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An American National Standard

Standard Practice for Underground Installation of Thermoplastic Pressure Piping[1]

This standard is issued under the fixed designation D2774; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

In general, thermoplastics pressure piping materials behave as ductile materials under load, meaning that they can undergo considerable deformation without damage. Piping made from such materials has the ability to bend under a load without breaking and to deform in other ways, while offering continued resistance. This flexibility allows ductile thermoplastic pipe to activate through pipe deformation lateral soil forces which create a pipe/soil system capable of safely supporting–even in pipes subject to little or no internal pressure–the earth and superimposed loads which are encountered in most pipe installations. However, proper installation techniques are required to ensure that the necessary support at the bottom and passive soil pressures at the sides of the pipe are developed and maintained.

Soils in which trenches are dug shall be examined and identified and the trenches prepared and backfilled in accordance with sound bedding procedures and this practice.

1. Scope*

1.1 This practice governs procedures and references ASTM specifications for underground installation of thermoplastic pressure piping, ~~63-in. (1372-mm)~~63 in. (1372 mm) nominal size and smaller. It is beyond the scope of this practice to describe these procedures in detail since it is recognized that significant differences exist in their implementation depending on kind and type of pipe material, pipe size and wall thickness, soil conditions, and the specific end use.

1.1.1 This practice assumes that over the range of anticipated operating conditions, including maximum external loading and minimum internal pressure, the soil/pipe system will offer sufficient structural stability to resist possible excessive diametrical deformation, or even collapse. In cases, particularly with large diameter thinner-walled pipe, for which the validity of this assumption may be in question, the selection of pipe and recommended installation conditions shall be determined by a qualified engineer.

1.1.2 Specific pipe characteristics and end-use requirements shall dictate addition to, or modification of the procedures stated or referenced herein.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in Sections 10 and 11.

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.61 on Water.

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***A Summary of Changes section appears at the end of this standard**

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1600 Terminology for Abbreviated Terms Relating to Plastics
D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
F412 Terminology Relating to Plastic Piping Systems
F1668 Guide for Construction Procedures for Buried Plastic Pipe

2.2 *AWWA Standard:*

C 651 Standard for Disinfecting Water Mains[3]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminology F412, unless otherwise specified. Abbreviated terms are in accordance with Terminology D1600. Installation terminology used in this practice is illustrated in Fig. 1.

3.1.2 The term pipe refers to both pipe and tubing, unless specifically stated otherwise.

3.1.3 *protective sleeve, n*—a short section of pipe installed over system piping where there is a transition from relatively rigid piping or structure to relatively flexible piping or structure to protect the transition region from excessive bending or shear stresses. For example, protective sleeves are installed at connections between plastic or non-plastic mains and plastic lateral branch or service lines (such as service or branch connections to tapping tees or saddles), where plastic pipe enters or exits a casing, or where plastic pipe penetrates a building or vault wall.

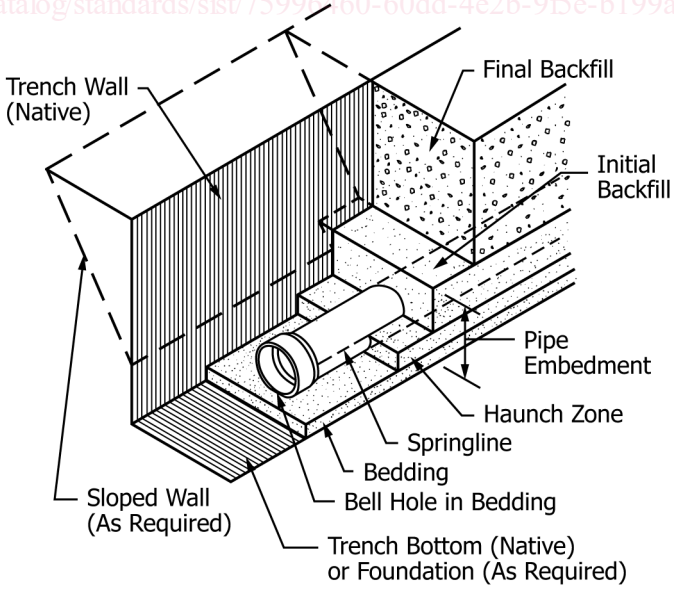

FIG. 1 Installation Terminology

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

4. Significance and Use

4.1 This practice may not apply to products which shall be subject to failure at relatively low strains. For low ductility materials, the installed pipe/soil system shall be sufficiently rigid to prevent pipe deformations which could strain the piping material beyond its safe strain limit.

