Designation: F2619/F2619M – 13

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 and health practices and determine the applicability of regulatory limitations prior to use.*

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 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

[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 Dec. 1, 2013. Published January 2014. originally approved in 2007. Last previous edition approved in 2011 as F2619/F2619M–11. DOI: 10.1520/F2619_F2619M-13.

[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**

F2206 Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE)

2.2 *Other Documents:*

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

Federal Register Vol. 71, No. 50, March 15, 2006[3]

CSA Z662 Oil and Gas Pipeline Systems[4]

FED-STD-123G Federal Standard Marking for Shipment (Civil Agencies)

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

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[5]

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[5]

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:

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.

[3] Available from U.S. Department of Transportation, Transportation Safety Institute, Pipeline Safety Division, PO Box 25082, Oklahoma City, OK 73125-5050.

[4] Available from Canadian Standards Association (CSA), 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, http://www.csa.ca.

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

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.

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 ± 3.6°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].

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.

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.

5.4 *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 ± 3.6°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 ± 3.6°F [23 ± 2°C] without regard to humidity. Five specimens are prepared from the sample per Test Method D2290. The minimum apparent tensile strength at yield shall be 2900 psi [20.2 MPa].

5.6 *Carbon Black Content*—Pipe shall be tested daily for carbon black content per 7.5. With the exception of color stripes, the carbon black content of the material in the pipe wall shall be 2 to 3 percent.

6. Fitting Requirements

6.1 Polyethylene fittings intended for use with correspondingly sized polyethylene line pipe shall be manufactured from

TABLE 3 Wall Thickness and Tolerance of 12 in. and Smaller Nominal Pipe Size

Nominal IPS Pipe Size	DR	Wall Thickness and Tolerance			
		Minimum Wall Thickness[A]		Tolerance[B]	
		in.	mm	in.	mm
½	13.5	0.062	1.58	+0.007	+0.18
	11.0	0.076	1.93	+0.009	+0.22
	9.0	0.093	2.36	+0.011	+0.28
	7.3	0.115	2.92	+0.014	+0.36
	7.0	0.120	3.05	+0.014	+0.36
¾	13.5	0.078	1.98	+0.009	+0.22
	11.0	0.095	2.41	+0.011	+0.28
	9.0	0.117	2.97	+0.014	+0.36
	7.3	0.144	3.66	+0.017	+0.43
	7.0	0.150	3.81	+0.018	+0.46
1	13.5	0.097	2.46	+0.012	+0.30
	11.0	0.120	3.05	+0.014	+0.36
	9.0	0.146	3.71	+0.018	+0.46
	7.3	0.180	4.57	+0.022	+0.56
	7.0	0.188	4.78	+0.023	+0.58
1¼	13.5	0.123	3.12	+0.015	+0.38
	11.0	0.151	3.84	+0.018	+0.46
	9.0	0.184	4.67	+0.022	+0.56
	7.3	0.227	5.77	+0.027	+0.69
	7.0	0.237	6.02	+0.028	+0.71
1½	13.5	0.141	3.58	+0.017	+0.43
	11.0	0.173	4.39	+0.021	+0.53
	9.0	0.211	5.36	+0.025	+0.64
	7.3	0.260	6.60	+0.031	+0.79
	7.0	0.271	6.88	+0.033	+0.84
2	17.0	0.140	3.56	+0.017	+0.43
	13.5	0.176	4.47	+0.021	+0.51
	11.0	0.216	5.49	+0.026	+0.66
	9.0	0.264	6.71	+0.032	+0.81
	7.3	0.325	8.26	+0.039	+0.99
	7.0	0.339	8.61	+0.041	+1.04
2½	21.0	0.137	3.48	+0.016	+0.41
	17.0	0.169	4.29	+0.020	+0.51
	13.5	0.213	5.41	+0.026	+0.66
	11.0	0.261	6.63	+0.031	+0.79
	9.0	0.319	8.10	+0.038	+0.97
	7.3	0.394	10.00	+0.047	+1.20
	7.0	0.411	10.43	+0.049	+1.25
3	21.0	0.167	4.24	+0.020	+0.51
	17.0	0.206	5.23	+0.025	+0.64
	13.5	0.259	6.58	+0.031	+0.79
	11.0	0.318	8.08	+0.038	+0.97
	9.0	0.389	9.88	+0.047	+1.19
	7.3	0.479	12.17	+0.058	+1.47
	7.0	0.500	12.70	+0.060	+1.52
4	32.5	0.138	3.51	+0.017	+0.43
	26.0	0.173	4.39	+0.021	+0.53
	21.0	0.214	5.44	+0.026	+0.66
	17.0	0.265	6.73	+0.032	+0.81
	13.5	0.333	8.46	+0.040	+1.02
	11.0	0.409	10.39	+0.049	+1.24
	9.0	0.500	12.70	+0.060	+1.52
	7.3	0.616	15.65	+0.074	+1.88
	7.0	0.643	16.33	+0.077	+1.96
5	32.5	0.171	4.35	+0.021	+0.52
	26.0	0.214	5.43	+0.027	+0.65
	21.0	0.265	6.73	+0.032	+0.81
	17.0	0.327	8.31	+0.039	+1.00
	13.5	0.412	10.47	+0.049	+1.26
	11.0	0.506	12.85	+0.061	+1.54
	9.0	0.618	15.70	+0.074	+1.88
	7.3	0.762	19.36	+0.091	+2.32
	7.0	0.795	20.19	+0.095	+2.42
6	32.5	0.204	5.18	+0.024	+0.61
	26.0	0.255	6.48	+0.031	+0.79
	21.0	0.315	8.00	+0.038	+0.97
	17.0	0.390	9.91	+0.047	+1.19
	13.5	0.491	12.47	+0.059	+1.50
	11.0	0.602	15.29	+0.072	+1.83
	9.0	0.736	18.69	+0.088	+2.24
	7.3	0.908	23.06	+0.109	+2.77
	7.0	0.946	24.03	+0.114	+2.90

