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Standard Specification for Multilayer Polyethylene-Polyamide (PE-PA) Pipe for Pressure Piping Applications[1]

This standard is issued under the fixed designation F2807; 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.

1. Scope

1.1 This specification covers requirements and test methods for ½ in. through 14 in. multilayer polyethylene-polyamide (PE-PA) pipe, which is a two-layer pipe (PE pipe layer bonded to an inner layer of PA). The multilayer pipe covered by this specification is intended for use in piping applications where the permeation and chemical resistance of polyamide (PA) compounds may be useful to protect the PE pipe layer, such as oil and gas producing applications that convey oil, dry or wet gas, and multiphase fluids.

NOTE 1—Permeability and chemical resistance depends on the type of PA used. The PA layer delays but does not prevent liquid hydrocarbons effects. Therefore, the hydrocarbon chemical design factor for this multilayer pipe should be the same as for PE pipe layer—see X1.2.

1.2 Electrofusion and mechanical joints are typically used for this multilayer pipe.

1.3 Unless specified otherwise, all the pipe requirements in this specification are for the multilayer pipe.

1.4 The PA layer is not taken into consideration for the design pressure of multilayer pipe meeting this specification. Design pressure rating is determined from the PE pipe layer alone—see Appendix X1.

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

1.6 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in figures and tables) shall not be considered as requirements of the standard.

1.7 The following precautionary caveat pertains only to the test method portion, Section 6, 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 limitations prior to use.*

1.8 *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]

D618 Practice for Conditioning Plastics for Testing

D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings

D1600 Terminology for Abbreviated Terms Relating to Plastics

D1603 Test Method for Carbon Black Content in Olefin Plastics

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe

D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique

D6779 Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA)

F412 Terminology Relating to Plastic Piping Systems

F1290 Practice for Electrofusion Joining Polyolefin Pipe and Fittings

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.68 on Energy Piping Systems.

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[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.

F2619/F2619M Specification for High-Density Polyethylene (PE) Line Pipe

2.2 *Federal Specifications:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[3]

MIL-STD 129 Military Marking for Shipment and Storage[4]

2.3 *ISO Standards:*[5]

ISO 1167 Thermoplastics pipes for the conveyance of fluids—Resistance to internal pressure

ISO 3126 Plastic piping systems—Plastic piping components—Measurement and determination of dimensions

ISO 6259 Thermoplastics pipes—Determination of tensile properties

ISO 8510-2 Adhesives—Peel test for a flexible-to-rigid specimen assembly—180° peel

2.4 *Plastic Pipe Institute:*[6]

PPI TR-3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe

PPI TR-4 PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe

PPI TR-9 Recommended Design Factors and Design Coefficients for Thermoplastic Pressure Pipe

PPI TR-23 Guidelines for Establishing the Pressure Rating for Multilayer and Co-extruded Plastic Pipes

2.5 *Other Documents:*

SAE J 2260 Nonmetallic Fuel System Tubing with One or More Layers[7]

EN 14125 Thermoplastic and flexible metal pipework for underground installation at petrol filling stations[8]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

3.1.2 *multilayer pipe, n*—plastic pipe comprised of more than one layer.

3.1.3 *re-rounding equipment, n*—tooling used to reform the pipe and permanently reduce ovality to 5 % or less.

3.1.4 *rounding equipment, n*—tooling, devices, clamps, and so forth, used to temporarily hold the pipe round while a joining procedure (heat fusion, electrofusion, or mechanical) is performed.

4. Compound Requirements

4.1 *PE Compound Requirements*—The PE compound used to make the PE pipe layer shall be virgin compound and shall have a Plastics Pipe Institute (PPI) hydrostatic design basis (HDB) rating in accordance with PPI TR-3 using Test Method D2837. The PE compound used for the PE pipe layer shall have a pipe material designation code of PE 4710 in accordance with PPI TR-3 Section F.7 and shall be listed in PPI TR-4, and shall meet Specification D3350 requirements, with a minimum cell class of 444474C.

4.1.1 *Additive Classes*—PE compounds shall be Code C as defined in Specification D3350. Code C compound shall contain 2.0 to 3.0 percent carbon black as measured by Test Method D1603 or D4218. The pipe manufacturer shall measure carbon black content of the compound once per week.

