

## 33 63 00 - Underground Steam and Condensate Distribution System

### 1. Introduction

- A. Steam is distributed to University and Medical Center buildings through an underground piping system year-round at a nominal 125 psig. Both West and East Campus (Buildings 7754 & 7254) plants will supply the same piping system to west, central, and east campuses. The majority of campus high-pressure steam (HPS) distribution and condensate return piping is direct-buried, with manhole access. The remainder of the piping is accessible via full-height tunnel.
- B. Designers should coordinate with and 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 underground steam and condensate utility distribution piping, 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 Power Piping Code, B31.1
- B. ASME Building Services Piping Code, B31.9
- C. ASME Pipe and Fittings Codes, B16
- D. Duke Standard Details
  - 1. Duke Steam Vault
  - 2. Duke Steam Pit Entry
  - 3. Duke Standard Steam Connections

### 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 the University may fully and accurately evaluate the project.
- B. Detailed documentation regarding as-built conditions of the site is required. This may include underground utility elevation profiles, analysis of systems to which connections will be made, and locations of existing utilities that may be disturbed. Additionally, existing conditions of surface expressions, landscaping features, and trees should also be recorded.

### C. Distribution Piping

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.
3. Piping should be routed to avoid trees, foundation walls/footings, roads, pedestrian access ways, railroad tracks, and paths of ingress and egress around buildings where possible.
4. Steam and condensate distribution must be designed as “three-pipe” system: steam delivery, pressurized condensate return, and pumped condensate return piping must be utilized. High-pressure condensate from main drip trap stations must not be returned to any pumped condensate piping. If installation of a high-pressure condensate line is not feasible, discharge from steam trap stations should be piped to the nearest building flash tank/condensate receiver.
5. Where steam and condensate piping are run in accessible tunnels, pipe insulation to be flexible aerogel type 3, grade 1 blanketing with aluminum jacketing. Non-ferrous wire or straps should be used to secure jacketing.
6. Where steam and condensate piping are direct-buried, piping must be of pre-insulated, three-layer piping system. System must include a carrier pipe, steel conduit, and impermeable outer membrane. Designer should select insulation layers appropriate to the project. Thermacor Duo-Therm “505” or equivalent is acceptable.
7. Steam piping to be Schedule 40 carbon (black) steel, ASTM A106, all welded construction. 300-pound rated fittings to be used throughout.
8. Condensate piping to be Schedule 80 carbon (black) steel, ASTM A106, all welded construction. Schedule 80 fittings to be used throughout.
9. Where possible, all steam and condensate piping should be installed in a manner that allows gravity return of condensate.
10. Acceptable methods of pipe thermal expansion compensation are U-bend “expansion loops” and metal bellows-type mechanical expansion joints. No other methods should be used.
11. Condensate collection pockets (“drip legs”) should be placed in steam piping at intervals no greater than 300 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-inches in diameter, but not less than 6 inches in diameter. Drip legs should be 12-18 inches long (unless space

conditions prohibit), and should include steam trap stations. Drip legs and steam trap stations must be accessible via manhole.

12. All take-offs intended as a future connection(s) shall be equipped with isolation valves and terminated with caps. A spool piece equipped with a 3/4" blowdown valve shall be installed between the isolation valve and cap in the spool piece.

#### D. Valves

1. Isolation valves shall be gate valves constructed from cast or wrought steel. Internal trim must be stainless steel. Triple offset high performance butterfly valves may be used where space is limited however will be approved on a case by case basis by system owner. In cases where triple offset high performance butterfly valves are used. Triple offset high performance butterfly valves must be capable of bi-directional flow and zero bubble per minute shut off.
2. All steam and condensate distribution isolation valves shall be butt welded or socket welded construction. First valve take-off from a main shall be located as close to the main as possible and be located preferably in the horizontal orientation. Drain valves shall be installed where piping slopes to the valve to aid in removal of collected condensate during shut downs.
3. Drain valves shall be ANSI Class 800, carbon steel, socket weld connection. Drains shall terminate with caps on end. Drain piping shall be positioned to discharge directly on the floor (should not drain on any piping, valves, equipment, etc.).

