



Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This specification covers polyethylene (PE) butt fusion fittings for use with polyethylene pipe (IPS, DIPS, and ISO) and tubing (CTS). Included are requirements for materials, workmanship, dimensions, marking, sustained pressure, and burst pressure.

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

2. Referenced Documents

2.1 ASTM Standards:²

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

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

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

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F412 Terminology Relating to Plastic Piping Systems

2.2 Federal Standard:

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

2.3 Military Standard:

MIL-STD-129 Marking for Shipment and Storage³

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.10 on Fittings.

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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.

³ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

2.4 National Sanitation Foundation Standard:

Standard No. 14 for Plastic Piping Components and Related Materials⁴

2.5 Plastic Pipe Institute⁵

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 Pipe⁷

PPI TR-4 HDB/SDB/PDB/MRS Listed Materials, 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

3. Terminology

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

3.2 *dimension ratio (DR) for thermoplastic pipe*—the ratio of diameter to wall thickness. For this specification it is calculated by dividing the specified outside diameter by the specified wall thickness of the fitting at its area of fusion. DRs are rounded and do not calculate exactly.

4. Classification

4.1 *General*—This specification covers butt fusion fittings intended for use with polyethylene pipe and tubing.

4.1.1 Fittings covered by this specification are normally molded. Fittings may be machined from extruded or molded stock.

4.1.2 Fittings fabricated by thermal welding are not included in this specification.

4.1.3 Fittings intended for use in the distribution of natural gas or petroleum fuels shall also meet the requirements of Specification D2513.

⁴ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.

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

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

TABLE 1 Specification D3350 Classification of Polyethylene Fittings Materials

Physical Properties	Cell Classification and Properties for Polyethylene Pipe Materials							
	PE2606	PE2706	PE2708	PE3608	PE3708	PE3710	PE4708	PE4710
Density	2	2	2	3	3	3	4	4
Melt Index	3 or 4	3 or 4	3 or 4	4	4	4	4	4
Flexural modulus	≥4	≥4	≥4	≥4	≥4	≥4	≥4	≥5
Tensile Strength	≥3	≥3	≥3	≥4	≥4	≥4	≥4	≥4
Slow crack growth resistance (F1473)	6	7	7	6	7	7	7	7
Hydrostatic strength classification	3	3	3	4	4	4	4	4
Color and UV Stabilizer ^A	C or E	C or E	C or E	C or E	C or E	C or E	C or E	C or E
HDB at 140°F (60°C), PPI TR-4, psi (MPa)	_B	_B	_B	_B	_B	_B	_B	_B
HDB at 73°F (23°C), PPI TR-4, psi (MPa)	630 (4.34)	630 (4.34)	800 (5.52)	800 (5.52)	800 (5.52)	1000 (6.90)	800 (5.52)	1000 (6.90)

^A See 6.2.

^B Listing required; consult manufacturer for listed value.

TABLE 2 IPS Sizing System Outside Diameters and Tolerances for Fittings for Use with Polyethylene Pipe, in.

Nominal Pipe Size	Average Outside Diameter at Area of Fusion ^A	Tolerance
1/2	0.840	±0.008
3/4	1.050	±0.008
1	1.315	±0.010
1 1/4	1.660	±0.010
1 1/2	1.900	±0.010
2	2.375	±0.010
3	3.500	±0.012
4	4.500	±0.015
6	6.625	±0.018
8	8.625	±0.025
10	10.750	±0.027
12	12.750	±0.036
14	14.000	±0.063
16	16.000	±0.072
18	18.000	±0.081
20	20.000	±0.090
21.5	21.500	±0.097
22	22.000	±0.099
24	24.000	±0.108
28	28.000	±0.126
32	32.000	±0.144
36	36.000	±0.162
42	42.000	±0.189
48	48.000	±0.216

^A Defined as measured 1/4 to 1/2 in. (6.4 to 12.7 mm) from fitting outlet extremity.

5. Ordering Information

5.1 When ordering fittings under this specification, the following should be specified:

5.1.1 Polyethylene compound (material designation or trade name)

5.1.2 Style of fitting (tee, 90° ell, and the like)

5.1.3 Size:

5.1.3.1 Nominal diameter.

5.1.3.2 CTS, IPS, DIPS, or schedule.

5.1.3.3 Dimension ratio number or schedule number.

6. Materials

6.1 *Polyethylene Compound*—Polyethylene material compounds suitable for use in the manufacture of fittings under this specification shall meet Specification D3350 and shall meet the Specification D3350 classification and property requirements in Table 1 and shall have PPI TR-4 HDB and HDS listings at 73°F (23°C) and HDB listings 140°F (60°C) in accordance with Table 1.

