DESIGN GUIDELINE 5.9
TUNNELS

General

The University of Michigan central campus has an extensive array of tunnels used for distribution of utilities, primarily from the Central Power Plant. This section identifies key design considerations for tunnel related projects.

All work in or near tunnels must be coordinated with the Utilities and Plant Engineering (UPE) – Tunnels Department, in conjunction with the U-M Design Manager.

All tunnel related projects shall be designed with the long-term serviceability and maintainability in mind.

Phasing and sequencing is a primary consideration for virtually all tunnel projects, due to the fact that systems operate year-round and disruption to utilities directly impacts U-M's core mission. Proposed design alternatives should consider phasing and sequencing to minimize near and long-term interruption of utilities. Construction documents must clearly define phasing and sequencing requirements. Designs must incorporate all necessary work (valves etc.) to achieve this plan.

Related Sections

Special Instructions to Designers:

4.6 – University Provided Utilities

Design Guideline Technical Requirements:
6.0 DG013639 – Tree Preservation
6.0 DG312500 – Soil Erosion and Sedimentation Control
6.0 DG221113 – Basic Piping Materials and Methods
6.0 DG260533 – Basic Electrical Materials and Methods
6.0 DG265100 – Indoor Lighting Systems

U-M Master Specifications:
7.0 MS221113 – Basic Piping Materials and Methods
7.0 MS220523 – Valves
7.0 MS220516 – Pipe Expansion Joints
7.0 MS220719 – Mechanical Insulation
7.0 MS232216 – Steam and Condensate Piping Systems and Specialties
7.0 MS260533 – Basic Electrical Materials and Methods

Tunnel Types

Standard Utility Tunnel: Most of the tunnel system consists of racked utility piping on one side and a walkway on the other. Some include piping on both sides. Construction of existing tunnels includes poured concrete, pre-cast concrete, and brick. Typical dimensions are

approximately 7 feet wide x 7 feet high, although size must be assessed on a project specific basis. Tunnel should be walkable, and allow for removal and replacement of valves, expansion joints etc. Tunnels are accessed through buildings or through sidewalk hatches.

Utility Tunnels Running Through Buildings: While most of the utility tunnel system is "outside", i.e., beyond the footprint of buildings, tunnel services continue through several buildings on campus. Special care is required in designing and installing these projects to ensure tunnel security is maintained, and to ensure piping is properly designed. Minimal connections should be made to the Utility main.

Box trench: Where cost of a standard tunnel cannot be justified, box trenches, and crawl trenches are occasionally used. Access and maintainability must be considered.

Direct Buried Piping Conduit Systems: Direct buried piping is used in some locations for utility piping. Use of a conduit system for utility piping must be approved by UPE.

Building (non-utility) Tunnel: Some buildings contain "non-utility" tunnels that fall within the footprint of a building and serve only the building it is under. Building tunnels should be treated the same as building mechanical rooms, and don't typically require coordination with the UPE-Tunnel department.

Tunnel Piping Utilities

The tunnel system was designed for the following piping utilities that emanate from the Central Power Plant: Low Pressure Steam, Medium Pressure Steam, Steam Condensate, Hot Water and Hot Water Return, and Compressed Air. These systems are operated and maintained by the UPE – Tunnels department. While most pipe materials, and design considerations for these systems are described elsewhere in the U-M Design Guidelines (Technical Requirements 221113) and U-M Master Specification Sections 221113 and 220523, considerations unique to the application of these systems within the tunnel system are noted below each system, or in paragraphs that follow:

- Low Pressure Steam (LPS) – operating pressure of 6-12 psig
    - While normally saturated, due to the fact that LPS is a byproduct of the co-generation steam turbines, this system experiences occasional temperature excursions. Temperature of the steam can reach 600F if the desuperheater fails. As such, all LPS piping in the tunnels shall be designed for expansion associated with 600F piping. Cast iron fittings are prohibited.
    - U-M maintains a flow model for the LPS distribution, and as such, generally defines required pipe sizes for LPS piping in the tunnels.
    - Use float and thermostatic (F&T) traps on LPS. Do not connect LPC from traps directly to the tunnel LPC system. Use condensate return unit to pump into the LPC main.
- Medium Pressure Steam (MPS) – operating pressure of 60 psig nominally

- Pressure Reducing Valves are used in some locations from the MPS system to the LPS system, for back-up and pressure maintenance during peak conditions. Associated relief valves should be routed to a safe location outside the tunnel. Refer to DG 4.6 University Provided Utilities for additional discussion on requirements for PRV's and back-up steam.

