

230520 HEAT GENERATION

Cornell's Design and Construction Standards provide mandatory design constraints and acceptable or required products for all construction at Cornell University. These standards are provided to aid the design professional in the development of contract documents and are not intended to be used verbatim as a contract specification nor replace the work and best judgement of the design professional. Any deviation from the Design and Construction standards shall only be permitted with approval of the University Engineer.

PART 1 GENERAL

1.01 RELATED CORNELL DESIGN AND CONSTRUCTION STANDARDS

- A. Section 222300 – Domestic Water Heating
- B. Section 230500 – HVAC Basic Materials and Methods
- C. Section 230523 – Valves
- D. Section 232500 – HVAC Water Treatment
- E. Section 230530 – Clean Steam Generation
- F. Section 230900 – Building Automation and Control System Guidelines

1.02 RELATED STANDARD DETAILS

- A. Detail 3.2.2, Condensate Receiver and Meter Detail
- B. Detail 3.2.3, Building Low Pressure Steam Trap Detail
- C. Detail 3.2.5, Heat Transfer Package Schematic
- D. Detail 3.2.6, Building High Pressure Steam Service Entrance Detail
- E. Detail 3.6.3, Steam and Condensate Monitoring Points
- F. Detail 3.8.7, BACS Central Heating Water Distribution System Control

1.03 HEAT SOURCE

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

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- B. Cornell considers low pressure steam to be 15 psig or less; and high pressure steam to be above 15 psig.
- C. Raw campus steam shall NOT be released through humidifiers, steam tables, or any other means due to treatment chemicals carried in the steam (DEAE). Consumable steam must be produced in a steam-to-steam generator or a gas boiler. See Section 230530 – Clean Steam Generation for specifics.
- D. Steam system pressure ratings:
 - 1. The steam system is a variable pressure system, which fluctuates based on season and location on the campus distribution system. The consultant is instructed to contact Facilities Engineering for project specific design parameters; but generally, operating pressures are as follows:
 - a. Minimum load day pressure: 40 psig
 - b. Design day pressure: 60-75 psig
 - c. Abnormal condition: 110 psig
 - d. ANSI pressure class: 125 psig
 - 2. 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 35 to 100 psig, and shall not malfunction over short periods with pressures of 125 psig. PRV and control valve drops must be accounted for.
 - 3. 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.
- E. Steam temperature ratings:
 - 1. Generally, the consultant can expect the steam temperatures to be delivered 0-50°F above saturated. Under abnormal conditions (loss of turbine generator and desuperheater), occasional extended excursions of up to 450°F (550°F near Alumni Fields) are possible. The consultant is instructed to contact Facilities Engineering for project specific design parameters; but generally, operating temperatures are as follows:
 - a. High pressure systems: 450°F
 - b. Facilities close to Alumni Fields: 550°F
 - 2. The design shall be sized, sloped and trapped for saturated steam.

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- F. The engineer is responsible for ensuring that all aspects of the steam system design are consistent with the maximum pressures and temperatures.
- G. 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. The engineer is responsible to accommodate pressure drops in the system design, starting at the steam main take-off.

1.04 SUBSTITUTIONS

- A. Where the engineered composite drawings, components or layout are redesigned by the contractor, the engineer is responsible to recalculate the thermal and pressure stresses, based on the substitution. The engineer shall be responsible for recovering the costs to evaluate the design substitution from the party making the substitution.

1.05 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 Facilities Engineering for further detail.
- B. For buildings not within 500' of a primary steam main, the University may not wish to provide service. Contact Facilities Engineering for further detail.
- C. To comply with Campus sustainability goals, a ground source heat pump is the preferred system to generate heat for facilities not supplied by the central steam system. The use of natural gas heating systems will be considered on a case-by-case basis. In these cases, the design professional is responsible for the complete system design.

1.06 DESIGN CRITERIA

- A. The University is beginning the process of planning for the conversion of the existing underground steam distribution system to distributed hot water; and would like to position all new buildings for easy conversion in the future.
 - 1. A plate and frame heat exchanger will be provided for each facility. It will be the responsibility of the consultant to design this equipment using the following criteria:

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- a. Primary (Campus Distribution) Side:
 - Entering water temperature => 180 °F
 - Leaving water temperature => 100 °F
 - b. Secondary (Building) Side:
 - Entering water temperature => 100 °F (ideally)
 - Leaving water temperature => 130 °F
2. Standard Detail: 3.8.7, BACS Central Heating Water Distribution System Control
- B. If feasible, it is preferred that the engineer design and specify all the building’s steam system components for a system pressure of 125 psig. This eliminates the need for a PRV station and safety valve.

PART 2 PRODUCTS

2.01 PRESSURE REDUCING VALVE SYSTEMS

- A. If a PRV Station is required, the engineer shall use a self-powered PRV system 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 shall become familiar with the design requirements of the equipment; and 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.
- 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.

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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 Facilities Engineering, 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:
 - 1. For installations where the initial maximum temperature is 450°F or less, cast iron bodies (of suitable grade) are acceptable.
 - 2. For installations where the initial maximum temperature is above 450°F, cast steel bodies (of suitable grade) shall be used.

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. For small valves on warm-ups, traps, etc., associated with the high pressure system or regulators, bronze or brass bodied are not acceptable.
- D. Instrumentation: Include upstream and downstream pressure gauges and thermometers. Thermometer scale shall be to 550°F.

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- E. Provide a pressure transmitter downstream of the PRV station. This sensor shall send a critical alarm to EMCS in the event of an over pressure situation.