5. Joining

5.1 Plastic pipe shall be joined together or to other pipes of dissimilar material using a number of different techniques. Commonly used procedures, joining materials, and fittings are defined by various standards. (See Appendix X1.) The technique used shall be suitable for the particular pipes being joined to one another. Manufacturers shall be consulted for specific instructions not covered by existing specifications. When requesting information, the intended service application shall be made known.

5.2 Skill and knowledge on the part of the installer are required using recommended techniques to obtain quality joints. Training of new installers shall be made under the guidance of skilled individuals. Detailed written procedures and visual aids used to train personnel are available from piping and joining equipment manufacturers.

5.3 The use of fittings and joining procedures which are not covered by a recognized standard is subject to the judgment and discretion of the purchaser. Each fitting and joining procedure used shall be qualified by investigation, testing, and experience to establish its suitability and safety for the intended service. Fittings and joints shall have long-term pressure capabilities equal to or greater than the system's maximum anticipated sustained operating pressure.

5.3.1 Thrust transmitting joints such as heat fused or solvent cemented, shall be capable of restraining maximum anticipated pipe pull-out forces generated by any unbalanced forces from internal pressure or pipe expansion/contraction, or both.

5.3.2 Gasketed and other non-thrust transmitting joints shall be restrained by means of properly engineered external restraints (thrust blocks) or joint restraint devices (see 7.3).

NOTE 1—Where there are unbalanced momentum forces and thrust is transmitted through the joints, consideration shall be given to the design capacity of each joint in the system to safely resist maximum anticipated axial thrust (see 7.3). Where a piping section having thrust transmitting joints is connected to a piping section having non-thrust transmitting joints, measures shall be taken to anchor or restrain the end of the thrust transmitting joint section against longitudinal movement so that contractive forces shall not be transmitted and cause disjoining of non-thrust transmitting joints.

6. Trenching-Recommended Installation Procedure

6.1 *Trench Stability*—During trench excavation, ensure that the trench sides shall be stable under all working conditions. The trench walls shall be sloped or appropriate supports provided to comply with all applicable local, state, and federal requirements for safety.

6.2 *Trench Width*—The width of the trench at any point below the top of the pipe shall be sufficient to provide adequate room for each of the following requirements: (*1*) joining the pipe in the trench if this is required; (*2*) snaking of small-diameter, heat fused or solvent cemented pipe from side-to-side along the bottom of the trench, when the effects of contraction are not otherwise accommodated; (*3*) filling and compacting the side fills; and (*4*) checking the elastomeric seal joints. Minimum trench widths shall be permitted to be utilized with most solvent-cemented and heat-fused pressure pipe materials by joining the pipe outside the trench and lowering the pipe into the trench after adequate joint strength has been attained (see 10.5). This practice shall be permitted to be used for gasket joint pipe, with manufacturers approval, providing care is taken to not disassemble the joints during lowering.

6.3 *Trench Bottom*—The trench bottom shall be prepared for the direct replacement of the pipe and shall be continuous, relatively smooth, free of rocks, and provide uniform support. For bell-ended or coupled pipe, suitable "bell-holes" shall be provided at each joint to permit the joint to be assembled and the pipe to be supported properly.

6.3.1 Where ledge rock, hardpan, or boulders are encountered, it shall be required to pad the trench bottom with a bedding of at least 4-in. (100-mm) thickness of compacted Class I or II material (see Table 1). In situations where rapid movement of water takes place through this bedding, the Class I or II material used shall have gradation that prevents loss by migration of any pipe embedment material (see 9.8).

