E.9.3.2. Daily work performed, including complaints received (with their dispositions) and deviations from plan.

E.9.3.3. Deferred work: A separate deferred work “punch list” shall be kept, detailing work to be finished pending materials, related trade work, or other contingency. This list shall include the work deferred, reason for deferral and resolution, if any. Work deferred shall appear in both the daily log as it occurs and in the cumulative “punch list”.

E.10. STEAMLINE SHUTDOWN AND START-UP PROCEDURE

A tailgate planning meeting will be held prior to commencement of work on any project that involves start-up and shut-down of steam distribution piping. The meeting shall be attended by the Contractor, Designer of Record and the University.

The installing contractor shall be on site during the Startup and be available to immediately correct any deficiencies in the installation discovered during startup.

Notification of service interruption is sent out to all affected areas of planned shutdown. In an emergency, the emergency notification process will take effect.

Only University employees will be allowed to operate steam valves:

E.10.1. SHUT DOWN

E.10.1.1. Shut main valve for area needed, either in a manhole or the Power Plant. Use lock-out and tag-out procedures at this time to secure valves. If more than one group is involved with the project, both parties must lock-out device.

E.10.1.2. Crews are now dispatched to the affected manholes to drain the steam supply and condensate systems. All valves that are moved from their normal position are tagged to identify them. Any flash tanks are drained at this time. Once isolation, bleeding off, and draining process is complete work on the system may begin. Pumps may be needed during the draining of the system to remove water from the manholes.

E.10.2. START UP

E.10.2.1. Designated persons or crew goes through the entire system to ready system for startup. They can open all blowdowns to be used in startup. They check the position of all other valves in the system. When complete, startup may begin.

E.10.2.2. Keys are placed on all blowdown valves so no persons are in the manholes during start up. Crews are assigned to specific manholes along the system to be turned on. At this time a radio check is done to assure proper communications. The Power Plant is notified of the startup.

October 12, 2012
E.10.2.3. Upon agreement of all people involved start up begins. A designated start up person at the head end opens the by-pass valve to start the process. The startup person communicates every action to all other people involved.

E.10.2.4. As steam travels down the line, it condenses and shows up as water at the blowdown lines. All along the system people are reporting the status of the steam to the startup person. As the line heats up the steam dries out to a point that the blowdown valves can be throttled down. The last person on line is the key to the whole system. The status of the steam at their manhole tells the others the condition of the startup. As the system heats up the startup person tells everyone that they are opening the main valve. This is done in a slow and steady manner. The system will now start to gain pressure. The blowdown valves all along the system are now being throttled down and turned off. Once the full desired pressure is reached the system is considered loaded.

E.10.2.5. At this time all along the system one person enters the manhole and shuts the main blowdown valve, using a wrench. They perform a visual inspection of the manhole and exit. Upon exiting the manhole they open the blowdown valve to relieve pressure in the line. Through radio communication, the system is considered charged and in good condition.

E.10.2.6. At this time if possible, the system is left alone with nobody entering the manholes. This is to let the system settle out and move as needed. This is for personal safety reasons. Once the system has sat for a while it will then be safe to enter the manholes as needed.

E.11. SAFETY

E.11.1. At all time during this process, all safety procedures must be followed. Including but not limited to, confined space entry, lock-out tag-out, and personal protection procedures.
F. STANDARD CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>Detail Drawing</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-01</td>
<td>Low Pressure Drip Leg</td>
</tr>
<tr>
<td>F-02</td>
<td>Medium Pressure Drip Leg</td>
</tr>
<tr>
<td>F-03</td>
<td>Wall-Mounted Flash Tank</td>
</tr>
<tr>
<td>F-04</td>
<td>Flash Tank Piping Detail</td>
</tr>
<tr>
<td>F-05</td>
<td>Pressure Reducing Station – Parallel</td>
</tr>
<tr>
<td>F-06</td>
<td>Pressure Reducing Station – Single</td>
</tr>
<tr>
<td>F-07</td>
<td>Steam Pressure Gauge Assembly</td>
</tr>
<tr>
<td>F-08</td>
<td>Lubrication and Service-Steam Radiator Trap</td>
</tr>
<tr>
<td>F-09</td>
<td>Radiator Valve Detail</td>
</tr>
</tbody>
</table>