TABLE 3 *Continued*

Nominal IPS Pipe Size	DR	Wall Thickness and Tolerance			
		Minimum Wall Thickness[A]		Tolerance[B]	
		in.	mm	in.	mm
8	32.5	0.265	6.73	+0.032	+0.81
	26.0	0.332	8.43	+0.040	+1.02
	21.0	0.411	10.44	+0.049	+1.24
	17.0	0.507	12.88	+0.061	+1.55
	13.5	0.639	16.23	+0.077	+1.96
	11.0	0.784	19.91	+0.094	+2.39
	9.0	0.958	24.33	+0.115	+2.92
	7.3	1.182	30.02	+0.142	+3.61
	7.0	1.232	31.29	+0.148	+3.76
10	32.5	0.331	8.41	+0.040	+1.02
	26.0	0.413	10.49	+0.050	+1.27
	21.0	0.512	13.00	+0.061	+1.55
	17.0	0.632	16.05	+0.076	+1.93
	13.5	0.796	20.22	+0.096	+2.44
	11.0	0.977	24.82	+0.117	+2.97
	9.0	1.194	30.33	+0.143	+3.63
	7.3	1.473	37.41	+0.177	+4.50
	7.0	1.536	39.01	+0.184	+4.67
12	32.5	0.392	9.96	+0.047	+1.19
	26.0	0.490	12.45	+0.059	+1.50
	21.0	0.607	15.42	+0.073	+1.85
	17.0	0.750	19.05	+0.090	+2.29
	13.5	0.944	23.98	+0.113	+2.87
	11.0	1.159	29.44	+0.139	+3.53
	9.0	1.417	35.99	+0.170	+4.32
	7.3	1.747	44.37	+0.210	+5.33
	7.0	1.821	46.25	+0.219	+5.56

[A] Minimum wall thickness = average outside diameter (from Table 2) divided by DR (from Table 3), and rounded to 3 decimal places for inch dimensions, or to 2 decimal places for mm dimensions.
[B] Wall thickness tolerance = plus 12 % of the minimum wall thickness, and rounded to 3 decimal places for inch dimensions, or to 2 decimal places for mm dimensions.

polyethylene material compounds in accordance with Section 4 of this specification and 6.1.1, 6.1.2, 6.1.3, 6.1.4, or 6.1.5.

