

DEPARTMENT OF VETERANS AFFAIRS  
DESIGN INSTRUCTIONS TO ARCHITECTS AND ENGINEERS

LOCATION :  
PROJECT TITLE :  
PROJECT NO. :

☐ SCHEMATICS

☐ DESIGN  
DEVELOPMENT

☐ CONSTRUCTION  
DOMUMENTS

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STEAM GENERATION/DISTRIBUTION

OUTSIDE STEAM DISTRIBUTION SYSTEMS DESIGN MANUAL  
(May 2006)

FROM:

DATE:

Package Preparer:

Telephone Number:

**OUTSIDE STEAM DISTRIBUTION SYSTEMS DESIGN MANUAL**  
**DEPARTMENT OF VETERANS AFFAIRS**

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**OUTSIDE STEAM DISTRIBUTION SYSTEMS DESIGN MANUAL  
DEPARTMENT OF VETERANS AFFAIRS**

**1. CRITERIA UNIQUE TO VA:**

**1.1** Outside steam distribution work includes all steam supply and steam condensate lines located underground or aboveground outside of buildings.

**1.2** Outside steam distribution work shall only be indicated on "MS"-series drawings (see VA Design and Construction Procedure, "Drawings").

**1.2.1** "MS"-series drawings shall include symbols and schedules, details, plot plans and profiles with interference from other utilities located and identified, manhole plans and sections, tunnel and trench plans and sections, location of expansion loops and anchors, demolition plans, other work as necessary.

**1.2.2** Only symbols and abbreviations shown on VA National CAD Standards 15051-1,2,3 can be used on the drawings.

**1.2.3** Pipe sizes shall be indicated on plot plans and on manhole plans and sections.

**1.2.4** Equipment and piping systems shown on the drawings shall be generic and not the configuration of a particular manufacturer.

**1.3** Major options and alternatives must be evaluated utilizing the life cycle cost analysis methods of NIST Handbook 135 using discount factors from the current edition of the Annual Supplement to the Handbook.

**2. GENERAL:**

**2.1** Design the outside steam distribution systems to comply with this design manual, and the current editions of VA Design Guides, VA Design and Construction Procedures, and the VA Master Specifications. The design shall also comply with the provisions of the current edition of ASME B31.1 Code for Pressure Piping, Power Piping. If state or local codes are more stringent than the above requirements, discuss with the VA Contracting Officer.

**2.2** Show outside steam distribution plot plans on drawings using a minimum scale of 1:250 (1"= 20'). Manhole piping plans and sections shall be drawn with a minimum scale of 1:30 (3/8" = 1').

**2.2.1** Existing work shall be identified in a way which easily distinguishes this work from the new work. Points of connection between new and existing work shall be identified.

**2.3** The outside steam distribution systems must be designed to provide the required steam flow and pressure at the point of use. All condensate must be returned to the boiler plant except where the design of steam-using equipment prevents this or, for very small loads, when it is not economical.

**3. TYPES OF SYSTEMS:**

**3.1** Pre-Engineered, Factory-Fabricated, Direct Buried Distribution Systems: These are systems of various manufacturers which include the carrier pipes, pipe insulation, protective enclosures and accessories. The systems may be "drainable-dryable-testable" or "water-spread-limiting" as defined in the VA Master Specification. The "drainable-dryable-testable" system specified is an enhancement of the standard products of manufacturers. The enhancements include thicker casings, type and thickness of insulation, superior coating, thicker end plates, cathodic protection. These enhancements are based on studies and recommendations made under the auspices of the Federal Agency Committee on Underground Heat Distribution Systems. The "water-spread-limiting" system specified is one which, before acceptance on VA projects,

must have passed tests required by the current Unified Facilities Guide Specification, UF 02546. Currently, no system has passed these tests.

**Caution: The design of direct buried systems must adhere strictly to the VA Master Specification, Section 02710. Numerous failures of manufacturer's standard systems have been experienced.**

**3.2 Concrete Shallow Trench Distribution Systems:** These are field-built systems designed specifically for each project. The tops of the trench covers are slightly above grade and the trenches are sized only for pipe, insulation, and pipe supports with no provision for personnel access other than the removable covers. These systems can be applied only where site conditions (such as water table below maximum trench depth, lack of surface water, level or continuous grades) permit. Refer to Master Specification Section 02710, Appendix I for acceptable conditions for application of shallow trenches.

**3.3 Concrete Tunnel Systems:** These are field-built systems designed specifically for each project and are sized to permit personnel walk-thru. They can often be justified on the basis of life cycle costs when other utilities, such as chilled water, share the tunnel.

#### **4. SELECTION OF TYPE OF SYSTEM:**

**4.1** The design engineer shall select the type of system primarily based on a comparison of the life cycle costs of the types of systems.

**4.2** In making the selection, the engineer shall also consider the service record of existing types of systems at the site. Consideration shall be given to the extent of the new systems, the ability to combine various utility services into one trench or tunnel, and maintenance requirements.

