



Standard Specification for Flexible Pre-Insulated Plastic Piping¹

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INTRODUCTION

~~This specification covers materials and test methods for flexible, pre-insulated piping with non-bonded insulation. For the purpose of this standard, flexible pre-insulated piping shall refer to a piping system that is supplied complete with carrier pipe, thermal insulation, and outer jacket manufactured as an integrated system, and is supplied in a coil. This specification covers the requirements, material specifications, and test methods of piping systems intended to convey hot and cold fluids. Piping systems may include one or more carrier pipes within a common outer jacket.~~

1. Scope*

1.1 ~~This specification covers flexible, pre-insulated plastic piping systems commonly used to convey hot and cold fluids. fluids, including piping systems that are supplied complete with plastic carrier pipe, thermal insulation, and outer jacket manufactured as an integrated system, and are supplied in a coil or as a straight length. Both bonded and non-bonded insulation types are included. Included are requirements and test methods for material, workmanship, dimensions, and endseal testing. Requirements for markings are also given. The components covered by this specification are intended for use in, but not limited to, residential and commercial, hot- and cold-potable water distribution systems, reclaimed water, fire protection, municipal water service lines, radiant heating and cooling systems, hydronic distribution systems, snow and ice melting systems, geothermal ground loops, district heating, turf conditioning, compressed air distribution and building services pipe, provided that the carrier pipe or tubing covered herein complies with applicable code requirements.~~

~~1.2 This specification establishes materials and performance requirements for flexible, pre-insulated piping intended for hot and chilled water applications:~~

1.2 Piping systems may include one or more carrier pipes within a common outer jacket.

1.3 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered part of this standard.

NOTE 1—Pre-insulated pipes covered by this specification are typically installed underground in buried applications.

1.4 *Units*—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.

1.5 The following safety hazards caveat pertains to the test methods portion, Section 7, of this specification. *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 requirements/limitations prior to use.*

1.6 *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

C168 Terminology Relating to Thermal Insulation

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.11 on Composite. Current edition approved Nov. 1, 2013/Jan. 1, 2019. Published December 2013/January 2019. Originally approved in 2002. Last previous edition approved in 2008/2013 as F2165– 02(2008):13. DOI: 10.1520/F2165-13.10.1520/F2165-19.

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.

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

- [C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus](#)
- [D1600 Terminology for Abbreviated Terms Relating to Plastics](#)
- ~~[D2104](#)~~[D2122 Specification for Polyethylene \(PE\) Plastic Pipe, Schedule 40](#)[Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings](#) (~~Withdrawn 2010~~)
- [D2239 Specification for Polyethylene \(PE\) Plastic Pipe \(SIDR-PR\) Based on Controlled Inside Diameter](#)
- [D3035 Specification for Polyethylene \(PE\) Plastic Pipe \(DR-PR\) Based on Controlled Outside Diameter](#)
- [F412 Terminology Relating to Plastic Piping Systems](#)
- [F714 Specification for Polyethylene \(PE\) Plastic Pipe \(DR-PR\) Based on Outside Diameter](#)
- [F876 Specification for Crosslinked Polyethylene \(PEX\) Tubing](#)
- ~~[F877 Specification for Crosslinked Polyethylene \(PEX\) Hot- and Cold-Water Distribution Systems](#)~~
- [F1281 Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene \(PEX-AL-PEX\) Pressure Pipe](#)
- [F1282 Specification for Polyethylene/Aluminum/Polyethylene \(PE-AL-PE\) Composite Pressure Pipe](#)
- [F2389 Specification for Pressure-rated Polypropylene \(PP\) Piping Systems](#)
- [F2769 Specification for Polyethylene of Raised Temperature \(PE-RT\) Plastic Hot and Cold-Water Tubing and Distribution Systems](#)
- [F2788 Specification for Metric and Inch-sized Crosslinked Polyethylene \(PEX\) Pipe](#)
- [F3123 Specification for Metric Outside Diameter Polyethylene \(PE\) Plastic Pipe \(DR-PN\)](#)
- [F3253 Specification for Crosslinked Polyethylene \(PEX\) Tubing with Oxygen Barrier for Hot- and Cold-Water Hydronic Distribution Systems](#)
- 2.2 *NSF Standards:*³
- [NSF/ANSI 14 Plastics and Plumbing System Components](#)
- [NSF/ANSI 61 Drinking Water System Components—Health Effects](#)³
- 2.3 *DIN Standards:*⁴
- [DIN 8074 Polyethylene \(PE\) Pipes, PE 63, PE 80, PE-100, PE-HD—General Quality Requirements and Testing](#)
- [DIN 8075 Polyethylene \(PE\) Pipes, PE 63, PE 80, PE-100, PE-HD—Dimensions](#)
- [DIN 8077 Polypropylene \(PP\) pipes- PP-H, PP-B, PP-R, PP-RCT -Dimensions](#)
- [DIN 8078 Polypropylene \(PP\) pipes- PP-H, PP-B, PP-R, PP-RCT - General quality requirements and testing](#)
- [DIN 16892 Crosslinked Polyethylene Pipes—General Quality Requirements and Testing](#)
- [DIN 16893 Crosslinked Polyethylene Pipes—Dimensions](#)
- 2.4 *ISO Standard*⁵
- [ISO 15875 Plastic Piping Systems for Hot and Cold Water-Installations-Crosslinked Polyethylene \(PE-X\)](#)
- [ISO 22391-2 Plastic Piping Systems for Hot and Cold Water Installations -- Polyethylene of Raised Temperature Resistance \(PE-RT\)](#)