6.1.1 Socket fusion fittings shall be manufactured per Specification D2683.

6.1.2 Butt fusion fittings shall be manufactured per Specification D3261.

6.1.3 Electrofusion fittings shall be manufactured per Specification F1055.

6.1.4 Fabricated fittings shall be manufactured per Specification F2206.

6.1.5 Transition fittings shall be manufactured per Specification F1973.

7. Test Methods

7.1 *Sampling*—For destructive tests, a sufficient quantity of sample pipe shall be taken from ongoing production to prepare test specimens and conduct the required tests. Non-destructive tests such as tests for dimensions and workmanship do not require removing a sample of pipe from production.

7.1.1 The manufacturer shall have a documented procedure for verifying that dimensions measured on unconditioned production pipe at temperatures other than 73.4 ± 3.6°F [23 ± 2°C] will conform to 5.2 when pipe is conditioned per 7.2.

7.1.2 For referee tests and in case of disagreement, samples for non-destructive tests shall be taken and conditioned per 7.2 before testing.

7.2 *Conditioning*—For tests where conditioning is required, for referee tests and in case of disagreement, condition samples and specimens prior to testing at 73.4 ± 3.6°F [23 ± 2°C] without regard to humidity for at least 1 hour in constant temperature circulating water or at least 4 hours in constant temperature circulating air.

NOTE 4—Conditioning is intended to produce a uniform 73.4 ± 3.6°F [23 ± 2°C] temperature through the pipe wall and all around the pipe. For larger pipes, conditioning time may be increased as necessary.

7.3 *Test Conditions*—Unless otherwise specified, conduct tests at 73.4 ± 3.6°F [23 ± 2°C] without regard to humidity.

7.4 *Inside Surface Ductility*—Test for inside surface ductility per 7.4.1 or 7.4.2.

7.4.1 *Tensile Test Method*—Four Type III or Type IV tensile specimens per Test Method D638 are prepared from the sample, one specimen from the middle of each quadrant around the pipe circumference and cut longitudinally from the pipe wall. For small pipe, specimens prepared from adjacent lengths along the sample are acceptable. Cut surfaces of tensile specimens shall be smooth; however, the pipe inside diameter surface in the gauge area shall be left unaltered. Test in accordance with Test Method D638 at a cross-head separation rate of 2 in. per minute [50.8 mm per minute].

7.4.2 *Bendback Test Method:*

7.4.2.1 From the pipe sample, squarely cut a pipe ring specimen with a minimum width of 1¼ in. [32 mm]. For wall thickness ⅜ in. [9.5 mm] or less test the entire wall thickness. For wall thickness above ⅜ in. [9.5 mm], remove material from the outside diameter surface of the ring specimen while maintaining an undisturbed inside diameter surface, to produce a ring specimen with consistent wall thickness of ⅜ in. [9.5

TABLE 4 Wall Thickness[A] for >12-in. Nominal Pipe Size

Nominal IPS Pipe Size	DR	Minimum Wall Thickness	
		in.	mm
14	32.5	0.431	10.95
	26.0	0.538	13.67
	21.0	0.667	16.94
	17.0	0.824	20.93
	13.5	1.037	26.34
	11.0	1.273	32.33
	9.0	1.556	39.52
	7.3	1.918	48.72
	7.0	2.000	50.80
16	32.5	0.492	12.50
	26.0	0.615	15.62
	21.0	0.762	19.35
	17.0	0.941	23.90
	13.5	1.185	30.10
	11.0	1.455	36.96
	9.0	1.778	45.16
	7.3	2.192	55.68
	7.0	2.286	58.06
18	32.5	0.554	14.07
	26.0	0.692	17.58
	21.0	0.857	21.77
	17.0	1.059	26.90
	13.5	1.333	33.86
	11.0	1.636	41.55
	9.0	2.000	50.80
	7.3	2.466	62.64
	7.0	2.571	65.30
20	32.5	0.615	15.62
	26.0	0.769	20.22
	21.0	0.952	24.18
	17.0	1.176	29.87
	13.5	1.481	37.62
	11.0	1.818	46.18
	9.0	2.222	56.44
	7.3	2.740	69.60
	7.0	2.857	72.57
22	32.5	0.677	17.20
	26.0	0.846	21.49
	21.0	1.048	26.62
	17.0	1.294	32.87
	13.5	1.630	41.40
	11.0	2.000	50.80
	9.0	2.444	62.08
	7.3	3.014	76.56
	7.0	3.143	79.83
24	32.5	0.738	18.75
	26.0	0.923	23.44
	21.0	1.143	29.03
	17.0	1.412	35.86
	13.5	1.778	45.16
	11.0	2.182	55.42
	9.0	2.667	67.74
	7.3	3.288	83.52
	7.0	3.429	87.10
26	32.5	0.800	20.32
	26.0	1.000	25.40
	21.0	1.238	31.45
	17.0	1.529	38.84
	13.5	1.926	48.92
	11.0	2.364	60.05
	9.0	2.889	73.38
28	32.5	0.862	21.89
	26.0	1.077	27.36
	21.0	1.333	33.86
	17.0	1.647	41.83
	13.5	2.074	52.68
	11.0	2.545	62.23
	9.0	3.111	79.02
30	32.5	0.923	23.44
	26.0	1.154	29.31
	21.0	1.429	36.30
	17.0	1.765	44.83
	13.5	2.222	56.44