TABLE 1 Soil Classes[A]

Class I	crushed rock[B,C] 100% passing 1-½-in sieve[D] , ≤ 15% passing #4 sieve, ≤ 25% passing ⅜-in sieve, ≤ 12% passing #200 sieve	
Class II	clean, coarse grained soils[E] or any soil beginning with one of these symbols (can contain fines up to 12%) uniform fine sands (SP) with more than 50% passing a #100 sieve should be treated as Class III material	**GW, GP, SW, SP**
Class III	coarse grained soils with fines or any soil beginning with one of these symbols sandy or gravelly fine grained soils or any soil beginning with one of these symbols with ≥ 30% retained on #200 sieve	**GM, GC, SM, SC** **ML, CL**
Class IV	fine-grained soils or any soil beginning with one of these symbols with ≤ 30% retained on #200 sieve	**ML, CL**
Class V	fine-grained soils, organic soils high compressibility silts and clays, organic soil	**MH, CH, OL, OH, Pt**

[A]Soil classification descriptions and symbols are in accordance with Practice D2487 and D2488.
[B]For Class I, all particle faces shall be fractured.
[C]See section 9.6 for additional restrictions on Class 1 material maximum particle size.
[D]Sieves and sieve cloths shall be in accordance with Specification E11.
[E]Materials such as broken coral, shells, slag, and recycled concrete (with less than 12% passing a No 200 sieve) should be treated as Class II soils.

6.4 *Trench Depth and Pipe Cover*—Excavation for pipe trenches shall be to the lines, grades, and dimensions shown on the contract drawings. Sufficient cover shall be maintained to adequately reduce the traffic or other concentrated and impact loads.

6.4.1 Reliability and safety of service shall assume major importance in determining minimum cover for any intended service. Local, state, or federal codes shall also govern. Pipe intended for winter water service shall have a minimum cover equal to or greater than the maximum expected frost penetration depth.

6.4.2 A minimum cover of 24 in. (610 mm) for pipe shall be required when subjected to heavy overhead traffic. In areas of light overhead traffic a minimum cover of 12 to 18 in. (305 to 457 mm) is required.

6.5 *"Trenchless" Installation*—Some types of thermoplastic pressure pipe shall be permitted to be installed using methods that do not require excavation.

7. Pipe Placement

7.1 *Pipe Joint Assembly*—Pipe assembly shall be conducted in accordance with the manufacturer's published recommendations. Above ground joining of pipe joined by solvent cementing, heat fusion or some other thrust transmitting connection shall be permitted. After the joint is appropriately "cured" (see Section 10) the pipe is lowered into the trench. This practice shall be permitted to be used for gasket joint pipe, with manufacturers approval, providing care is taken to not disassemble the joints during lowering.

7.2 *Pipe Bending*—Assembled thermoplastic pipe may be bent longitudinally if the bending radius is within limits prescribed by the manufacturer. There shall be two limits, one for pipe without joints and the other for pipe sections with joints.

7.3 *Thrust Restraint*—When installing piping systems with joints that cannot transmit the anticipated maximum longitudinal thrust, thrust restraint shall be required at changes in direction, or terminal ends, to prevent joint disengagement.

7.3.1 Where the piping system employs non-self restraining joints (for example, elastomeric seal bell and spigot type joints) at

points where line shift or joint separation at system operating pressure can be anticipated, that is, pump discharge, directional changes, reducers and dead ends, thrust restraint shall be required to prevent joint disengagement and ensure the proper performance of the pressure piping system.

7.3.2 Where the piping system employs self-restraining joints (for example flanges, heat fusion, mechanical joint restraint or solvent cement joints) at these points in the system, thrust blocking shall not be required for thrust restraint.

7.4 *Thrust Restraint Methods*—Thrust restraint shall be achieved by use of mechanical thrust restraint devices or by use of concrete thrust blocking.

7.4.1 *Mechanical Thrust Restraint Devices:*

7.4.1.1 Devices used for thrust restraint of PVC pipe shall conform to Standard F1674.

7.4.1.2 Consult device manufacturer for design assistance.

7.4.2 *Cast In Place Concrete Thrust Block Construction:*

7.4.2.1 The thrust block shall be constructed of cast in place concrete having a compression strength of 2000 psi (14 MPa) or more. Precast concrete blocking, wood blocking, or stone blocking with wood wedges, are not acceptable.

7.4.2.2 The thrust block acts as an anchor between pipe or fitting and the solid trench wall. The size of the thrust block shall be adequate to prevent pipe movement at the point of thrust. Consult the system designer.

7.4.2.3 The thrust block cavity shall be hand dug into undisturbed soil and framed, with soil or wood to hold freshly poured concrete. The earth bearing surfaces shall be undisturbed.

7.4.2.4 Before pressurizing the line, adequate time shall be required for the concrete thrust blocks to gain sufficient strength.

7.4.2.5 Precast concrete thrust blocks shall not be used in direct contact with thermoplastic fittings for buried pressure piping systems.

