40 10 00 Building Steam & Condensate Systems

1. Introduction

   A. Medium Pressure and Low Pressure Steam are utilized exclusively inside building envelopes on the Duke University and Duke Medical Center campuses. Each building receives high-pressure steam from the campus distribution system, where it is automatically regulated down to a pressure suitable for building equipment. Typically, medium pressure service is utilized for process loading (washers, autoclaves, pressure-powered condensate pumps, etc.) and low-pressure service is utilized for HVAC purposes. For the purposes of this Standard, Medium Pressure Steam (MPS) refers to any systems operating between 75 psig – 16 psig, and Low Pressure Steam refers to systems operating at or below 15 psig. Medium Pressure Condensate (MPC) and Low Pressure Condensate (LPC) correspond to the same respective pressure ranges.

   B. Designers should coordinate with Duke Utilities & Engineering Services (DUES) on all phases of projects requiring steam and condensate utility service. These projects may include, but are not limited to: a) efforts requiring new steam piping and equipment b) changes to the existing piping, or c) removal of existing piping. Designers are expected to share and review any project data, load calculations, and site condition evaluations.

2. References

   A. ASME Building Services Piping Code, B31.9

   B. ASME Pipe and Fittings Codes, B16

   C. ASHRAE Standard 90.1 – 2007

   D. Duke Standard Details

      1. Duke Standard Steam Connections

      2. Duke Standard 2-Stage Pressure Reducing Valve (PRV) Station

3. Design Standards

   A. All steam and condensate system designs must take into account energy efficiency, reliability, serviceability, operational functionality, and life-safety issues, such that Duke may fully and accurately evaluate the project.

   B. Detailed documentation is required with regard to existing conditions. This may include, but is not limited to, documentation of existing steam-fired equipment, analysis of building steam loads, and evaluation of building distribution piping.

   C. Building Service Pressure Reduction

1. Where MPS is required or if the building requires less than 10 psig, high-pressure steam (HPS) must be reduced in pressure in two stages such that the first stage pressure-reducing valve provides MPS service, and the second stage provides LPS service.
2. If load diversity is 70% or less of designed peak load, utilize parallel valves sized at a 1/3 - 2/3 ratio of the peak load.
3. PRVs should be pilot-operated, cast iron body, class 250-rated body and connections.
4. Designers should NOT include bypass lines around PRV stations.
5. PRV stations must be designed with steam trapping at HPS, MPS, and LPS header piping.
6. PRV stations must utilize safety relief valves for each stage of pressure reduction. Relief vent piping must be piped to exterior. An intermediate (medium pressure) safety relief valve is not required if MPS does not serve equipment and is only used for intermediate reduction to LPS.
7. Safety Relief Valve piping must have no other equipment vent tie-ins.

D. Building Piping

Service	Size	Fitting Connection	Pipe Connection	Material
High Pressure Steam	2" and smaller	Socket Weld	Socket Weld	SCH 80, A106 Carbon Steel, Seamless
	2-1/2" and larger	Butt Weld	Butt Weld	SCH 40, A106 Carbon Steel, Seamless
Medium Pressure Steam	2" and smaller	Threaded (NPT)	Socket Weld or Threaded (1” and smaller)	SCH 80, A106 Carbon Steel, Seamless
	2-1/2" and larger	Class 150 Flange	Butt Weld	SCH 40, A106 Carbon Steel, Seamless
Low Pressure Steam	2" and smaller	Threaded (NPT)	Socket Weld or Threaded (1” and smaller)	SCH 80, A106 Carbon Steel, Seamless
	2-1/2" and larger	Class 150 Flange	Butt Weld	SCH 40, A106 Carbon Steel, Seamless
High Pressure Condensate	2" and smaller	Socket Weld	Socket Weld	SCH 80, A106 Carbon Steel, Seamless

Service	Size	Fitting Connection	Pipe Connection	Material
	2-1/2" and larger	Butt Weld	Butt Weld	SCH 80, A106 Carbon Steel, Seamless
Medium Pressure Condensate	2" and smaller	Threaded (NPT)	Socket Weld or Threaded (1" and smaller)	SCH 80, A106 Carbon Steel, Seamless
	2-1/2" and larger	Class 150 Flange	Butt Weld	SCH 80, A106 Carbon Steel, Seamless
Low Pressure Condensate	2" and smaller	Threaded (NPT)	Socket Weld or Threaded (1" and smaller)	SCH 80, A106 Carbon Steel, Seamless
	2-1/2" and larger	Class 150 Flange	Butt Weld	SCH 80, A106 Carbon Steel, Seamless
Continuous Vent	2" and smaller	Threaded (NPT)	Threaded	SCH 40, A 53 Gr. B Carbon Steel, Seamless
	2-1/2" and larger	Class 150 Flange	Butt Weld	SCH 40, A53Gr. B Carbon Steel, Seamless
Steam Relief Vent	2" and smaller	Threaded (NPT)	Socket Weld or Threaded (1" and smaller)	SCH 80, A106 Carbon Steel, Seamless
	2-1/2" and larger	Class 150 Flange	Butt Weld	SCH 40, A106 Carbon Steel, Seamless

