15550  HEAT GENERATION

PART 1:  GENERAL

1.01  HEAT SOURCE

A.  Heat for most Cornell campus buildings shall be provided from the central steam distribution system.

B.  Steam system pressure ratings:  The steam system is a variable pressure system. Pressure range is 0 to 125 psig. The system has central safety valves set at 125 psig. Normal operating pressures are from 40 psig in the summer to 100 psig in the winter. The engineer is instructed to design around the following parameters:

1.  Low pressure is 15 psig or less.  High pressure is above 15 psig.

2.  Heating loads:  Minimum load day pressure:  40  psig
    Design day pressure:  75  psig
    ANSI pressure class:  125  psig

3.  Process loads:  All process loads, such as domestic water heaters, sterilization equipment, etc., shall be designed to meet rated load with 40 psig of steam pressure entering the building. Control for such equipment shall be designed to handle the pressure variation from 40 to 100 psig, and shall not malfunction over short periods with pressures of 125 psig. PRV and control valve drops must be accounted for. For domestic hot water converters, the engineer is advised that the winter cold water temperature is 40˚F and 70˚F in the summer. This significantly reduces the converter load.

    All pressures are measured at the tie point to the existing distribution main. Line loss evaluations to the building entrance are the responsibility of the engineer.

C.  Steam temperature ratings:  Normal steam temperatures shall be 0-50˚F above saturated. Occasional extended excursions of up to 450˚F (550˚F near Alumni Fields) are possible.

    The engineer is instructed to use the following guidelines:

1.  Design temperature for high pressure systems shall be 450˚F.  For buildings close to the Alumni Fields use 550˚F.

2.  The design shall be sized, sloped and trapped for saturated steam.

3.  For buildings close to the Alumni Fields, heat exchangers shall be rated for 550˚F.
D. The engineer is responsible for all site utilities within the site boundaries, unless instructed differently. In the case of steam utilities and PRV systems, the engineer is required to provide a fully engineered and specified job, inclusive of isometrics, plan and elevation views, stress calculations, and material lists. The engineer is not responsible for getting steam to the site boundary unless instructed differently. He or she is responsible to accommodate pressure drops in the system design, starting at the steam main take-off.

1.02 SUBSTITUTIONS

Where the engineered composite drawings, components or layout are redone by the contractor, the engineer is responsible to recalculate the thermal and pressure stresses, based on the submission. Costs for the evaluation of such a design substitution shall be the responsibility of the engineer to recover from the party making the substitution.

1.03 EXCEPTIONS

A. For loads within 1/4 mile of manholes “F,” “A-2,” or the Central Heating Plant, peak pressures and temperatures will be higher. Contact the Department of Planning, Design and Construction for further detail.

B. For buildings not within 500' of a primary steam main, the University may not wish to provide service. Contact the Department of Planning, Design and Construction for further detail.

C. For those loads not supplied by central steam, natural gas will be the preferred fuel. In these cases, the engineer is responsible for the complete boiler plant design. The engineer is not responsible for design of the gas main up to the construction site boundary.

PART 2: PRODUCTS

2.01 PRESSURE REDUCING VALVE SYSTEMS

A. The engineer is instructed to use self-powered PRV systems as manufactured by Spence. The University’s rationale for this is twofold.

1. Self-powered valves close when the inlet steam pressure drops below a specified point. This constitutes an automatic load shed during upset conditions at the central plant, protecting the distribution system from extremely high pipe velocities in periods of low pressure. This condition varies from many situations in that the consumer is not normally interested in protecting the utility’s piping.

2. The University has personnel trained on the repair of Spence equipment and stocks most parts.
B. The engineer is advised that self-powered systems are not equivalently interchangeable with Leslie pneumatic systems. The engineer shall become familiar with the design requirements of the equipment. The engineer shall evaluate the load and confirm that the PRV system will function over the range of ambient temperatures and corresponding steam pressures. The design shall include valve train layout drawings and material lists for Spence equipment. A control logic diagram shall also be prepared.

Designs and drawing cuts for a typical Leslie pneumatic based design are not acceptable.

C. The engineer is advised that two-stage systems using self-powered hardware are difficult to make function at the lower end of the steam pressure supply range. Because the University lowers the steam supply pressure on a seasonal basis, single stage systems have proven to be reliable for most applications. The engineer shall evaluate the load profile and determine if a single stage system is appropriate. Examination of transient supply pressure excursions during periods of low load shall also be made. If a two-stage system is deemed necessary, the engineer shall advise Planning, Design and Construction, in writing, as to the reasons why.