3. Terminology

3.1 Definitions are in accordance with Terminology [F412](#) for plastic piping systems and [C168](#) for thermal insulating materials; abbreviations are in accordance with Terminology [D1600](#) unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bonded insulation system, n*—a product that is the result of applying thermal insulation to a carrier pipe where a bond forms between the insulation and the carrier pipe that exceeds the modulus of elasticity of the carrier pipe.

3.2.2 *carrier pipe, n*—the pipe(s) that are used to convey the medium.

3.2.3 *compression fittings, n*—types of fittings for pipe or tubing, such as insert-type fittings that utilize a reinforcing insert which is inserted into the pipe or tubing and a ring or clamp that compresses the pipe or tubing over the insert, and cold-expansion fittings that require the expansion of the pipe or tubing prior to insertion of the reinforcing insert that is inserted into the pipe or tubing and a ring or clamp which compresses the pipe or tubing over the insert.

3.2.4 *crosslinked polyethylene (PEX) plastic, n*—a polyethylene material which has undergone a change in molecular structure using a chemical or a physical process whereby through processing whereby a majority of the polymer chains are chemically linked.[linked](#)

3.2.5 *end seal, n*—a device that provides a seal between the outer jacket and carrier pipe, providing a moisture barrier for the insulation.

3.2.6 *flexible pre-insulated pipe system, n*—a factory manufactured pre-insulated pipe system consisting of carrier pipe(s), thermal insulating material, and protective jacket. This product is supplied in coils.

³ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.

⁴ Available from Beuth Verlag GmbH (DIN-- DIN Deutsches Institut für Normung e.V.), Burggrafenstrasse 6, 10787, Berlin, Germany, <http://www.en.din.de>.

⁵ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

3.2.7 *jacket, n*—the outer covering of the flexible pre-insulated pipe system. The jacket provides mechanical and moisture protection for the insulation.

3.2.8 *non-bonded insulation system, n*—a product that is the result of applying thermal insulation to a carrier pipe without bonding the insulation to the carrier pipe, allowing the carrier pipe to move freely within the insulation.

3.2.9 *pipe joint, n*—a connection between two sections of piping material. The pipe joint shall include the connection of the carrier pipe, insulation of the bare section carrier pipe, and protective outer jacket.

3.2.10 *thermal insulation, n*—a general term used to describe any material that reduces heat transfer.

3.2.11 *ultraviolet (UV) stability, n*—the resistance to ultraviolet degradation of the jacket material.

4. Significance and Use

4.1 This specification establishes materials and performance requirements for flexible, pre-insulated plastic piping intended for hot and chilled waterfluid applications.

