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.

Designation: F2619/F2619M – 20

Standard Specification for High-Density Polyethylene (PE) Line Pipe[1]

This standard is issued under the fixed designation F2619/F2619M; 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 high-density polyethylene (PE) materials, pipe and fittings for pressure or non-pressure oil and gas producing applications to convey fluids such as oil, dry or wet gas, multiphase fluids, and non-potable oilfield water. This specification does not cover pipe for gas distribution applications.

1.1.1 For the purposes of this specification, high-density polyethylene material is Specification D3350 density cell classification 3 or higher. This specification does not cover materials having Specification D3350 density cell classification less than 3 such as medium or low density polyethylene materials.

1.1.2 See Specification D2513 for polyethylene pipe and fittings intended for use in the distribution of natural gas, or for use with liquefied petroleum gas.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the 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.*

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]

D638 Test Method for Tensile Properties of Plastics

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

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

D2513 Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings

D2683 Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

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

D3261 Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

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

F412 Terminology Relating to Plastic Piping Systems

F1055 Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene

[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.

Current edition approved April 1, 2020. Published May 2020. originally approved in 2007. Last previous edition approved in 2019 as F2619/F2619M–19. DOI: 10.1520/F2619_F2619M-20.

[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

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and Crosslinked Polyethylene (PEX) Pipe and Tubing
F1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
F1973 Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems
F2206 Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE)

2.2 *DOT Document:*[3]

CFR 49 Part 192 Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards[3]

2.3 *Canadian Standard:*[4]

CSA Z662 Oil and Gas Pipeline Systems

2.4 *Military Standard:*[5]

Military Standard 129P Standard Practice—Military Marking for Shipment and Storage

2.5 *Federal Standard:*[5]

FED-STD-123G Federal Standard Marking for Shipment (Civil Agencies)
Federal Register Vol. 71, No. 50, March 15, 2006

2.6 *PPI Standards:*[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 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

[3] Available from U.S. Department of Transportation, Transportation Safety Institute, Pipeline Safety Division, 6500 South MacArthur Boulevard Oklahoma City, OK 73169, https://www.transportation.gov.

[4] Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, http://www.csagroup.org.

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

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

3. Terminology

3.1 *Definitions*—Unless otherwise specified, definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *multiphase fluid, n*—oil, gas, and water in any combination produced from one or more oil or gas wells, or recombined oil or gas well fluids that may have been separated in passing through surface facilities.

3.2.2 *oilfield water, n*—fresh or salt water transported by pipeline, regardless of purity or quality, from wells or surface locations for the purpose of providing water injection to underground reservoirs; or disposing of waste water from hydrocarbon or gas production, processing, or storage facilities.

3.2.3 *production run, n*—the continuous extrusion of pipe of a specific diameter, wall thickness and material compound (see 4.1).

3.2.3.1 *Discussion*—Continuous production may be temporarily interrupted by loss of power or circumstances such as breakdowns or screen changes, etc.; however, a change of diameter or wall thickness (dimension ratio) or material compound constitutes a new production run.

3.2.4 *sample, n*—pipe or an element of pipe that represents a quantity of pipe and provides a specimen or specimens for testing.

3.2.5 *specimen, n*—pipe or an element of pipe that is subjected to test.

4. Materials

4.1 Polyethylene compounds suitable for use in the manufacture of pipe and fittings under this specification shall meet the following requirements:

TABLE 1 Polyethylene Compound Requirements

	Material Designation	
	PE3608	PE4710
Requirement	Required Value	
HDB at 140ºF (60ºC), psi (MPa), per Test Method D2837 and PPI TR-3[A]	800 (5.5)	800 (5.5)
HDS for water at 73°F (23°C) psi (MPa), per Test Method D2837and PPI TR-3[A]	800 (5.5)	1000 (6.9)
Melt flow rate per Test Method D1238	≤0.15 g/10 min Cond. 190/2.16, or ≤20 - >4.0 g/10 min Cond. 190/21.6	≤0.15 g/10 min Cond. 190/2.16, or ≤20 - >4.0 g/10 min Cond. 190/21.6
Nominal natural base resin density per Specification D3350, g/cm^3	>0.940-0.947	>0.947-0.955
Minimum average SCG Resistance per Specification D3350, PENT, hours (Test Method F1473, molded plaque, 176°F (80°C), 348 psi (2.4 MPa), notch depth per Table 1)	100	500

[A] HDB and HDS listings that are published in PPI TR-4 are optional.