1. Steam and condensate piping should be routed in the most efficient manner allowable, such that maximum loading per linear-foot of pipe may be achieved.
2. Steam and condensate system should include valving appropriate for required isolation of branch and main lines. Isolation valves shall be located as close to main as possible and still provide accessibility.
3. Where possible, all steam and condensate piping should be installed in a manner that allows gravity return of condensate.
4. Building LPC and MPC piping should be routed to allow gravity drainage to appropriate flash vessels and/or condensate pumping equipment. Condensate return and pumped condensate flow paths must not intersect.
5. MPS, LPS, MPC, and LPC piping and fittings should be insulated. Insulation losses must meet current ASHRAE 90.1 standards for energy usage.

6. MPS and LPS piping to be Schedule 40 carbon (black) steel, ASTM A53B or A106. All welded construction. Class 150-rated fittings to be used. Notable exceptions include but are not limited to small bore piping with threaded connections. Welding requirements can be reviewed where necessary on a case by case basis.

7. Condensate piping to be Schedule 80 carbon (black) steel, all welded construction. Schedule 80 fittings to be used throughout. Threaded piping may be used under certain circumstances and must be approved by DUES prior to utilizing.

8. Acceptable methods of pipe thermal expansion compensation are U-bend "expansion loops" and externally pressurized metal bellows-type mechanical expansion joints. No other methods should be used.

9. Condensate collection pockets ("drip legs") should be placed in steam piping at intervals no greater than 200 feet, AND at steam pipe elevation changes. Drip leg piping should be full line-size in distribution piping up to 6-inch NPS, and at least one-half the nominal diameter for all piping over 6-inch diameter, but not less than 6 inches in diameter. Drip legs should be 12-18 inches long (unless space conditions prohibit), and should include fully isolatable steam trap stations and blowdown valves.

E. Valves

1. Isolation valve bodies may be cast or wrought steel. Internal trim must be stainless steel. Valve must be rated for steam service.

2. Valves 2" diameter and below should use socket-weld connections. Piping greater than 2" diameter. Should be use butt-welded connections.

3. Automatic control valve bodies may be of steel, iron, or bronze construction. Valve must be rated for steam service.

F. Steam Traps

1. All steam trap assemblies shall be installed per Duke Standard Steam Trap Details found in A336300 Steam Energy Distribution appendix.

2. Steam trap preferences for medium-pressure lines are as follows:

    a. First choice – Thermodynamic (TD) traps

    b. Second Choice – Float and Thermostatic (F&T) traps – should be used primarily on medium pressure process equipment, HVAC equipment, or any other applications where steam/condensate flow is automatically controlled.

3. Low-pressure systems must use F&T type steam traps for all applications.

G. Flushing & Testing

1. Field and shop welded piping for both all steam and condensate shall be tested 10% or a minimum of 5, whichever is more by means of radiograph by an approved third party testing agency. Welds shall be inspected in accordance with ASME B31.1 Power Piping code requirements. All welds shall be selected by a DUES representative.

    a. If any welds are found to be defective, the weld must be cut out and re-welded. Repair of defective welds by adding weld material over the defect, or by peening shall not be permitted. Welders responsible for the defective welds shall be re-qualified before performing additional welding on the job. Any failed weld shall be retested by radiograph at the contractor's expense.

        (1) For any welding failures, radiograph testing shall continue until 100% of 10% of remaining welds pass. Additional testing will be at the contractor's expense.

        Example: Steam system has 50 welds, which 5 welds would be tested. One weld fails testing. The failed weld would be reworked and retested. The remaining 45 welds would be tested at 10%. An additional 5 welds would need to be tested and pass before the testing procedure would be complete. If another weld failed, the process repeats until 100% of the 10% of tested welds pass.

    b. Hydrostatic testing is required on steam or condensate piping inside the building. Hydrostatic test pressures shall be a 1-1/2 times operating pressure for 2 hours. Pressure test should be witnessed by engineer of record or a DUES representative.

        (1) All steam piping shall be blown down with steam from the distribution piping as a means for final flushing. Contractors shall make provisions for blowing down steam system and shall include installing temporary piping to blow down to atmosphere, vent silencers, etc. as required by FMD DUES. Temporary piping shall be carbon steel. Threaded connections are acceptable on all piping smaller than 2" for blowdown. All blow own procedures must be approved at least 2 weeks prior to performing blowdown with FMD DUES. A blow down will not be scheduled until project including a final inspection is performed.

        (2) Condensate piping shall be hydrostatically tested at pressure steam piping is tested and flushed prior to energizing.

4. <u>Documentation and Review Requirements</u>

    A. Analysis of the building MPS and LPS systems should be considered in the Life Cycle Cost analysis required for project approval.

B. Provide finite-element analysis of pipe system prior to release for bid. Analysis may be performed by designer or by manufacturer of pipe system, but must identify locations of high stress in system.

C. Provide estimated energy loss calculation for all distribution piping.