~~4.2 The bending force test ensures that the installer will obtain materials that will be suitable for installation as flexible piping.~~

5. Materials

5.1 *Carrier Pipe(s):*

5.1.1 PEX carrier pipe shall conform to one or more of the following: Specifications ~~F876, F877~~F2788, F3253; DIN 16892 ~~or~~ DIN 16893; ISO 15875.

5.1.2 PE carrier pipe shall conform to one or more of the following: Specifications ~~D2104, D2239, D3035, F714, F3123~~; DIN 8075 ~~or~~ DIN 8074.

5.1.3 ~~Composite carrier pipe shall conform to one or more of the following:~~ Specifications F1281 or F1282.

5.1.4 ~~PP carrier pipe shall conform to one or more of the following:~~ Specification F2389; DIN 8077 or DIN 8078.

5.1.5 ~~PE-RT carrier pipe shall conform to one or more of the following:~~ Specification F2769; ISO 22391-2.

5.1.6 Other piping materials as specified by customer specifications.

5.2 *Thermal Insulation:*

5.2.1 Insulation shall have a maximum thermal conductivity of 0.30 BTU·in./h·ft²·°F (0.04 W/(m·K) when measured in accordance with Test Method C177.

5.2.2 All seams of the ~~non-bonded insulation sheets shall be sealed permanently joined.~~

5.2.3 ~~Insulation~~ Non-bonded insulation shall be visually inspected for voids and other defects prior to the application of the jacket. Any voids or variance in thickness greater than 0.1 in. shall be reason for rejection. Manufacturer shall repair or replace defective insulation before product is shipped to the customer. Channels for heat trace, control wiring, or orientation markings are excluded from this requirement.

5.2.4 ~~Insulation shall not be bonded to the carrier pipe.~~

5.3 *Outer Jacket:*

5.3.1 The outer jacket shall be constructed of a ~~watertight, corrugated~~ watertight polyethylene material.

5.3.2 The outer jacket shall contain ~~2 weight percent~~ 2–3 % carbon black, finely divided and thoroughly dispersed to provide protection from UV degradation.

5.4 ~~Materials~~ Fittings to join sections of the carrier pipe or to transition the carrier pipe to other piping materials shall be supplied by the system supplier and shall be one of the following types:

5.4.1 Compression Fittings, ~~or~~ for PE, PP, PE-RT, PEX or composite pipe materials or

5.4.2 Heat-Fusion ~~Welding~~ Welding for PE, PP or PE-RT pipe materials.

5.4.3 Fitting materials shall meet the applicable requirements as described in relevant specifications.

5.5 The system supplier shall supply insulation and cover for any joints.

6. Requirements

6.1 ~~The system shall be supplied in coil form. Carrier pipe, thermal insulation, and protective-jacket material shall be continuous and uniform throughout the coil. Connections and joints in the carrier pipe and the protective jacket shall not be allowed within the coil throughout.~~

6.2 ~~End Seats:~~ Seals for Non-bonded Piping Materials:

6.2.1 End seals for non-bonded piping materials shall be installed at all terminal ends of each section of piping.

6.2.2 ~~End~~ When tested in accordance with 7.1, end seals shall be watertight after being subjected to an external-pressure equivalent to a 20 ft water column for 48 h, as described in h.7.1.

NOTE 2—~~Experience has shown that the oxygen barrier of PEX-Insulation materials used for non-bonded piping products utilize insulating foam material in the form of flat sheets, which are applied in layers, and may have the ability to absorb water into the insulation or allow water to pass between insulation layers, or both. A watertight end seal as defined in 6.2 piping systems can be damaged by excessive heat being applied to heat-shrink materials~~

during installation, is required to prevent infiltration of water into buried pipes and subsequent loss of insulating performance. Insulation materials used for bonded piping products are typically closed-cell expanding foam materials which inherently do not absorb water and are bonded to the jacket and carrier pipe(s). Therefore, requirements for end seals apply only to piping products that utilize nonbonded foam insulating materials.