4.1.2 *Chemical Resistance*—Testing shall be conducted per 6.10 on specimens of PE compound from compression molded plaques or from a ring specimen prepared from pipe.

NOTE 2—This test is only an indication of what may happen as a result of short-term exposure to these chemicals. Contact the manufacturer for specific chemical resistance information for this product.

4.1.3 *Elevated Temperature*—The PE 4710 compound shall have an HDB at 140 °F (60 °C) of at least 1000 psi listed in PPI TR-4.

4.2 *PA Compound Requirements*—The PA compound shall be a non-reinforced PA with the three-digit cell class (group, class, grade) in accordance with Classification D6779 per Table 1.

4.2.1 *Chemical Resistance*—Based on the intended application and the corresponding need for chemical resistance, the multilayer pipe manufacturer shall provide chemical resistance properties for the type of PA compound used in the PA layer of this multilayer pipe.

4.2.2 *Color*—The PA layer shall have a different color from the black PE pipe layer so that it can be easily recognized, such as the APWA color coding system of yellow for gas and oil lines.

4.3 *Rework Compound*—To prevent possible contamination between PE and PA, rework (regrind) shall not be used for the polyethylene and polyamide layers.

4.4 *Documentation*—A documentation system to allow for traceability of compounds used in the manufacture of the multilayer pipe product meeting the requirements of this specification shall exist and be supplied to the purchaser, if requested.

TABLE 1 Polyamide Type and Cell Class

Polyamide (PA) Type	PA Cell Class
PA 6	214
PA 11	322
PA 12	423

[3] Available from U.S. Government Publishing Office, 732 N. Capitol St., NW, Washington, DC 20401, http://www.gpo.gov.

[4] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

[5] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

[6] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

[7] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

[8] Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

5. Multilayer Pipe Requirements

5.1 *General*—Multilayer pipe shall be supplied in either coils or straight lengths. Pipe that will be supplied in coils shall meet the minimum test values required by this specification after being bent to minimum radius used for coiling and then uncoiled or straightened prior to testing.

5.1.1 The multilayer pipe shall meet all the performance requirements of this specification. There shall be no delamination of the bonded PA layer during coiling, shipping, handling or operation of the multilayer pipe.

5.2 *Workmanship*—The multilayer pipe shall be homogeneous throughout each layer. The multilayer pipe shall be free of visible cracks, holes, foreign inclusion, blisters, and dents, or other injurious defects. Each respective layer of the multilayer pipe shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

5.3 *Multilayer Pipe Dimensions and Tolerances:*

5.3.1 *PE Pipe Layer Dimensions*—The PE dimensions shall be specified by wall thickness and outside diameter.

5.3.1.1 *Diameters*—The average outside diameter of the polyethylene pipe layer shall meet the requirements given in Table 2 when measured in accordance with 6.5.1.1.

5.3.1.2 *Toe-In*—When measured in accordance with 6.5.1.1, or in accordance with the manufacturer's procedures for multilayer pipe dimensions, the outside diameter at the cut end of the multilayer pipe shall not be more than 1.5 % smaller than the undistorted outside diameter. Measurement of the undistorted outside diameter shall be made no closer than 1.5 pipe diameters or 11.8 in. (300 mm), whichever distance is less, from the cut end of the multilayer pipe. The undistorted outside diameter of the PE pipe layer shall meet the requirements of Table 2.

5.3.1.3 *Wall Thickness*—The wall thickness of the PE pipe layer shall be as specified in Table 3 when measured in accordance with 6.5.1.2.

5.3.2 *PA Layer Wall thickness*—The minimum wall thickness of the PA layer shall be 0.039 in. (1.0 mm) and the maximum wall thickness shall be 0.047 in. (1.2 mm) when measured in accordance with 6.5.1.2.

5.3.3 *Ovality*—The ovality (cross section) of 3 in. IPS (88.9 mm) and smaller multilayer pipe shall not exceed 5 % when determined in accordance with 6.5.2. Measurements of coiled multilayer pipe shall be made on a sample cut from the coil, and in case of disagreement, conditioned per 6.3.