TABLE 4 *Continued*

Nominal IPS Pipe Size	DR	Minimum Wall Thickness	
		in.	mm
	11.0	2.727	69.27
	9.0	3.333	84.66
32	32.5	0.985	25.02
	26.0	1.231	31.27
	21.0	1.524	38.71
	17.0	1.882	47.80
	13.5	2.370	60.20
	11.0	2.909	73.89
34	32.5	1.046	26.57
	26.0	1.308	33.22
	21.0	1.619	41.12
	17.0	2.000	50.80
	13.5	2.519	63.98
	11.0	3.091	78.51
36	32.5	1.108	28.14
	26.0	1.385	35.18
	21.0	1.714	43.54
	17.0	2.118	53.80
	13.5	2.667	67.74
	11.0	3.273	83.13
42	32.5	1.292	32.82
	26.0	1.615	41.02
	21.0	2.000	50.80
	17.0	2.471	62.76
	13.5	3.111	79.02
48	32.5	1.477	37.52
	26.0	1.846	46.89
	21.0	2.286	58.06
	17.0	2.824	71.73
54	32.5	1.662	42.21
	26.0	2.077	52.76
	21.0	2.571	65.30
	17.0	3.176	80.67
63	32.5	1.938	49.22
	26.0	2.423	61.55
	21.0	3.000	76.20
65	32.5	2.000	50.80
	26.0	2.500	63.50
	21.0	3.095	78.61

[A] Minimum wall thickness = average outside diameter (from Table 2) divided by DR (from Table 3), and rounded to 3 decimal places for inch dimensions, or to 2 decimal places for mm dimensions. See 5.2.7 for wall thickness eccentricity.

TABLE 5 Elevated Temperature, 176°F [80°C], Sustained Pressure Requirements

Condition	Test Temperature, °F [°C][A]	PE3608		PE4710	
		Test Pressure Hoop Stress,[B] psi [kPa][A]	Minimum Average Time Before Failure, hours	Test Pressure Hoop Stress,[B] psi [kPa][A]	Minimum Average Time Before Failure, hours
1	176 [80]	670 [4600]	170	750 [5170]	200
2	176 [80]	650 [4480]	340	730 [5020]	400
3	176 [80]	630 [4345]	510	705 [4870]	600
4	176 [80]	610 [4210]	680	685 [4715]	800
5	176 [80]	590 [4070]	850	660 [4565]	1000
6	176 [80]	580 [4000]	1000	640 [4415]	1200

[A] Tolerance on test temperature = ±3.6°F [±2°C]. Tolerance on test pressure hoop stress = ±5 psi [±35 kPa].
[B] Calculate internal test pressure in accordance with:

$$P = \frac{2S}{\left(\frac{D_O}{t} - 1\right)}$$

where P = test pressure, psig [kPa]; S = test pressure hoop stress, psi [kPa]; D_O = measured outside diameter, in. [mm]; and t = measured minimum wall thickness, in. [mm].