6.3 Outer Jacket:

6.3.1 The outer jacket diameter shall be determined by measuring the outside diameter of the jacket, jacket in accordance with Test Method [D2122](#). In the case of a corrugated jacket, the outsidemaximum diameter of the corrugation shall be measured.

6.3.2 The outer jacket thickness shall be based on outer diameter of the jacket. Outer jacket thickness shall be as in [Table 1](#).

7. Test Methods

7.1 End Seal Testing—Testing for Non-bonded Piping Materials:

7.1.1 Testing samples shall be selected randomly from completed stock.

7.1.2 A section of pipe a minimum of 12 in. long shall be fitted with end seals on both ends.

7.1.3 A test fixture shall be prepared that allows for the test sample to be submerged in water, exposed to an external-pressure equivalent to a 20 ft water column.

7.1.4 Prior to test, testing sample with end seals installed shall be weighed and recorded.

7.1.5 Maintain the hydrostatic pressure for 48 h at $70^{\circ}\text{F}; 73 \pm 4^{\circ}\text{F}$ (23°C).

7.1.6 After 48 h, the pipe assembly shall be inspected for water infiltration. Any indications of water infiltration by 5 % or greater weight increase of the sample or by visual inspection shall be grounds for rejection.

7.2 Bending Force Test:

7.2.1 The flexible pre-insulated pipe system sample shall be selected randomly from completed stock in normal coil form.

7.2.2 Bend testing shall be carried out at $70 \pm 10^{\circ}\text{F}$.

7.2.3 Pipe sample shall be $15 \times$ jacket diameter in length.

7.2.4 The bend force test will be conducted by attaching the pipe sample to a rotating bending-mandrel that is part of a test fixture that also includes a roller guide, pulling cable, and load cell as shown in [Fig. 1](#). The mandrel is sized so that it will form the radius as required in [Table 2](#) or [Table 3](#). For piping systems with more than 2 carrier pipes in a common jacket, the bending radius shall be $6 \times$ the jacket diameter.

7.2.5 The sample shall be firmly attached to the rotating bending-mandrel with the end of the sample in direct contact with the mandrel.

7.2.6 The bending force required to bend the pipe sample 90° shall be measured. The pipe sample shall be bent against the natural curve the pipe develops from being stored in a coil. The pipe sample shall be tested within 1 h after being taken from the coil.

7.2.7 The bending radius shall be in accordance to [Table 2](#) or [Table 3](#).

7.2.8 The rotating mandrel shall include a cable tray that is the same radius as the rotating-bending-mandrel. The pulling cable shall be installed in the cable tray and attached to the mandrel. The cable is pulled by a winch, causing the rotating bending-mandrel to turn. The force required to bend the pipe sample shall be measured with “a calibrated load cell” installed in the pulling cable. The pulling cable shall not be attached directly to the pipe sample.

7.2.9 The load cell shall be calibrated and certified accurate to within 0.5 weight percent.

7.2.10 The pulling cable shall be pulled by a winch that is rated at a no-load cable speed of minimum 7.5 ft/min, and 4 ft/min at full load.

7.2.11 The force required to bend each carrier pipe and jacket size combination shall be tested, with the resulting force marked on the outer jacket.

7.2.12 *Jacket Inspection*—Any cracks or discoloration in the outer jacket shall be grounds for rejection.

8. Certification

8.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each product have been tested and inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

TABLE 1 Outer-Jacket Dimensions

Outer-Jacket Outside Diameter		Outer Jacket Thickness Min. Thickness	
in.	(mm)	in.	(mm)
Up to 2.5 inclusive	(Up to 63)	.040	(1)
Up to 2.5	(Up to 63)	.040	(1.0)
Over 2.5 to 3.5 inclusive	(63–90)	.045	(1.1)
Over 3.5 to 5.0 inclusive	(90–128)	.050	(1.2)
Over 5.0 to 6.3 inclusive	(128–160)	.070	(1.8)
Over 6.3 to 7.9 inclusive	(160–200)	.085	(2.1)
Over 6.3	(160 and larger)	.085	(2.1)