*** End of Steam and Condensate System Guideline ***
LOW PRESSURE STEAM Drip Leg Detail

NOT TO SCALE

1. 1" 800# SOCKET WELD GATE VALVE
2. 1" IPS BLACK STRAINER WITH 3/8" PLUG
3. SS NIPPLES WITH 1/4" 300# BRONZE GATE VALVE

NOTES:
1. This detail shall apply to all areas of this project.
2. Where installation space permits, trap station assemblies shall be built with a common spacing, allowing UMass to later quickly exchange preassembled spares.
3. Install trap assembly not higher than tie in to drip leg.
4. For drip leg installations within buildings, a single 2" drain shall be installed so that the valve can be actuated from a remote location. If space limitations necessitate, the drain valve may be installed off the side of the drip leg.
5. Pipe joints between 1st 4 3rd unions shall be threaded. Socket weld elsewhere.
1. 1" 800# SOCKET WELD GATE VALVE
2. 1" IPS BLACK STRAINER WITH 3/8" PLUG
3. SS NIPPLES WITH 1/4" 300# BRONZE GATE VALVE

NOTES:
1. THIS DETAIL SHALL APPLY TO ALL AREAS OF THIS PROJECT.
2. WHERE INSTALLATION SPACE PERMITS, TRAP STATION ASSEMBLIES SHALL BE BUILT WITH A COMPARABLE SPACING, ALLOWING CLIENT TO LATER QUICKLY EXCHANGE PRE-ASSEMBLED SPARES.
3. DUAL TRAP ASSEMBLIES ARE SHOWN VERTICALLY STACKED FOR DRAWING PRESENTATION ONLY. INSTALL TRAP ASSEMBLIES HORIZONTALLY, BOTH NOT HIGHER THAN TIE IN TO DRAIN LEG.
4. FOR DRAIN LEG INSTALLATIONS WITHIN BUILDINGS, A SINGLE 2' DRAIN VALVE SHALL BE INSTALLED SO THAT THE VALVE CAN BE ACTUATED FROM A REMOTE LOCATION. IF SPACE LIMITATIONS NECESSITATE, THE DRAIN VALVE MAY BE INSTALLED OFF THE SIDE OF THE DRAIN LEG.
5. PIPE JOINTS BETWEEN 1ST 3 300# UNIONS SHALL BE THREADED, SOCKET WELD ELSEWHERE.

MEDIUM PRESSURE STEAM DRIP LEG DETAIL
NOT TO SCALE
WALL MOUNTED FLASH TANK DETAIL

NOT TO SCALE
FLASH TANK PIPING DETAIL

TO SCALE

UMASS PROJECT NO.

CONSTRUCTION STANDARD DETAILS

CONTRACT NO.