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4.1.1 *Material Code*—Polyethylene compounds shall meet Table 1 requirements applicable to the material designation code.

4.1.2 *Color and Ultraviolet (UV) Stabilization*—Polyethylene compounds in pipe and fittings shall contain 2 to 3 percent carbon black when tested per 5.6. Color polyethylene compound used outside surface color stripes shall contain sufficient UV stabilizer for at least 24 months of unprotected outdoor storage.

4.1.3 Polyethylene compounds shall comply with thermal stability, brittleness temperature and elongation at break per Specification D3350.

4.1.4 The manufacturer shall have procedures for ensuring that materials meeting 4.1 are received in a condition that is suitable for processing, including receiving inspection to discover damage or contamination from shipping and verification of appropriate material properties.

NOTE 1—Changes to Specification D3350 and PPI TR-3 resulted in changes to thermoplastic material designation codes for polyethylene materials. (See Terminology F412 for the thermoplastic material designation code definition.) A Specification D3350 requirement to use a 4 for SCG resistance values of 4 or 6 was deleted, density cell 3 was split into cells 3 and 4, and a SCG resistance value of 7 (>500 h per Test Method F1473 (PENT)) was added. Changes to PPI TR-3 provide for an increased HDS for water at 73°F for materials that demonstrate >500 h SCG resistance per Test Method F1473 (PENT), and a LCL/LTHS ratio of at least 90 percent per Test Method D2837, and substantiation per PPI TR-3 to show that extrapolation of the 73°F stress regression curve is linear to the 438 000-h (50-year) intercept.

4.2 *Rework Material*—Rework material is acceptable to manufacture pipe and fittings in accordance with this specification as part of a blend with virgin material compound meeting 4.1 and 4.1.2. Rework material shall be polyethylene material compound from the manufacturer's own pipe or fitting production that met 4.1 and 4.1.2 as virgin material compound. Rework material shall be traceable per 4.2.1 and shall have the same Specification D3350 cell classification and property value or material designation code per Table 1 as the virgin material compound in the blend. Pipe containing rework material shall meet the requirements of this specification.

4.2.1 The manufacturer shall have procedures for ensuring that rework material is clean before use and shall have procedures for tracing rework material from its initial processing as virgin material through the manufacturer's rework process to ensure that material blends containing rework material comply with 4.2. Testing rework material for compliance with Table 1 classification and properties is not required.

5. Pipe Requirements

5.1 *Workmanship*—Pipe shall be homogeneous throughout. To the extent commercially practical, pipe exiting production line processing equipment but before coiling or packaging for shipment shall be free of injurious defects such as visible cracks, holes, foreign inclusions, voids, blisters, dents, and grooves, ridges and high or low (flat) areas that extend lengthwise along the pipe (see 5.2.5). To the extent commercially practical, pipe and fittings shall be uniform throughout in finish, opacity and color except for color stripes if applicable.

5.1.1 Pipe outside surface color stripes are not required, but if applied, shall be inseparably co-extruded as part of the pipe outside surface. The colors red, orange, blue, green, and purple (lavender) shall not be applied to pipe meeting this specification.