2.03 SHELL AND TUBE 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. Heat exchangers using low pressure steam shall be ASME rated for a minimum of 125 psig, with a 375°F head and shell rating, and a 300°F tube sheet rating.
- C. Heat exchangers using high pressure steam shall also be ASME rated, and 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).
- D. The operating pressure shall be established based on the type of pressure relief system required (see below).
- E. The shell shall be provided with an ASME approved pressure/temperature relief device, piped appropriately.
- F. For systems with redundant parallel heat exchangers, provide automated isolation on each exchanger.

2.04 HYDRONIC LOOPS

- A. Perimeter heating and reheat systems shall be hydronic.
- B. Preheat systems shall be hydronic, 40% propylene glycol filled, with pumped coils.
- C. Loop pumps over 2 hp shall be variable flow with variable frequency drives. Loop pumps 2 hp and below shall have EC motors. All pumps shall be controlled from the building's building automation and control system (BACS).
- D. Provide a complete riser diagram/flow schematic on the contract drawings, which shall, as a minimum, include the following information:
 - 1. All line sizes
 - 2. All loads with flows
 - 3. Riser flows
 - 4. Control valves

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- 5. Pumps with design flows and head
 - 6. Differential pressure transmitter locations
 - 7. Future pump and piping capabilities
- E. Provide a pressure transmitter in the hydronic loop to monitor pressure in the system. This sensor shall send a critical alarm to EMCS in the event of a loss of system pressure indicating a leak.

2.05 PRESSURE RELIEF DEVICES

A. Steam Safety Valves

- 1. When needed, the use of ASME safety valves is the preferred approach to provide overpressure protection of downstream piping components.
- 2. The University recognizes the architectural considerations of accommodating such a system. Building floor plans and mechanical room layouts shall be adjusted to allow the use of a safety valve, drip pan elbow and vent stack to the roof.
- 3. Safety valves will eliminate the tripping of the steam system during periods of rapid load or inlet pressure swings and also provide a visible means of detecting a malfunctioning PRV system.
- 4. Steam outages caused by tripped valves cannot be tolerated. These operational characteristics of a safety valve approach are very important.
- 5. An anchoring device shall be provided on the steam piping at the safety valve.

B. Vent Stacks

- 1. When required, vent stacks shall be sized to keep the backpressure on the safety valve within the valve manufacturer’s requirements. A drip pan elbow shall be used, which shall be anchored separately from the safety valve. It is important to note that vent systems sized based on the outlet connection size of the safety valve may not be sufficient to support this requirement. The consultant shall forward sizing calculations to Facilities Engineering for review.
- 2. Vent stacks shall be designed to accommodate the thermal growth.
- 3. 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.

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C. Hot Water Relief Valves

1. Discharge of hot water relief valves is to be piped to the nearest sanitary floor drain for perimeter heating and reheat systems; and to the glycol mix tank on pre-heat and other glycol filled systems.
2. The use of automatic air vents on glycol systems is not permitted.

2.06 STEAM TRAPS

A. Drip Legs

1. 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.

B. Trap Selection

1. Because of the pressure and temperature fluctuations, only thermodynamic traps shall be used on the high pressure system drip legs. The use of a thermodynamic trap mounted on a universal connector with integral strainer and blowdown valve shall be specified.
2. F&T traps shall be used on exchangers.
3. 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.
4. Float type traps shall be protected from water hammer where necessary.

C. Strainers

1. All traps shall have strainers. All strainers shall have valves on the cleaning port.

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.

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

2.08 METERS

- A. The meter shall measure the condensate return flow; and shall be sized and provided by Cornell for installation by the Contractor.
- B. Meter will be vortex shedding design. Expect a 1-inch NPS pipe size, which handles flows from 3 – 70 gpm. Meters will have eight digit local totaling displays (gallons) and a one pulse per gallon, 5 volt pulse output. Output shall be tied to the building BACS. Meters shall have internal line voltage power supply.
- C. Meters shall be located in a readable location, three to five feet off finished floor.
- D. Meters shall be installed downstream of a vented condensate receiver as indicated on Standard Detail 3.2.2 – Condensate Receiver and Meter.
- E. Post metering run piping shall incorporate a spring loaded, self-seated check valve to prevent backflow leakage.
- F. Condensate pump discharge piping shall contain anti-siphon elements.
- G. Allow for 24-inches of straight 1-inch pipe upstream of the meter; and 12-inches of straight 1-inch pipe downstream of the meter.
- H. Meters shall be valved to allow verification of check valve leakage and to allow calibration using a 32 gallon trash can.
- I. 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 flow rating of a single pump is **SIZED AT 110% OF THE PRV** station capacity, with sufficient head to return condensate to final receiver. This design requirement is intentionally less than recommended by the manufacturers. Verify discharge head design values with Cornell Utilities.
- B. All receivers shall be sized to prevent overflow and excessive cycling. Use largest practical receiver possible.
- C. All condensate pump sets shall be single phase, duplex with an alternator, HOA switch and audible high-level alarm.

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- D. Specifications will include instructions to field set level floats to prevent overflow and air entrapment before pump shutoff.

2.10 CONDENSATE DISCHARGES

- A. No steam condensate can be discharged to surface or groundwater without a State Pollution Discharge Elimination System (SPDES) permit from the NYS DEC. The Facilities Engineering Civil and Environmental Section must approve all new condensate discharges to storm sewers, surface water, or groundwater.

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