D. For typical loads, using a single stage system and a 15 psig (or less) delivery pressure, standard (25 psi) springs shall be used in the regulator, and parabolic disks shall be specified to give a turndown of at least 15:1. If the load turndown exceeds this, then a split range system using two parallel regulators shall be specified (1/3-2/3). A two stage system will require careful analysis of the selected valve, spring and disk selections to achieve proper performance.

E. The regulator shall be supplied with gauges showing the supply, intermediate, and delivery pressures.

F. Valve body material: For installations where the initial maximum temperature (see exceptions above) is 450˚F or less, cast iron bodies (of suitable grade) are acceptable.

2.02 PRV STATION LAYOUT

A. Accessibility: PRV shall be arranged so as to be accessible without the removal of extraneous hardware and without the use of a ladder if possible. All gauges shall be readable from the floor.

B. Bypasses: The use of jackscrews on the regulator is not approved. Steel globe valve bypasses shall be supplied around each regulator stage (one bypass per stage), with a delivery pressure gauge visible from the valve.
C. Valving:

1. Each regulator shall be valved so as to allow its removal from the system, while the system is in operation.

2. Valves over 4" in size shall be high performance butterflies, rated for the service, and equipped with gear operators.

3. For small valves on warm-ups, traps, etc., associated with the high pressure system or regulators, bronze or brass bodied are not acceptable. Only WCB or equivalent steel bodies are permissible due to the 450°F+ design temperatures.

D. Instrumentation: Include upstream and downstream pressure gauges and thermometers. Thermometer scale shall be to 550°F.

2.03 HEAT EXCHANGERS

A. All heat exchangers shall have a pressure rating of at least 125 psig for both the shell and tube bundle, even if the operating pressures are less. For high pressure applications (above 15 psig), the shell and head shall be rated for the maximum steam temperature available at the building location.

B. Low pressure exchangers shall be rated 125 psig, with a 375°F head and shell rating, and a 300°F tube sheet rating.

C. The operating pressure shall be established based on the type of pressure relief system required (see below).

D. The shell shall be provided with an ASME approved pressure/temperature relief device, piped appropriately.

E. Heat exchangers using high pressure steam shall be piped and tested in accordance with the ASME Power Piping Code. Hydrostatic tests are required of all high pressure components, inclusive of tests across closed valves (leakage tests). Both high and low pressure exchangers shall be ASME rated.

F. For heat exchange performance purposes (peak load) assume at the take off from the main 75 psig, 100°F superheated steam delivered on central campus, 30 psig, 100°F superheated at north and west campus.
2.04 HYDRONIC LOOPS

A. Reheat

1. Reheat systems shall be hydronic.

B. Preheat

1. Preheat systems shall be hydronic, 40% propylene glycol filled.

C. Loop pumps over 2 hp shall be equipped with variable speed pumps and controlled from the building’s DDC.

2.05 PRESSURE RELIEF DEVICES

A. Safety Valves

ASME safety valves are the strongly preferred approach to protection of the low pressure system. The University recognizes the architectural considerations of such a system. Building floor plans and mechanical room layouts shall be adjusted to allow the use of a safety valve and vent stack to the roof. Safety valves will, however, eliminate the tripping of the steam system during periods of rapid load or inlet pressure swings. They also provide a visible means of detecting a malfunctioning PRV system. Steam outages caused by trip valves cannot be tolerated. These operational characteristics of a safety valve approach are very important.

B. Vent Stacks

1. Vent stacks shall be sized so as to keep the back pressure on the safety valve within the valve manufacturer’s requirements.

2. Vent stacks shall be connected so as to keep the stresses on the valve body within the valve manufacturer’s requirements. Drip pan elbows are not preferred if the stresses and stack condensate can be accommodated by other means.

3. Vent stacks shall be designed to accommodate the thermal growth.

4. Safety vent stacks shall have a fully detailed cut for the roof penetration, designed so that the temperature will not damage the roofing system or void the roof warranty.
C. Alternatives to Safety Valves

1. High pressure systems: The first alternative to safety valves is to design all heat exchange systems to operate directly off the high pressure system. The exchangers are already specified to be rated at the high pressure conditions. Operation with a 75 psig design should reduce their size. A cost trade-off exists as parts of the system must be built to Power Piping Code.

2. Code does allow the use of two separate PRVs in series in lieu of a safety valve. This can be a PRV and a trip valve, or a two stage system equipped with a safety pilot on the high pressure valve. The safety pilot approach does not result in tripping the system, but does not provide a ready means of indicating a malfunction. Care must be taken that all intermediate pressure loads are rated at 125 psig.