5.1.2 Cut pipe ends shall be squarely cut and clean without ledges, shaving tails, burrs or cracks.

5.1.3 The interior of the pipe shall be free of cuttings, shavings and debris when produced.

5.2 *Dimensions and Tolerances:*

5.2.1 Dimensions and tolerances shall apply at 73 ± 4 °F [23 ± 2 °C] without regard to humidity.

5.2.2 Pipe shall be supplied in coils or straight lengths by agreement between the manufacturer and purchaser.

5.2.3 *Pipe Diameter*—The outside diameter of the pipe shall meet the outside diameter per Table 2 or 5.2.8 when measured in accordance with Test Method D2122. The outside diameter measurement shall be taken at a distance at least 1.5 times the average outside diameter or 11.8 in. [300 mm], whichever is less, from the cut end of the pipe.

5.2.4 *Toe-In*—When measured in accordance with Test Method D2122, the outside diameter at the cut end of the pipe shall not be more than 1.5 percent smaller than the outside diameter per Table 2 or 5.2.8.

5.2.5 *Outside Surface Irregularity*—Outside surface irregularity tolerance per Table 2 shall be measured per 7.6. Measurement is not required where there is no tolerance in Table 2.

NOTE 2—Irregular outside surface conditions from the extrusion line processing equipment that are not field correctable can affect the suitability of pipe for joining with devices that secure or seal to the pipe outside surface, especially electrofusion devices.

5.2.6 *Ovality*—The ovality (elliptical shape) of pipe when exiting production line processing equipment but before coiling or packaging for shipment shall not exceed 5 percent when determined in accordance with 7.7.

NOTE 3—Ovality is a field correctable condition that results from packaging or storage. When coiled, pipe will deflect to an oval or elliptical profile, and when packaged or stored, higher DR pipe may deflect to an oval or elliptical profile. If necessary, commercially available equipment can be applied to minimize percent ovality during field joining or installation.

5.2.7 *Pipe Wall Thickness*—Pipe wall thickness shall be as specified in Table 3 or Table 4 or 5.2.8 when measured in accordance with Test Method D2122. For pipe larger than 12-in. Nominal IPS Pipe Size, the wall thickness variability (eccentricity) as measured and calculated in accordance with Test Method D2122 in any diametrical cross section of the pipe shall not exceed 12 percent.

5.2.8 *Special Sizes*—Outside diameter not specified in Table 2 and wall thickness not specified in Table 3 or Table 4 are acceptable by agreement between the manufacturer and the purchaser. If not otherwise specified, the total tolerance on special size outside diameter shall not exceed +0.90 percent of the minimum special outside diameter or ±0.45 percent of the average special outside diameter. If not otherwise specified, the tolerance on special size wall thickness shall be +12 percent of the minimum special size wall thickness for 12-in. Nominal IPS Pipe Size [324-mm] and smaller special sizes. If not otherwise specified, wall thickness shall be in accordance with 5.2.7 for special sizes larger than 12-in. Nominal IPS Pipe Size [324-mm].

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TABLE 2 Pipe Outside Diameter and Tolerance

Nominal IPS Pipe Size	Outside Diameter and Tolerance[A]				Outside Surface Irregularity	
	Average		Tolerance		Tolerance[B]	
	in.	mm	in.	mm	in.	mm
½	0.840	21.34	±0.004	±0.10	0.03	0.8
¾	1.050	26.67	±0.004	±0.10	0.03	0.8
1	1.315	33.40	±0.005	±0.13	0.03	0.8
1¼	1.660	42.16	±0.005	±0.13	0.03	0.8
1½	1.900	48.26	±0.006	±0.15	0.06	1.5
2	2.375	60.33	±0.006	±0.15	0.06	1.5
2½	2.875	73.03	±0.007	±0.18	0.06	1.5
3	3.500	88.90	±0.008	±0.20	0.06	1.5
4	4.500	114.30	±0.009	±0.23	0.10	2.5
5	5.563	141.30	±0.010	±0.25	0.10	2.5
6	6.625	168.28	±0.011	±0.28	0.12	3.0
8	8.625	219.08	±0.013	±0.38	0.24	6.1
10	10.750	273.05	±0.015	±0.38	0.24	6.1
12	12.750	323.85	±0.017	±0.43	0.28	7.1
14	14.000	355.60	±0.063	±1.60	...	...
16	16.000	406.40	±0.072	±1.83	...	...
18	18.000	457.20	±0.081	±2.05	...	...
20	20.000	508.00	±0.090	±2.29	...	...
22	22.000	558.80	±0.099	±2.51	...	...
24	24.000	609.60	±0.108	±2.74	...	...
28	28.000	711.20	±0.126	±3.20	...	...
30	30.000	762.00	±0.135	±3.43	...	...
32	32.000	812.80	±0.144	±3.66	...	...
34	34.000	863.60	±0.153	±3.89	...	...
36	36.000	914.40	±0.162	±4.11	...	...
42	42.000	1066.80	±0.189	±4.80	...	...
48	48.000	1219.20	±0.216	±5.49	...	...
54	54.000	1371.60	±0.243	±6.17	...	...
63	63.000	1600.20	±0.284	±7.20	...	...
65	65.000	1651.00	±0.293	±7.43	...	...