- Steam Condensate Return (LPC)

  - The steam condensate is typically metered at individual buildings, and pumped into the LPC. While the system is under some backpressure at certain points, it is generally considered to be a low-pressure gravity return system.
    Do not directly connect LPC from building loads or drip and traps to LPC main. Use condensate return unit.

  - Drip and traps from MPS should not be routed directly to the LPC. Use flash tank and pumped condensate return unit.

  - Condensate return units (CRUs). A combination of electric and pressure powered CRUs are used in the tunnels.

- (Domestic) Hot Water (HW) and Hot Water Return (HWR)

  - Existing piping is primarily Type-L grooved copper piping using Victaulic fittings. U-M has an ongoing program to replace remaining steel piping with copper. Unless directed otherwise, use grooved copper piping for all DHW and DHWR in tunnels.

  - U-M has experienced numerous problems with expansion joints in HW and HWR systems. Refer to U-M Master Specification 220516 Expansion Joints for current specification requirements.

  - All flexible piping on HW and HWR shall be of all stainless steel construction. Ball valves on HW and HWR shall have stainless steel body and ball.

  - Because of hydraulic and maintenance problems within the DHWR system, all new buildings are required to have their own internal DHWR system, typically with a small shell and tube heat exchanger and pump to reheat the DHWR back to 125F. For existing building connections, where practical, connections to the tunnel DHWR system should be eliminated, and replaced with an internal return system.

- Compressed Air (CA) – operating at 90-100 psig (refer to DG 4.6 for clarification)

  - For building take-off, include two check valves installed in series to protect tunnel piping from possible contamination, and to protect the building compressed air loads from sudden loss of pressure if

compressed air is turned off.

Other Piping Considerations

Piping Expansion and Stress Analysis:
For new connections to tunnel piping, analyze piping expansion and stress, and anchoring forces up to and including first anchor on either side of new connection. Provide pipe stress calculations to prove new and existing piping is not overstressed.

Three Valve Arrangements for Building Take-Offs:
In general, branch take-offs for individual buildings should include a three valve arrangement, to allow the building to be fed from either direction in the utility loop.

B31.1 Requirements:
Refer to Master Specification Sections 221113 Basic Piping Materials and Methods and 232216 Steam and Condensate Piping Systems & Specialties for B31.1 welding requirements on utility piping.

Insulation:

- Aluminum jacketing is required on all insulated LPS, LPC and MPS piping in tunnels. Refer to Master Specification Section 220719 Mechanical Insulation for materials and required thickness.

Other Piping and Utilities in Tunnels

The following services are not considered Utility Piping. Coordinate with UPE-Tunnels prior to routing these systems through tunnels.

Chilled Water (CHW): Chilled water is not generally distributed via the tunnel system, although CHW piping is routed between buildings, through the tunnels in several areas. Additional insulation will be required within the tunnel.

Fire Protection Water: In some locations, fire protection piping may be routed through the tunnels, especially where a fire pump is shared between buildings.

City Water, Sanitary, and Storm: Beyond the building footprint, these services are generally owned and maintained by the City of Ann Arbor, and should not be routed through the tunnels without approval by the City and UPE-Tunnels. Coordinate modifications to these services through the City of Ann Arbor, UPO-Civil department and U-M Design Manager.

Architectural and Structural Requirements and Considerations

Load bearing capacity:
Tunnels shall be designed for H-20 (Highway) loading. In general, wall and roof sections should be a minimum of 8" thick reinforced concrete. Some older sections of the tunnel system do not meet this loading requirement and may need shoring where heavy loads must cross the tunnel. Confirm structural design requirements with U-M Design Manager.

Vaults:
Vaults are required in many areas at key junctions in the tunnel piping. Vault shall be designed to accommodate installation and maintenance of intersecting pipes, including flash tanks, condensate return units, etc. Provide a sump and simplex, high temperature sump pump at low point of each vault.