#### E. Steam Traps

1. All steam traps must be installed with upstream isolation valve and strainer with blowdown valve, downstream spring assisted in-line check and isolation valves, and unions on either side of the trap. Refer to Duke Standard Connections Detail for more details.
2. Steam trap preferences for high pressure distribution lines are as follows:
  - a. First choice – Inverted-bucket traps
  - b. Second choice – Thermodynamic (TD) traps.
  - c. Third choice – should Duke ever require any high-pressure process equipment where steam/condensate is automatically controlled, float and thermostatic type traps should be used.

#### F. Manholes

1. Manholes must be at least 8 feet long, by 8 feet wide, by 8 feet tall in dimensions. Size must increase as required to allow adequate clearance around pipes, valves,

- equipment, etc. Manholes must be pour-in-place concrete, with waterproofed base slab and water seal at the key joint. Precast manholes are acceptable where necessary and require approval by DUES. Each manhole must have at least two openings, diagonally opposed. Where possible, manholes should be located to provide easy access from roads and sidewalks. Placement of manholes in delicate landscapes and extensive hardscapes should be avoided where possible.
2. Manholes must have a minimum 30-inch by 30-inch x 30-inch sump. Sump should drain by gravity to storm sewer system and be equipped with a back water valve to prevent backflow into manhole. Flood rim of storm structure outfall shall be evaluated prior to designing for gravity system. Sump placement shall be offset from MH ladders not directly under MH opening (refer to Duke Steam Vault Detail found in A33 63 00 for additional details). Ductile iron drainage pipe should be used for gravity drains. Where gravity drainage is not feasible, a high temperature sump pump shall be installed (refer Pumps and Pumping Systems in the Duke Design Guidelines for materials of construction and ratings). Sump pump discharge shall be 2" type K copper pipe inside vault and 4" ductile iron outside vault to storm sewer system.
  3. Manholes must be provided with a welded steel ladder for entry and exit, anchored to the top, bottom, and side faces of the interior space. Ladders shall be located at each access point. Ladder steps shall not be welded to the side flat bar, but shall continue through the side flat bar and be welded on each side of the flat bar.
  4. Two access points are required for each manhole. Access points shall be 36 inch and 24 inch in diameter and shall be preferably located diagonally across from each other. The 36 & 24 inch manhole cover shall be carbon fiber lockable covers with a minimum HS20 load rating. Fiber lids shall be reviewed and approved by DUES prior to construction. The lid shall include permanent engraving of the MH number and shall have STEAM identified on the lid. Manhole numbering shall be provided by DUES personnel.

#### G. Flushing & Testing

1. All field and shop welded piping for both steam and condensate shall be 100% radiograph tested by an approved third party testing agency. Welds shall be inspected in accordance with ASME B31.1 Power Piping code requirements.
2. 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 more welding on the job. Any failed weld shall be retested by radiograph at the contractor's expense.
3. Hydrostatic testing is not required on steam or condensate piping but may be performed at the contractor's discretion and expense. Condensate piping shall be

flushed with water prior to energizing. All direct buried steam piping shall be blown down with steam for final flushing. Contractors shall make provisions for blowing down steam system and shall include installing temporary piping to blowdown to atmosphere, vent silencers, etc. Temporary piping shall be steel and can be threaded. All blowdown procedures must be approved at least 2 weeks prior to performing blowdown with DUES. A blowdown will not be scheduled until project including a final inspection is performed.

#### 4. Documentation and Review Requirements

- A. Analysis of the steam distribution system 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. Designers should show calculations for pipe fluid velocities, thermal stress and expansion, heat energy losses and insulation selection.

#### 5. Installation and Performance Requirements

- A. Confirm installation responsibilities at out-set of project. Installation services will be provided in-house or contracted out.
- B. Coordinate all required tie-in points with DUES.
- C. Coordinate all commissioning efforts with DUES.