7.5 *Protecting Transition Regions*—A transition region between relatively rigid piping or structures and relatively flexible piping is subject to intensified localized bending or shear stresses, especially during soil consolidation after initial installation. In these transition regions, plastic pipe is protected against excessive stresses with a protective sleeve and stable bedding and backfill, or with stable bedding and backfill. The preferred practice is the combination of a protective sleeve and stable bedding and backfill.

7.5.1 Protective sleeves are usually plastic tubes, either extruded for the purpose or cut from lengths of plastic pipe, but they shall be permitted to be any material of sufficient strength and durability. Protective sleeves extend from rigid piping of structure across the transition region and along the plastic pipe for a length that ensures that plastic pipe at the transition region is not subject to excessive stress. The protective sleeve is appropriately secured to remain in place during backfilling. Where plastic piping penetrates a building or a vault wall, one end of the protective sleeve shall be embedded in the wall.

7.5.2 The diameter, wall thickness and length of the protective sleeve provide greater bending and shear resistance than the plastic pipe it protects. The inside diameter of the protective sleeve has minimal clearance to the plastic pipe or the connection (including any protective coating over the connection). The wall thickness of the protective sleeve shall be adequate to protect against shear and bending The protective sleeve is of sufficient length (typically 12 in. (305 mm) or longer) to cover the transition region, and extend such that the opposite end rests on undisturbed foundation soil or stable bedding soil beneath the plastic pipe. Additional information is available from manufacturers.

7.5.3 A protective sleeve shall be permitted to be split longitudinally for installation purposes, provided it is designed for long term structural integrity as a longitudinally split protective sleeve and includes external reinforcement such as stainless steel band clamps.

7.5.4 Whether a protective sleeve is installed or not, all transition regions are fully encapsulated with stable, compacted embedment materials. Take extra care during bedding and backfilling to provide firm and uniform support for the plastic pipe and transition region. See Section 9.

7.6 *Service Connections:*

7.6.1 *General*—Service connections on thermoplastic pipe are made by means of a suitable saddle, tapped coupling, direct taps, or service connector. These shall be installed in accordance with the manufacturer's published recommendations.

7.6.2 *Live Tapping*—Service connections for tapping of pressurized lines are commercially available. Installation by the proposed trenchless methodology shall only be specified after consultation and approval of the piping manufacturer. The specific published manufacturer's recommendations for each design shall be followed when making a live tap.

7.6.3 *Bends in Service Pipe*—When establishing the location of the tap, consideration shall be given to minimizing service pipe bends near tap and house connections, since soil settlements at these points could result in excessive shear or pull-out loads. Bends in the service pipe shall not be closer than 10 pipe diameters from any fitting or valve. The pipe shall not be bent beyond the limits recommended by the manufacturer. In the case of coiled pipe, these limits are often more restrictive when bending the pipe against the natural curvature than with the curvature. Service pipe or tubing which becomes kinked during bending, handling, or installation shall not be used. Take care in locating pipe bends and in conducting backfill operations to ensure that kinking will not develop during or after installation.

7.6.4 *Service Connections*—Depending on the materials used and the recommendations of the pipe manufacturer, flare, insert, compression, solvent-cement, or heat-fusion type fittings shall be employed to connect service pipe or tubing to itself and to the corporation and curb stops. When compression fittings with an internal stiffener are used, select a type which will ensure that the internal stiffener will not move from its proper position prior to and during tightening. The stiffener shall be a continuous annular section (tube), snugly fit in the pipe, providing support in the entire area under the gasket and compression element. Each pipe connection shall use a separate stiffener. Precautions for precluding possible problems which could be occasioned by differential settlement of flexible pipe with more rigidly held connectors include the following:

7.6.4.1 Take extra care during bedding and backfilling to provide firm and uniform support for the pipe or tubing at the point of connection.

7.6.4.2 Consult the pipe and fitting supplier for application suitability and installation instructions.

7.6.4.3 Place a protective sleeve or shield (which can consist of a short section of plastic pipe split lengthwise) over the connection and short section of pipe if protection is needed against possible differential settlement.

8. Appurtenances

8.1 Valves, hydrants, fittings, and other appurtenances shall be provided and installed as shown on the contract drawings or specifications.

8.2 The weight of valves, hydrants, and fittings shall be separately supported and not be carried by the plastic pipe. The support shall also be designed to protect the plastic pipe against excessive torsional or other loads which may develop when the valves or hydrants are operated.