NOTE 3—Other factors, that is, installation compaction, static soil loading, and dynamic vehicular loads may increase the ovality; therefore, 5 % was chosen as the limit for the amount contributed by manufacturing, packing, in-plant storage, and shipping. Before or during installation, coiled multilayer pipe larger than 3 in. IPS (89 mm) should be processed by the installer through re-rounding equipment that corrects ovality to 5 % or less.

NOTE 4—Ovality is a packaging condition that occurs when roundable pipe is wound into a coil—the pipe flattens out as it is coiled. Ovality is corrected when joining equipment is applied to roundable pipe, or by field processing roundable pipe through re-rounding and straightening equipment during installation.

5.3.3.1 *Length*—The multilayer pipe shall be supplied in straight lengths or coils as agreed upon between the manufacturer and the purchaser. The length shall not be less than the minimum length agreed upon when corrected to 73 °F (23 °C).

5.4 *Sustained Pressure*—To assure slow crack growth resistance of the multilayer pipe construction, the multilayer pipe shall not fail as defined in Test Method D1598, when tested in accordance with 6.6.

5.5 *Minimum Hydrostatic Burst Pressure:*

5.5.1 Multilayer pipe shall have a minimum burst stress of 3200 psi (22.1 MPa) when tested in accordance with 6.7 using the wall thickness for the multilayer pipe.

5.5.2 For multilayer pipe sizes above 4-in. nominal diameter, the apparent ring tensile strength test per 5.6 is an acceptable alternative.

5.6 *Apparent Tensile Stress at Yield*—Multilayer pipe shall have a minimum apparent tensile stress at yield of 3200 psi (22.1 MPa) when tested in accordance with 6.8 using the wall thickness for the multilayer pipe.

5.7 *Adhesion (Bonding) of PE and PA Layers:*

5.7.1 The PA layer shall be bonded to the PE pipe layer either with a bonding layer or by chemical means so that the peel force adhesion requirement of 5.7.2 is met. Layers shall not delaminate upon rapid decompression from the design pressure to atmospheric pressure at the design temperature in the operating environment.

5.7.2 When manufactured, the peel force adhesion for the PE pipe layer bonded to the PA layer shall be greater than 28.5

TABLE 2 Average Outside Diameters and Tolerances for Polyethylene Pipe Layer, in. (mm)

Nominal Pipe Size (NPS)	Average Outside Diameter	Tolerance	Maximum Out-of-Roundness SDR 32.5	Maximum Out-of-Roundness SDR 26	Maximum Out-of-Roundness SDR 21	Maximum Out-of-Roundness SDR 17, 13.5 and 11
½	0.840 (21.3)	±0.004 (±0.102)	...	...	0.03 (0.76)	0.016 (0.40)
¾	1.050 (26.7)	±0.004 (±0.102)	...	...	0.03 (0.76)	0.020 (0.50)
1	1.315 (33.4)	±0.005 (±0.127)	...	...	0.03 (0.76)	0.020 (0.50)
1¼	1.660 (42.1)	±0.005 (±0.127)	...	...	0.03 (0.76)	0.024 (0.6)
2	2.375 (60.3)	±0.006 (±0.152)	...	...	0.06 (1.52)	0.024 (0.6)
3	3.500 (88.9)	±0.008 (±0.203)	...	...	0.06 (1.52)	0.030 (0.76)
4	4.500 (114.3)	±0.009 (±0.229)	...	...	0.1 (2.5)	0.030 (0.76)
6	6.625 (168.3)	±0.011 (±0.279)	0.12 (3)	0.11 (2.74)	0.1 (2.5)	0.070 (1.77)
8	8.625 (219.1)	±0.013 (±0.330)	0.24 (6.1)	0.16 (4.06)	0.12 (3)	0.080 (2.0)
10	10.750 (273.0)	±0.015 (±0.381)	0.24 (6.1)	0.2 (5.08)	0.14 (3.58)	0.1 (2.5)
12	12.750 (323.8)	±0.017 (±0.432)	0.28 (7.12)	0.2 (5.08)	0.14 (3.58)	0.1 (2.5)
14	14.000 (355.6)	±0.063 (±1.60)	0.32 (8.12)	0.24 (6.1)	0.16 (4.06)	0.12 (3)