6.2 *Color and Ultraviolet (UV) Stabilization*—Polyethylene material compounds shall meet Specification Table 1 code C or E. Code C material compounds shall have 2 to 3 percent carbon black. Code E material compounds shall be colored with UV stabilizer.

6.3 *Rework Material*—Clean polyethylene compound from the manufacturer's own production that met 6.1 and 6.2 as virgin material is suitable for remolding into fittings, either alone or blended with new compound of the same cell classification or material designation. Fittings containing the rework material shall meet the material and product requirements of this specification.

7. Requirements

7.1 *Dimensions and Tolerances:*

7.1.1 *Outside Diameter*—Nominal outside diameters of butt fusion fittings shall conform to the nominal iron pipe size (IPS), ductile iron pipe size (DIPS) or copper tubing size (CTS) dimensions at area of fusion. These dimensions and tolerances shall be as shown in Table 2, Table 3, Table 4 and of this specification.

7.1.2 *Inside Diameter (CTS Fittings Only)*—Inside diameters of butt fusion fittings for tubing at area of fusion shall conform to the dimensions of the tubing being joined. The dimensions and tolerances for the fittings are shown in Table 5.

7.1.3 *Wall Thickness*—The wall thicknesses of butt fusion fittings shall not be less than the minimum specified for the pipe or tubing. The wall thicknesses and tolerances at the area of fusion shall be as shown in Table 5, Table 6, Table 7, and Table 8 of this specification.

7.1.4 *Measurements*—These shall be made in accordance with Test Method D2122 for roundable pipe.

7.1.5 *Design Dimensions*—Overall fitting dimensions may be as preferred from a design standpoint by the manufacturer and accepted by the purchaser consistent with 7.1.3.

7.1.6 *Special Sizes*—Where existing system conditions or special local requirements make other diameters or dimension

TABLE 3 DIPS Sizing System Outside Diameters and Tolerances for Fittings for Use with Polyethylene Pipe, in.

Nominal Pipe Size	Average Outside Diameter at Area of Fusion	Tolerance ^A
3	3.96	±0.016
4	4.80	±0.022
6	6.90	±0.031
8	9.05	±0.041
10	11.10	±0.050
12	13.20	±0.059
14	15.30	±0.069
16	17.40	±0.078
18	19.50	±0.088
20	21.60	±0.097
24	25.80	±0.116
30	32.000	±0.144
36	38.30	±0.172
42	44.50	±0.200
48	50.80	±0.229

^A Defined as measured ¼ to ½ in. (6.4 to 12.7) from fitting outlet extremity.

TABLE 4 ISO Sizing System (ISO 161/1) Outside Diameters and Tolerances for Fit for Use with Polyethylene Pipe, mm

Nominal Pipe Size	Average Outside Diameter at Area of Fusion	
	Min	Max ^A
90	90.0	90.8
110	110.0	111.0
160	160.0	161.4
200	200.0	201.8
250	250.0	252.3
280	280.0	282.5
315	315.0	317.8
355	355.0	358.2
400	400.0	403.6
450	450.0	454.1
500	500.0	504.5
560	560.0	565.0
630	630.0	635.7
710	710.0	716.4
800	800.0	807.2
900	900.0	908.1
1000	1000.0	1009.0
1200	1200.0	1210.8
1400	1400.0	1412.6
1600	1600.0	1614.4

^A Specified in ISO 3607.

ratios necessary, other sizes or dimension ratios, or both, shall be acceptable for engineered applications when mutually agreed upon by the customer and the manufacturer, if the fitting is manufactured from plastic compounds meeting the material requirements of this specification, and the strength and design requirements are calculated on the same basis as those used in this specification. For diameters not shown in **Table 2**, **Table 3** or **Table 4**, the tolerance shall be the same percentage as that shown in the corresponding tables for the next smaller listed size. Minimum wall thickness for these special sizes shall not be less than the minimum wall specified for the pipe or tubing the fitting is designed to be used with. The maximum wall thickness allowed shall not be greater than 20 % thicker than the specified minimum wall, and shall be determined by **10.4.3** of this specification.

7.2 Pressure Test Requirements :

7.2.1 *Short-Term Rupture Strength for Fittings ½ to 12 in. and 90 to 315 mm, Nominal Diameter*—The minimum short-term rupture strength of the fitting and fused pipe or tubing shall not be less than the minimum short-term rupture strength of the pipe or tubing in the system when tested in accordance with **10.5.3**. These minimum pressures shall be as shown in **Table 9** of this specification. Test specimens shall be prepared for testing in the manner described in **10.5.1** of this specification. The test equipment, procedures, and failures definitions shall be as specified in Test Method **D1599**.