[A] Outside diameter rounded to 3 decimal places for inch dimensions or to 2 decimal places for mm dimensions.
[B] See 5.2.5.

5.3 *Inside Surface Ductility*—The pipe inside surface shall be ductile in accordance with 5.3.1 or 5.3.2.

5.3.1 *Tensile Elongation Test*—A sample of pipe shall be taken from ongoing production and specimens shall be prepared from the sample and tested per 7.4.1. The minimum elongation at break for each tensile specimen from the sample shall exceed 400 percent of the gauge length.

5.3.2 *Bendback Test*—Bendback testing is conducted per 7.4.2. Visual examination of bendback specimens from the sample pipe shall not reveal inside surface crazing or cracking.

5.4 *Elevated Temperature Sustained Pressure*—Elevated temperature sustained pressure tests for each polyethylene compound (material designation) per 4.1 and Table 1 used to manufacture pipe in accordance with this specification at the facility shall be conducted per 7.8 and Table 5. Conduct elevated temperature sustained pressure tests when the polyethylene compound (material designation) is first used to manufacture pipe meeting this specification at the facility and twice annually thereafter such that the tests generally represent a first half or a second half of the annual production at the facility.

5.4.1 Passing results are *(1)* non-failure for all three specimens at a time equal to or greater than the Table 5 "minimum average time before failure", or *(2)* not more than one ductile specimen failure and the average time before failure for all three specimens shall be greater than the specified "minimum average time before failure" for the selected Table 5 Condition. For Table 5 Conditions 1 through 5: if more than one ductile failure occurs before the "minimum average time before failure", it is permissible to conduct one retest at a Table 5 Condition of lower stress and longer minimum average time before failure for the material designation. For Table 5 Condition 6 no retest is allowed. Brittle failure of any specimen when tested at Table 5 Condition 1 through 6 constitutes failure to meet this requirement and no retest is allowed.

5.4.2 *Provision for Retest (if applicable)*—The retest sample shall be three specimens of the same pipe or tubing size and material designation from the same time frame as the "test sample". For the retest, any specimen failure before the "minimum average time before failure" at the retest condition of lower stress and longer minimum average time before failure constitutes failure to meet this requirement.

5.5 *Short-Term Strength*—Pipe meeting this specification is tested at least once per production run for short-term strength in accordance with 5.5.1 or 5.5.2.

5.5.1 *Short-Term Pressurization*—Pipe 12-in. Nominal IPS Pipe Size and smaller is tested in accordance with Test Method D1599 at 73 ± 4 °F [23 ± 2 °C] without regard to humidity. The test sample is five specimens. Specimen ruptures shall be ductile and the minimum hoop stress at burst shall be 2900 psi [20.2 MPa].

5.5.2 *Apparent Tensile Strength at Yield*—Pipe of 3-in. Nominal IPS Pipe Size and larger is tested in accordance with Test Method D2290 at 73 ± 4 °F [23 ± 2 °C] without regard to humidity. Five specimens are prepared from the sample per

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