**4.3** VA and DOD have experienced short service life with the direct buried systems. Constant supervision of the installation work is necessary to avoid damage to the protective coatings on the casings, to obtain sound welds of carrier pipes and casings, and to obtain proper installation of the cathodic protection system, including the dielectric connections at manholes and buildings. Because of this, the concrete shallow trenches are favored over direct buried systems in situations where concrete shallow trenches can be applied.

#### **5. SYSTEM DESIGN:**

##### **5.1 Steam Load Calculations:**

**5.1.1** Loads include HVAC, domestic hot water, kitchen, laundry, sterilizers, other process loads, and line losses.

**5.1.2** Load profiles must include diversity factors and credits for heat recovery systems which are in operation during the peak load conditions.

**5.1.3** Existing loads should be determined by reviewing boiler steam flow rate data for winter periods when the outside temperature approaches ASHRAE design conditions. Loads can be apportioned among separate buildings by analysis of major steam-using equipment and comparing building floor areas, whichever is most accurate.

**5.1.4** Consider future loads for new construction projects which are programmed.

##### **5.2 Steam Distribution Pressure:**

**5.2.1** Distribution should be at the boiler plant header pressure unless existing conditions make this impractical.

**5.2.2** It is recommended that existing pressures not be increased on existing distribution systems. Pressures on existing systems can be increased only if

a complete engineering analysis of the system is performed in regard to ability to accept increased thermal expansion, increased pressures and temperatures.

**5.3 Connecting to Existing Steam Distribution Systems:** Calculate steam flows and pressure drops on the portions of the existing system which are affected by the new steam loads. The new steam loads must not impose excessive pressure drops or velocities on the existing systems.

**5.4 Sloping and Dripping of Steam Lines:**

**5.4.1** Steam lines shall pitch down 50 mm in 12 meters (two inches in 40 feet) in the direction of flow. Provide drip pockets and steam traps at all risers and immediately ahead of all isolation valves that would collect condensate if the valves are closed. Distance between drip pockets shall not exceed 150 meters (500 feet) and should be less if possible. Locate all drip pockets and steam traps in manholes or buildings. Provide oversized drip pockets (refer to standard detail). Steam drip traps should discharge into a drip return line which is separate from other types of condensate return lines such as pumped returns and vacuum returns.

**Caution: Water hammer is dangerous and must be prevented. It can occur when condensate is not properly removed from steam lines. Steam lines must be properly sloped and drained.**

**5.4.2** Steam traps for steam line drip service must handle normal steady state radiation and convection heat loss condensate and also high levels of condensate and air flow when the steam line is being warmed-up. The preferred trap type is the inverted bucket type with thermal vent (for air release on warm-up) in the bucket. This type is resistant to water hammer and wire drawing of the valve and seat. Caution must be exercised when sizing the traps because oversized traps can "blow-through" (fail open) and lose their prime.

**Caution: Fixed orifice steam traps with no operating mechanism should not be applied on steam line drip service. VA experience is that the small diameter orifices become plugged with dirt and the trap fails closed. This will cause build-up of condensate in the steam main and dangerous water hammer may occur.**

**5.5 Condensate Return:** Generally, all condensate should be collected at condensate return pump sets and then be pumped to the boiler plant. Exceptions include existing systems being replaced which have other types of condensate returns such as vacuum or gravity. Also drip returns from the steam line drip traps may be returned directly to the boiler plant if practical.

**5.6 Thermal Expansion:**

**5.6.1** Locate and design the anchors and the expansion joints, bends and loops so that piping will not be overstressed. The locations must be shown. Sizes of bends and loops need not be shown on direct buried systems because the system manufacturer is responsible for loop and bend sizing. Expansion loops should be used instead of expansion joints whenever possible. This is because expansion joints can fail.

**5.6.2** Pipe anchors should be provided within 0.6 to 1.5 meters (two to five feet) outside of manhole walls to minimize pipe movement through the manhole. For piping which passes through the manhole, do not anchor on both sides of the manhole unless the piping within the manhole has sufficient offset to avoid overstress. Thermal expansion stress calculations must always be conducted to ensure proper anchor locations throughout the system. Those calculations must also account for the pipe expansion in the manholes.

**5.6.3** All anchoring and expansion joints, bends and loops must be completely designed and specified in the contract documents except for anchors and

expansion loops and bends being furnished as part of a direct buried system. These are the responsibility of the manufacturer of the direct buried system to design.

**5.6.4** Design steam systems for boiler plant header pressure and temperature (930 kPa, 181 °C)(135 PSI, 358 °F) minimum, and design condensate systems for 207 kPa, 135 °C (30 PSI, 275 °F). Pipe stresses must not exceed allowable stresses calculated in accordance with ASME B31.1, ASME Code for Pressure Piping, Power Piping.

**5.7** Fiberglas Reinforced Plastic (FRP) Pipe for Condensate: This not permitted.

#### **5.8 Manholes:**

**5.8.1** In direct buried systems and in concrete trench systems all devices requiring access for operation and maintenance shall be located in manholes. These devices include valves, steam traps, expansion joints, flanged and threaded joints, unions.

**5.8.2** Manholes shall be reinforced concrete. Prefabricated manholes are not permitted because of the difficulty of properly locating underground pipe openings in the manhole walls. Concrete floor slabs shall be of sufficient weight to prevent floatation in high water table areas.