NOTE—Table 5 conditions are based on PE validation requirements per PPI TR-3 with Condition 6 being 85% of Condition 1 test pressure hoop stress and six times greater minimum average time before failure. Conditions 2 through 5 are linear stress and time interpolations between Conditions 1 and 6. The intent of multiple conditions is to maintain equivalent performance criteria, but provide for retest in the event of ductile failure. The test pressure hoop stress levels for Conditions 2-5 are linear interpolations for arbitrarily chosen time increments. An equivalent performance requirement, however, may be determined by arbitrarily choosing a test pressure hoop stress between Conditions 1 and 6 and linearly interpolating the minimum average time before failure. For example for PE3710 and PE4710 material, at 670 psi test pressure hoop stress, the minimum average time before failure would be 927 hours (200 + (750 – 670) × ((1200 – 200) / (750 – 640)) = 927).

mm]. Test the ring in its entirety, or cut the ring into representative sectors to produce individual bend-back test specimens for at least each quadrant around the pipe.

7.4.2.2 In a well-lit area test per the following procedure within 5 min: *(1)* Bend the specimen inside-out (reverse-bend so that the pipe ID surface is on the outside surface of the bent specimen). *(2)* Using an apparatus such as a vise or other suitable bending equipment, close the legs of the specimen together. When the specimen legs are closed together, the top of the bend-back specimen shall protrude the lesser of 1⅛ in. [29 mm] or three wall thicknesses above the point of closure (jaws). *(3)* With the unaided (naked) eye, visually examine the protruding reverse-bent pipe ID surface for brittle cracking or crazing.

7.5 *Carbon Black Content*—At least one specimen from a sample taken from the pipe wall shall be tested for percentage carbon black content in accordance with Test Method D1603 or Test Method D4218. Color stripe material shall not be included as part of the specimen.

7.6 *Outside Surface Irregularity*—Measure outside surface irregularity per 7.6.1 or 7.6.2.

7.6.1 Apply a rounding device to the pipe and tighten securely. At any gaps between the rounding device and the pipe circumference, fit a feeler gage or gage wire having the same thickness as the outside surface irregularity tolerance specified in Table 2 into the gap. If the gage does not fit, the pipe is in compliance. To ensure that the full circumference is checked, rotate the rounding device approximately 90 degrees, tighten securely and repeat the measurement procedure.

7.6.2 Apply a rounding device to the pipe and tighten securely. Determine the average outside diameter of the pipe within 2 in. [50.8 mm] to the edge of the rounding device using a circumferential wrap tape (pi-tape). Measure the pipe outside diameter at any gaps between the rounding device and the pipe outside diameter with calipers. The caliper diameter measurement shall not differ from the average outside diameter measurement by more than the outside surface irregularity tolerance specified in Table 2.

7.7 *Ovality*—Determine ovality in accordance with Test Method D2122. Measure the average outside diameter with a circumferential wrap tape (pi-tape). Except as provided in 7.7.1, determine the maximum and minimum diameter at the same location where the average diameter was measured with calipers or a tape measure accurate to 1/32 in. [0.80 mm] for 16-in. and smaller pipes or to 1/16 in. [1.59 mm] for larger pipes. When minimum (or maximum) diameter is determined, rotate calipers or tape measure approximately 90 degrees around the pipe circumference to determine the corresponding maximum (or minimum) diameter. Calculate ovality by subtracting the minimum diameter from the maximum diameter, dividing the difference by the measured average outside diameter, and multiplying by one hundred.

7.7.1 When maximum and minimum diameter are measured at the end of the pipe, the average outside diameter shall be measured 11.8 in. [300 mm] or one pipe diameter, whichever is less, from the end of the pipe so that the average outside diameter measurement is not affected by toe-in.

7.8 *Elevated Temperature Sustained Pressure Test*—The "test sample" shall be three specimens of a generally representative pipe or tubing size. Select one Table 5 Condition for the material designation and test the three specimen test sample. Condition test specimens per 7.2. Specimen length between end closures for 6-in. nominal size pipe and smaller shall be five times the pipe diameter, but not less than 12-in. [304-mm]. Specimen length between end closures for larger than 6-in. nominal size pipe shall be the lesser of three times the pipe diameter or 30-in. [762-mm]. Test per Test Method D1598 using water as the pressurizing medium for the minimum average hours before failure specified in Table 5.