REVISION DATE

DRAWING NUMBER

UNDIVERSITY OF MASSACHUSETTS DESIGN &

STANDARD UTILITY DETAILS

UMASS-AMHERST

UMASS-AMHERST

MASSACHUSETTS

F-04
3"LPS MAIN
90 PSIG STEAM
1"LPS BYPASS
3"LPS DRIP LEG
TYP. MPS TRAP STATION (SEE DETAIL)
2"LPS DRAIN

10 PIPE DIAM. MIN.

20 PIPE DIAM. MIN.

6"LPS VENT
THROUGH WALL TO SAFE LOCATION
4"LPS VENT
3X4 KUNKLE
4"LPS DRAIN

6" LPS MAIN
13 PSIG STEAM

UMASS-AMHERST
UNIVERSITY OF MASSACHUSETTS DESIGN & CONSTRUCTION STANDARD DETAILS
STANDARD UTILITY DETAILS

F-06
DRAWING NUMBER

4-20-2012
REVISION DATE

CLASS 300 PSIG HIGH PERFORMANCE VALVE
CLASS 150 PSIG HIGH PERFORMANCE VALVE

PRESURE REDUCING VALVE, PRV-1

PERSONNEL DETAIL (SINGLE STAGE)
NOT TO SCALE
STEAM PRESSURE GAUGE ASSEMBLY

NOT TO SCALE

1/2" NPT PIPE SYPHON (360° COIL)

PIPE REDUCER, MALLEABLE IRON, THREADED CLASS 300# EXTRA HEAVY

SOCKET WELD 3/4" 800LB GATE VALVE

1" PIPE

STEAM MAIN (HORIZONTAL TO SECTION)

STEAM SERVICE

WELD THRU VALVE

PROVIDE 2" 1/2" FORGED STEEL, SOCKET WELD CLASS 300# ELBOW IF STEAM MAIN IS VERTICAL

1" Sock-O-Let
### Lubrication & Service Steam Radiator Trap Detail

#### Parts and Operation Performed

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Operation Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover</td>
<td>Remove &amp; Lube</td>
</tr>
<tr>
<td>Cover Threads</td>
<td>Lube</td>
</tr>
<tr>
<td>Trap Shoulder</td>
<td>Lube</td>
</tr>
<tr>
<td>Trap Baul</td>
<td>Scour Clean</td>
</tr>
<tr>
<td>Outlet Opening</td>
<td>Scour Clean</td>
</tr>
<tr>
<td>Union Threads</td>
<td>Lube</td>
</tr>
<tr>
<td>Union Shoulder</td>
<td>Lube</td>
</tr>
<tr>
<td>Union Ring</td>
<td>Lube</td>
</tr>
</tbody>
</table>

---

*Not to Scale*
<table>
<thead>
<tr>
<th>Part Name</th>
<th>Operation Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Handle Screw 8-32</td>
<td>Remove &amp; Lube</td>
</tr>
<tr>
<td>2. Handle &amp; Pointer</td>
<td>Remove</td>
</tr>
<tr>
<td>3. Gland Nut</td>
<td>Remove</td>
</tr>
<tr>
<td>4. Coil Spring</td>
<td>Remove &amp; Lube</td>
</tr>
<tr>
<td>5. Washer</td>
<td>Remove</td>
</tr>
<tr>
<td>6. Packing</td>
<td>Remove &amp; Lube</td>
</tr>
<tr>
<td>7. Stem Upper</td>
<td>Remove &amp; Lube</td>
</tr>
<tr>
<td>8. Screw Driver</td>
<td>Lube</td>
</tr>
<tr>
<td>9. Bonnet</td>
<td>Remove &amp; Lube Threads</td>
</tr>
<tr>
<td>10. Packing Gland</td>
<td>Lube</td>
</tr>
<tr>
<td>11. Bonnet Assembly</td>
<td>Remove Prior to steps 1-12</td>
</tr>
<tr>
<td>12. Bonnet Threads</td>
<td>Lube</td>
</tr>
<tr>
<td>13. Disc Screw</td>
<td>Remove &amp; Lube</td>
</tr>
<tr>
<td>14. Disc</td>
<td>Replace on Rebuilt Valves</td>
</tr>
<tr>
<td>15. Valve Shoulder</td>
<td>Lube</td>
</tr>
<tr>
<td>16. Union Thread</td>
<td>Lube</td>
</tr>
<tr>
<td>17. Union Shoulder</td>
<td>Lube</td>
</tr>
<tr>
<td>18. Union Ring</td>
<td>Remove to Access Shoulder</td>
</tr>
</tbody>
</table>

LUBRICATION RADIATOR VALVE DETAIL

NOT TO SCALE