**5.8.3** Do not locate manholes in roads or parking areas because of access and ventilation problems.

**5.8.4** Manhole structure and mechanical layout shall be completely designed by the A/E. Allow adequate working space and headroom.

**5.8.5** Provide two separate entrances from grade with full-size manhole covers. One shall be for access with grab-bars set in the manhole wall, the other shall be for ventilation while working in the manhole. Locate the ventilation access directly above the sump.

**5.8.6** Provide 600 mm (24 inch) square by 600 mm (24 inch) deep sump in floor and provide duplex submersible sump pumps. Where feasible, provide gravity drainage to a storm sewer.

**5.8.7** The engineer must review the "confined space" regulations of the facility and design the manholes to allow maximum possible access convenience. The designs must be reviewed by the appropriate facility officials regarding these regulations. A possible design feature to ease the "confined space" limitations could be the use of sidewalk-type access doors instead of manhole covers.

**5.8.8** Show all pipe supports. Completely design all pipe anchors to withstand the applied forces.

**5.8.9** Place waterproof membranes in or below the concrete bottom slabs and continue them up the outer sides to the top of the sidewalls.

**5.8.10** Provide ventilation pipes through the top of the manhole.

#### **5.9 Site Investigations:**

**5.9.1** The design engineer must determine the most economical and practical locations for the system and accessories. In addition, the determination of soil conditions is necessary when direct buried systems are selected.

**5.9.2** It will be necessary to perform:

**5.9.2.1** Land surveys to determine routing and grades and location of interferences.

**5.9.2.2** Testing to determine water table depth and, if direct buried systems are applied, soil corrosiveness, soil type, moisture content, and pH. This must be performed by a professional geotechnical engineer. Test samples should be taken every 30 meters (100 feet) (minimum) along the routes of the systems.

**5.9.2.3** Review "as-built" drawings and interview VAMC maintenance personnel to locate underground interferences.

**5.9.3** Field work by the A/E or his consultant must be administered under the terms of the contract between VA and the A/E.

#### **5.10 Design of Direct Buried Systems:**

**5.10.1** The manufacturer is responsible for the design of the system within the parameters of the VA specification. This responsibility includes insulation types, pipe guides and anchors, end seals, corrosion protection, expansion bends and loops, and carrier pipes. The A/E is responsible for all other aspects of the design including manhole structure and piping, system locations, profiles, pipe sizing, anchor location. The contract drawings should include no details of the elements of the system for which the manufacturer is responsible.

**5.10.2** The condensate return piping shall not be included in the same conduit as the steam piping. This will prevent condensate piping failures from affecting the steam piping. Typically, condensate pipes have a much higher failure rate than the steam pipes due to the acid corrosion that can occur if water treatment is not correctly applied.

**5.10.3** Depth of burial of the systems shall be 0.6 to 1.5 meters (two to five feet) to top of conduit casing.

**5.10.4** The A/E is completely responsible for the manhole design including manhole structure, ventilation and piping.

#### **5.11 Design of Concrete Shallow Trench Systems:**

**5.11.1** The A/E is completely responsible for the entire design including concrete trenches, pipe anchors, sizing of expansion loops and bends, sizes of expansion joints, pipe supports and guides, manhole structure and piping, system locations, profiles, pipe sizing.

#### **5.12 Design of Concrete Tunnel Systems:**

**5.12.1** The A/E is completely responsible for the entire design including concrete tunnel, pipe anchors, sizing of expansion loops and bends, sizes of expansion joints, pipe supports and guides, tunnel structure and piping, system locations, profiles, pipe sizing.

**5.12.2** The tunnel must include ample walking space with height for persons to stand erect, and drain system to handle ground water and piping leaks.

**5.12.3** Provide ample lighting and electrical receptacles designed for high temperatures.

**5.12.4** Provide ventilation systems to allow personnel to work safely.

#### **5.13 Design Notes:**

**5.13.1** Provide pressure gages at the outlet side of all main steam valves so that personnel can observe the gages while warming-up the steam line.

**5.13.2** Provide steam drip traps and manual drains on steam lines at all low points and upstream of all valves and pressure reducing stations. Spacing shall not exceed 150 meters (500 feet).

**5.13.3** Provide isolation valves (gate valves) on all branch connections to the main piping runs.

**6. INDEX OF OUTSIDE STEAM DISTRIBUTION NATIONAL CAD STANDARDS:**

DETAIL	DATE	TITLE
15051-1	03-06	General Information, Piping Symbols and Abbreviations
15051-2	03-06	Piping Symbols
15051-3	03-06	General Symbols and Abbreviations, Supports for Piping - Symbols and Abbreviations
15339-2	03-06	Steam Line Drip Pocket - Steam Trap Assembly
02710-1	03-06	Concrete Steam Manhole with Typical Piping

**7. INDEX OF OUTSIDE STEAM DISTRIBUTION MASTER SPECIFICATIONS:**

SECTION	DATE	TITLE
02710	06/04	Distribution and Transmission Systems (Steam)

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