7.9 *Apparent Tensile Strength at Yield Test*—A sample of pipe shall provide five ring specimens that shall be tested in accordance with Test Method D2290. Ring specimens shall be aligned so that the minimum wall is located at the disk split.

8. Marking

8.1 *Pipe*—Markings shall be legible, visible, and permanent. To ensure permanence, marking shall be applied so that removal requires physically removing part of the pipe wall. The marking shall not reduce the wall thickness to less than the minimum value for the pipe, shall not affect the long-term strength of the pipe, and shall not provide leakage channels for joining devices that seal or join to the outside surface of the pipe. The marking shall repeat at intervals not exceeding 2 ft [0.6 m]. Marking in a color that contrasts with that of the pipe is preferred.

8.2 The marking shall consist of the following:

8.2.1 The nominal pipe size followed by the sizing system used, such as IPS or MM or OD per 8.2.1.1.

8.2.1.1 Special size pipe shall be marked with the special size outside diameter value followed by the units and OD, for example, "XX IN OD" or "YY MM OD" where XX and YY are numbers.

8.2.2 The DR or the minimum wall thickness value followed by the wall thickness value units, for example, "XX DR", or "Y>YYY IN", or "ZZ.Z MM".

8.2.3 The manufacturer's name or trademark.

8.2.4 The material designation per Table 1.

NOTE 5—Changes to Specification D3350 and PPI TR-3 in 2005 and 2006 resulted in the material designation PE3408 being superseded by material designations PE3608 and PE4710. Recognizing that a period of time is necessary for the dissemination of information and to update specifications and literature, during a transitional period, product markings that include both older and newer materials designations, for example PE3408/PE3608, may occur.

8.2.5 ASTM F2619.

8.2.6 A manufacturing lot code.

8.2.6.1 The manufacturing lot code is determined by the manufacturer to provide information relating to pipe manufacture including production location, resin and other information such as production line and shift. Upon request, the manufacturer shall provide information for deciphering the manufacturing lot code.

8.2.7 The date of manufacture.

8.2.8 Additional optional markings such as coil number, footage, third-party certification marks, etc., shall follow the date of manufacture.

8.3 Markings referring to pipe pressure rating such as pressure rating, PR, working pressure, WP, working pressure rating, WPR, pressure class, PC, or nominal pressure, PN or NP, are prohibited.

8.4 *Using Color*—It is not mandatory to use color but when color is used, such as with stripes, the colors red, orange, blue, green, and purple (lavender) shall not be used.

8.5 Markings that identify potable water use are prohibited.

8.6 *Fittings*—Fittings shall be marked with the fitting specification designation: ASTM D2683, ASTM D3261, ASTM F1055, ASTM F1973, or ASTM F2206, per 6.1.1, 6.1.2, 6.1.3, 6.1.4 or 6.1.5 and shall be marked with the material designation per Table 1.

9. Quality Assurance

9.1 *Retest and Rejection*—Unless specified otherwise in this specification, if the results of any test(s) do not meet the requirements of this specification, retesting products represented by the test(s) by agreement between the manufacturer and the purchaser is permissible. However, there shall be no agreement to alter minimum requirements such as by omitting tests that are a part of the specification, substituting or modifying a test method, or changing specification limits. In retesting, the requirements of this specification shall be met and the test methods designated in this specification shall be followed. If failure occurs upon retest, the quantity of product represented by the test(s) does not meet the requirements of this specification.

9.2 When the product is marked with this designation, ASTM F2619, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

10. Keywords

10.1 gas; gas gathering; LVP; multiphase; oil; oilfield; PE fittings; PE line pipe; PE pipe; plastic pipe; polyethylene fittings; polyethylene line pipe; polyethylene pipe; water

SUPPLEMENTARY REQUIREMENTS

Federal Government Civil/Military Procurement

These requirements apply only to federal government civil/military procurement, not domestic sales or transfers.

S1. Responsibility for Inspection

S1.1 Unless otherwise specified in the contract or purchase order, the producer is responsible for performance of all inspection and test requirements specified herein. The producer shall use its own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1—In U.S. federal contracts, the contractor is responsible for inspection.