Waterproofing:
Top and sides of tunnels should include waterproofing, typically membrane type. Coordinate with U-M Design Manager for waterproofing requirements.

Separation between Buildings and Tunnels:
Appropriate separation is required between buildings and tunnels. At a minimum, a lockable door is required at the tunnel (using U-M standard core). Fire rated separation is not typically required. Confirm separation requirements with U-M Design Manager.

Hatches:
Hatches are often required to maintain reasonable access to sections of the tunnel system. Location of hatches must be carefully coordinated with U-M Design Manager and UPE-Tunnels. In general, hatches must be designed to allow installation of 20 foot long pipe sections. All sidewalk or grade level exits will be equipped with a crash bar type opening mechanism and sufficient lifting assistance mechanisms to allow a worker in a diminished physical state to fully open the hatch with one hand. Include steel ladder at each hatch. Refer to Master Specification Section 05500 – Metal Fabrication.

General Requirements and Design Considerations

Coordination with City of Ann Arbor:
Work on tunnels is often affected by City of Ann Arbor requirements associated with right of ways, street closings and paving, etc. Review proposed concepts and issues with the City of Ann Arbor in early stages of design. Coordinate all contact with the City through the UPO – Civil department, and U-M Design Manager.

Coordination with UPO-Civil:
Coordinate soil erosion control, tree protection, and staging through the UPO-Civil department and U-M OSEH department, in conjunction with the U-M Design Manager.

Confined Space:
Portions of the tunnel system are considered “confined space”, and are therefore subject to associated U-M OSEH requirements.

Field Surveys:
Design must be based on actual field surveyed conditions. U-M has extensive records on modifications made in the tunnels. However, design must be validated by field inspection prior to release of construction documents.

Mechanical Requirements and Considerations

Ventilation:
Consider need for ventilation on all tunnel projects. Confirm ventilation needs with U-M

Design Manager and Utilities. Tunnels are ventilated primarily with outside air, through the use of supply and/or exhaust fans. Kiosks are used extensively to house ventilation intake and relief. In some areas of campus, a more aesthetically sensitive alternative may be necessary. Design ventilation system to maintain ambient plus 10F during the summer.

Water Detection:
U-M is concerned about rapid detection and response to water leaks in the tunnel system, and has installed water sensors at several system low points. Confirm water detection requirements during design. Typically, install a water sensor at low point in any new tunnel section if any point in the new tunnel section is lower than the connection point to the existing tunnel. Water sensors should be connected to the Building Automation System.

Drains:
Tunnel system does not typically include floor drains, footing drains or sumps at regular intervals. However, a sump with a simplex high temperature sump pump should be installed at vaults and building entrances.

Electrical Requirements and Considerations

Lighting:
Lighting shall be designed to maintain a minimum light level of 25 FC at the walk surface. Fixtures shall be 24 watt minimum, compact fluorescent type, with globe glass and guard. Lighting should be controlled by 20 amp manual dial timer (12-hour) located at tunnel entrances, and at intervals of 200 feet.

Electrical Receptacles:
Duplex Receptacles are typically required throughout the tunnel system. Receptacles shall be 20 amp GFCI type with waterproof covers. They shall be installed at each tunnel entrance, and at intervals of 300 feet throughout the tunnel.

Cable Trays:
All tunnels shall include an aluminum ladder-type cable tray for future use for ITCom, and other services. Tray should be approximately 12” wide x 4” deep, with 9” rung spacing and 12” minimum bending radius, unless project specific requirements are higher. Tray should be located just outside the piping supports, near the ceiling.

Conduit:
Conduit in Utility tunnels, and box trenches shall be fiberglass-reinforced epoxy, or Schedule 80 PVC, with matching fittings. Provide expansion joints every 100 feet and on both sides of every change in direction. In utility tunnels that are completely dry, consult U-M Design Manager as to whether rigid galvanized steel conduit may be specified instead. Building tunnels may use EMT conduit.

Fire and Smoke Detection and Alarm:

The Utility Tunnel system does not typically require a fire alarm system or notification appliances.