3. Trip valves: The least preferred approach is to use some form of a pressure trip valve. As noted, the possibility of trips increases certain life safety hazards and can be hard on equipment. Where trips must be used, the engineer shall follow the following guidelines:

   a. A pressure reset device to close the PRVs (safety pilot) in the event of a pressure pilot failure is required as a back-up. Pressure sensing shall be via separate piping.

   b. Electrical pressure switches, as used with a Leslie system, are not acceptable, even if powered off an emergency circuit. Use a mechanical (stop/trip) pilot.

   c. Code requires the use of a separate trip valve. Such a valve has a pressure drop associated with it. The engineer shall take this into account in designing the system.

2.06 STEAM TRAPS

A. Drip Legs

Each steam service entrance shall have a low point with a full size dirt leg at least 8" (eight inches) deep, located ahead of the first valve. This dirt leg shall have a 2" (two inch) nipple and cap in the bottom to facilitate cleaning. Trap take-offs shall be at least 2" (two inches) above the bottom. Each leg shall have two take-offs, each equipped with steel body root valves, with 2" (two inches) of vertical separation. Trap connections shall be to the upper connection. Blow-offs shall be connected to the lower port. Drip legs on underground steam distribution piping have special requirements. Contact Planning, Design and Construction.
B. Trap Selection

1. Because of the pressure and temperature fluctuations, only thermodynamic traps shall be used on the high pressure system drip legs. F&T traps shall be used on exchangers.

2. On the low pressure system, trap selection shall be made based on the load type, amount of allowable piping noise during trap operation, and the possibility of high levels of superheat.

3. Float type traps shall be protected from water hammer where necessary.

C. Strainers

1. All traps and blow-offs shall have strainers. All strainers shall have valves on the cleaning port.

D. Following a strainer, dirt leg blow-offs shall be arranged with a 1/2" valve on the strainer, to atmosphere and a 1/2" valve followed by thermodynamic trap to atmosphere. The purpose of this arrangement is to facilitate unsupervised warm-up of the distribution system. The free-vented thermodynamic trap will begin to function at 3 psig, and not be limited by any back pressure on the condensate piping. The trap will throttle the flow as the steam quality improves, preventing the space from filling with steam.

2.07 CONDENSATE PIPING

A. Condensate piping shall be laid out and sized for quiet operation. Air vents shall be included where required due to elevation changes.

B. General standards for sizing condensate piping indicate a maximum velocity of 50 fps where mixed phase flow exists.

C. Condensate mains over 2" (two inches) in diameter shall be of extra heavy wall pipe.

2.08 STEAM METERS

A. Condensate Meters

1. All steam meters shall be condensate meters unless otherwise directed.

2. Meters shall be a vortex shedding design, manufactured by EMCO or Yokogawa. A 1" (one inch) meter should be used, handling flows from 3 – 70 gpm. Meters shall have local totaling displays (gallons) and a one pulse per gallon, 5 volt pulse output. Output shall be tied to the building DDC system.
A separate 24 VDC power supply (NEMA 4X) is required. If larger than a 1" (one inch) meter is needed, the condensate pump is oversized.

3. Meters shall be located in a readable location.

4. Meters shall be installed downstream of a vented condensate receiver as indicated on Detail 15050-1.

5. Meters shall incorporate a spring loaded, self-seated check valve to prevent backflow leakage, as made by Metraflex.


7. Meters shall use 24" (twenty-four inches) of 1" (one inch) pipe upstream and 12" (twelve inches) of 1" (one inch) pipe downstream.

8. Meters shall be valved to allow verification of check valve leakage and to allow calibration using a 32 gallon trash can.

9. Meters are noise sensitive. Meters shall be located as far from condensate pumps as possible.

2.09 CONDENSATE PUMPS

A. The final condensate pump leaving the building shall be sized so that the rating of a single pump is no greater than 100% of the PRV station capacity. This is intentionally less than recommended by the vendors.

B. Internal condensate transfer pumps shall be sized according to manufacturer’s recommendations.

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

D. All condensate pump sets shall be duplex with an alternator and high level override.

E. Specifications will include instructions to field set level floats for a one minute run time.
2.10 CONDENSATE DISCHARGES

A. Whenever feasible, all discharges of steam condensate must be routed to the sanitary sewer system. Discharges must meet all IAWWTF sewer use ordinance requirements. Reference 15400, 1.03.

B. No steam condensate can be discharged to surface or groundwater without a State Pollution Discharge Elimination System (SPDES) permit from the NYS DEC. Cornell University’s Environmental Compliance Office must approve all new condensate discharges to storm sewers, surface water, or groundwater.

END OF SECTION