S2. Packaging and Marking for U.S. Government Procurement

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practices in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

S2.2 *Marking*— Marking for shipment shall be in accordance with FED-STD 123G for civil agencies and Military Standard 129P for military agencies.

NOTE S2—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLE QUALITY PROGRAM

X1.1 Pipe produced in accordance with this specification is manufactured using a quality program. The quality program in this appendix is an example only. Manufacturer's quality programs may be different from this example quality program.

X1.2 Where quality program information is confidential or proprietary, it is acceptable for the manufacturer to require measures to protect confidential and proprietary information against public disclosure.

X1.3 The results of tests conducted in accordance with specification requirements are made available to the purchaser upon request.

X1.4 The manufacturer maintains records of tests conducted in accordance with specification requirements for five years or for a period acceptable between the manufacturer and the purchaser.

X1.5 *Quality Control Samples*—To determine compliance with specification requirements, the sample and number of specimens required per the test method are tested. For quality control purposes, not for determining compliance with requirements, a one specimen sample is acceptable.

X1.6 *Testing Frequency*—Materials and pipe are tested at frequencies such as those in Table X1.1.

TABLE X1.1 Example Quality Program Tests and Testing Frequencies

Test Description	Testing Frequency
Materials	
Virgin material cleanliness	Each material lot before use
Virgin material density per Test Method D1238	Each material lot before use
Virgin material melt flow rate per Test Method D792 or Test Method D1505	Each material lot before use
Rework material cleanliness	Before use
Pipe	
Workmanship	Hourly or once per length, whichever is less frequent
End cut	Each length
Interior cleanliness	Each length
Diameter	Hourly or once per length, whichever is less frequent
Toe-in	Once per production run
Outside surface irregularity	At the beginning of the production run and daily during the production run
Percent ovality	At the beginning of the production run and daily during the production run
Wall thickness	Hourly or once per length, whichever is less frequent
Inside surface ductility	At the beginning of the production run and weekly during the production run
Elevated temperature sustained pressure	Every six months for pipe made from each material compound
Short-term pressurization	At the beginning of the production run; applies to 12-in. and smaller sizes; for 3-in. and larger, apparent tensile strength at yield is an alternate test
Apparent tensile strength at yield	At the beginning of the production run; applies to 3-in. and larger sizes; for 12-in. and smaller, short-term pressurization is an alternate test
Carbon black content	Daily during the production run

X2. PRESSURE RATING DESIGN

X2.1 *Pipe Pressure Design*:

X2.1.1 For the purposes of this specification, the design pressure for pipe of a given material, diameter, minimum wall thickness, service fluid application and service temperature is determined by:

$$P = \frac{2S}{\left(\frac{D_O}{t} - 1\right)} \times F_S \times F_T = \frac{2S}{(DR - 1)} \times F_S \times F_T \quad (X2.1)$$

where:

P = design pressure, psi [MPa],
S = hydrostatic design stress (HDS) at 73°F [23°C], psi [MPa] (Table 1),
F_S = service fluid design factor (Table X2.1),
F_T = temperature design factor (Table X2.2),
D_O = pipe outside diameter, in. [mm] (Table 2 or 5.2.8),
t = minimum wall thickness, in. [mm] (Table 3 or Table 4 or 5.2.8), and
DR = dimension ratio (Table 3 or Table 4 or 5.2.8).

$$DR = \frac{D_O}{t}$$

NOTE X2.1—Formulas for design pressure are published in various industry documents; however, term nomenclature and definition may vary depending on the specific formula. The nomenclature F_S and F_T have been chosen for use in this appendix, but these terms are not necessarily the same as similar terms in other published design pressure formulas. In particular, similar factors that are applied in design pressure formulas that use HDB for the design stress term rather than HDS as used in this appendix may have similar meanings but different values. When comparing design pressure obtained using the various published equations for pressure rating, the user should also compare the definitions for the terms used in the specific equation. Using factor values for one version of a design pressure equation in a different version of a design pressure equation can lead to erroneous results.