8.3 Valves, hydrants, and fittings shall be adequately anchored against movements in the axial direction when connected to pipe by a joint not designed to transmit axial thrust. When using such joints, consideration shall be given to the extent of pipe movement within the socket as a consequence of thermal expansion/contraction or axial thrust.

9. General Requirements for Bedding and Backfill

9.1 The pipe shall be uniformly and continuously supported over its entire length on firm stable material. Blocking shall not be used to change pipe grade or to intermittently support pipe across excavated sections.

9.2 Pipe shall be permitted to be installed in a wide range of native soils. The pipe embedment shall be stable and placed in such a manner as to evenly support and physically shield the pipe from damage. Attention shall be given to local pipe laying experience which shall indicate solutions to particular pipe bedding problems.

9.3 The pipe embedment materials shall be stable, sufficiently workable to be readily placed under the sides of the pipe to provide

satisfactory haunching, and readily compactable to achieve soil densities specified by contract documents. The embedment shall be either Class I, II or III soils, as described in Table 1.

9.4 Initial backfill materials shall be placed in compacted layers.

9.5 All native and other materials in the pipe embedment zone shall be free from refuse, organic material, cobbles, boulders, large rocks or stones, or frozen soils.

9.6 The particle size of material in contact with the pipe shall not exceed the following: ½ in. for pipe to 4 in., ¾ in. for pipes 6 to 8 in.; 1 in. for pipes 10 to 16 in.; and 1½ in. for larger pipes. Each soil layer shall be sufficiently compacted to uniformly develop lateral passive soil forces during the backfill operation.

9.7 To minimize deformation of thinner-walled pressure pipelines, such as used in irrigation, the pipeline shall be first filled with water, all air removed, and kept full during the backfill operation.

NOTE 2—An identification system of soils based on visual examination and manual tests is given in Practices D2488.

9.8 When installing pipe in locations where rapid movement of ground water shall result in migration of soil fines into, out of, or between layers of the embedment material, the bedding and back fill shall be of such gradation in particle size as to preclude this possibility. Soil migration shall also be controlled by using an appropriate soil filter or a geotextile filter fabric between coarse embedment and fine soils.

9.9 Suggested procedures for placing and compacting the recommended soils are given in Section 14 of Guide F1668.

9.10 Uncompacted final backfill can be either Class I, Class II, Class III, Class IV, or Class V soil. If backfill is to be compacted, do not use Class V soils. The final backfill shall be placed and spread in approximately uniform layers in such a manner as to fill the trench completely so that there will be no unfilled spaces under or about rocks or lumps of earth in the backfill. Large rocks, stones, frozen clods, and other debris greater than 3 in. (76 mm) in diameter shall be removed. When compaction is required, rolling equipment or heavy tampers shall only be used to compact the final backfill, provided the pipe is covered by at least 18 in. of backfill. Trenches under pavements, sidewalks, or roads shall be backfilled and compacted to the required density specified by contract documents or by the appropriate government jurisdiction.

10. Installation Precautions

10.1 Plastic pipe shall be stored so as to prevent damage by crushing or piercing. If stored outdoors for a prolonged period the pipe shall require protection from weathering. Consult the manufacturer for recommendations. In warmer climates, the covering shall allow air circulation in and around the pipe.

10.2 Care shall be taken to protect the pipe from excessive heat or harmful chemicals. If used, cleaning solutions, detergents, solvents, etc., shall be used in accordance with the pipe manufacturer's recommendations.

10.3 For pipe joined with elastomeric seals (gaskets), protect gaskets from harmful substances such as dust and grit, solvents and petroleum-based greases and oils. Do not store gaskets close to electrical equipment that produces ozone. Some gaskets may need to be protected from sunlight.

10.4 Pipe joined by solvent cementing or heat fusion shall not be handled or installed in the trench until after the joints are sufficiently "cured" or cooled in accordance with the manufacturer's recommendations to prevent weakening the joint.

10.5 When installing pipe, avoid imposing strains that overstress or buckle the piping or impose excessive stress on the joints.

10.6 Provisions for pipe expansion and contraction shall be made with all thrust transmitting joint systems. When assembled outside the trench, the pipe shall be allowed to cool in the trench before backfilling to minimize stress due to thermal contraction.

10.7 Suitable anchoring methods shall be used to prevent excessive longitudinal or bending movement of the piping.