NOTE X2.2—Gas gathering lines in the United States may be subject to regulation in accordance with CFR 49 Part 192 when installed in Class 2, 3 or 4 locations as defined in CFR 49 Part 192. Regulated gas gathering lines are pressure rated (and pressure limited if applicable) in accordance with CFR 49 Part 192 and Federal Register Vol. 71, No. 50, March 15, 2006. For dry gas gathering in Class 2, 3 or 4 locations in the United States that are subject to U.S. Department of Transportation regulations per CFR 49 Part 192, contact the manufacturer for assistance in determining design pressure.

TABLE X2.1 Service Fluid Design Factor (F_S) for Use With X2.1.1

Service	F_S
Dry gas gathering[A]	1.00
Wet gas gathering	0.50
Multiphase fluid	0.50
Liquid hydrocarbons	0.50
Oilfield water	1.00[B]

[A] Dry gas gathering involves a service fluid that, given the design and operating conditions of the pipeline, contains no associated hydrocarbon liquids and is above the hydrocarbon dew point. The service fluid, in this case, may contain measurable quantities of water. See Note X2.2.
[B] Where oilfield water contains significant quantities of liquid hydrocarbons (≥2 %), 0.50 is used.

TABLE X2.2 Temperature Design Factor (F_T) for Use With X2.1.1[A]

Design Service Temperature		F_T	
°F	°C	PE3608	PE4710
≤50-60	≤10-16	1.16	1.12
>60-70	>16-21	1.08	1.05
>70-80	>21-27	1.00	1.00
>80-90	>27-32	0.90	0.93
>90-100	>32-38	0.82	0.87
>100-110	>38-43	0.75	0.65
>110-120	>43-49	0.68	0.61
>120-130	>49-54	0.61	0.56
>130-140	>54-60	0.54	0.52

[A] Table X2.2 factors were derived for the midrange temperature using the LTHS extrapolation formula in PPI TR-3. The temperature design factors in Table X2.2 are dependent on the PE compound and may or may not apply to PE3608 compounds having HDB's of 1600 psi [11.0 MPa] at 73°F [23°C] and 800 psi [5.5 MPa] at 140°F [60°C], and may or may not apply to PE4710 compounds having HDB's of 1600 psi [11.0 MPa] at 73°F [23°C] and 1000 psi [6.9 MPa] at 140°F [60°C]. PE materials that have different HDB's at 73°F [23°C] and at 140°F [60°C] will have different temperature design factors. *Before using* Table X2.2 *factors, consult with the manufacturer* to confirm HDB ratings at 73°F [23°C] and 140°F [60°C] and to determine if the temperature design factors in Table X2.2 are suitable for use with the manufacturer's PE compound. See also Note X2.1.

X2.1.2 Industry experience indicates that polyethylene piping that is handled with reasonable care, installed in accordance with applicable standards, and operated under normal service conditions gives satisfactory long-term service at the design pressures determined in accordance with X2.1.1. Other design pressures may be recommended by the pipe or fitting manufacturer or may be determined by the system designer for special or unusual application conditions such as those described in X2.1.3.

X2.1.3 Design pressures for a particular application will vary from standard ratings depending on actual application conditions. Smaller overall design factors should be applied to systems operating under special or unusual conditions or where the pipe transports fluids or is installed in an environment that is known to have some degrading effect on the properties of polyethylene, or when specified in Codes or Regulations or by the authority having jurisdiction. See Note X2.2. When used at temperatures above 80°F [27°C], elevated temperature stress ratings for the material are used to determine design pressure. The actual choice of design factors (and design pressure) for a particular application rests with the system designer, taking into account applicable Codes and Regulations, transportation and on-site handling conditions, the quality of installation, the fluid being transported, the external environment, and the possibility of deviation from design operating conditions of internal pressure and external load. A further uncertainty factor should be applied at the designing engineer's discretion where warranted by consideration of these or other conditions for the particular application. Users should consult the pipe manufacturer to confirm Table X2.1 service factors and Table X2.2 temperature factors and for elevated temperature and other

information relating to pipe performance in various applications and application conditions. Information is also available from the Plastics Pipe Institute, PPI.

X2.2 *Fitting Pressure Design*:

X2.2.1 The design pressure of fittings is determined by the fitting manufacturer, and should not be less than the design pressure of the pipeline system in which they are used.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2619/F2619M–11) that may impact the use of this standard.

(1) Updated material requirements.