7.2.2 *Short-Term Strength for Fittings 14 to 48 in. and 355 to 1600 mm, Nominal Diameter*—Fittings shall not fail when tested in accordance with **10.5.3**. The minimum pressure shall be as shown in **Table 9** of this specification. Test specimens shall be prepared for testing in the manner described in **10.2** of this specification. The test equipment and procedures shall be as specified in Test Method **D1599**.

7.2.3 *Sustained Pressure*—The fitting and fused pipe or tubing shall not fail, as defined in Test Method **D1598**, when tested at the time, pressures, and test temperatures selected from test options offered in **Table 10**. The test specimens shall be prepared for testing in the manner prescribed in **10.5.1**.

8. Workmanship, Finish, and Appearance

8.1 The manufacture of these fittings shall be in accordance with good commercial practice so as to produce fittings meeting the requirements of this specification. Fittings shall be homogeneous throughout and free of cracks, holes, foreign inclusions, or other injurious defects. The fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

9. Sampling

9.1 Parts made for sale under this specification should be sampled at a frequency appropriate for the end use intended. When the fittings are to be installed under a system specification (such as Specification **D2513** for gas), the minimum requirements of that specification must be satisfied.

10. Test Methods

10.1 *General*—The test methods in this specification cover fittings to be used with pipe and tubing for gas, water, and other engineered piping systems. Test methods that are applicable from other specifications will be referenced in the paragraph pertaining to the particular test. Certain special test methods applicable to this specification only are explained in the appropriate paragraph.

10.2 *Conditioning*—Unless otherwise specified, condition the specimens prior to test at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) for not less than 6 h in air, or 1 h in water, for those tests where conditioning is required and in all cases of disagreement. Newly molded fittings shall be conditioned 40 h prior to test.

10.3 *Test Conditions*—Conduct the tests at the standard laboratory temperature of $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) unless otherwise specified.

10.4 Dimensions and Tolerances:

10.4.1 *Outside Diameter*—Measure the outside diameter of the fittings at the area of fusion in accordance with the Wall

TABLE 5 Diameter, Wall Thickness, and Tolerances for Fittings for Use with Plastic Tubing

Tubing Type in. (mm)	Nominal Tubing Size, in.	Diameter at Area of Fusion ^A				Minimum Wall Thickness, in. (mm)
		Outside, in. (mm)		Inside, in. (mm)		
		Average	Tolerance	Average	Tolerance	
0.062 (1.57)	½ CTS	0.625 (15.88)	±0.010 (±0.26)	0.495 (12.58)	±0.004 (±0.10)	0.062 (1.58)
	¾ CTS	0.875 (22.22)	±0.010 (±0.26)	0.745 (18.92)	....	...
0.090 (2.29)	½ CTS	0.625 (15.88)	±0.010 (±0.26)	0.437 (11.10)	±0.004 (±0.10)	0.090 (2.28)
	¾ CTS	0.875 (22.22)	±0.010 (±0.26)	0.687 (17.44)	±0.004 (±0.10)	0.090 (2.28)
DR 11	1 CTS	1.125 (28.58)	±0.013 (±0.34)	0.937 (23.80)	±0.005 (±0.12)	0.090 (2.28)
	1¼ CTS	1.375 (34.92)	±0.013 (±0.34)	1.187 (30.14)	±0.005 (±0.12)	0.090 (2.28)
	¾ CTS	0.875 (22.22)	±0.010 (±0.26)	0.715 (18.16)	±0.004 (±0.10)	0.077 (1.96)
	1 CTS	1.125 (28.58)	±0.013 (±0.34)	0.915 (23.24)	±0.005 (±0.12)	0.101 (2.56)
DR 9.3	1¼ CTS	1.375 (34.92)	±0.013 (±0.34)	1.125 (28.58)	±0.005 (±0.12)	0.121 (3.08)
	½ CTS	0.625 (15.88)	±0.010 (±0.26)	0.483 (12.26)	±0.004 (±0.10)	0.067 (1.70)
	¾ CTS	0.875 (22.22)	±0.010 (±0.26)	0.679 (17.24)	±0.004 (±0.10)	0.094 (2.38)
	1 CTS	1.125 (28.58)	±0.013 (±0.34)	0.873 (22.18)	±0.005 (±0.12)	0.121 (3.08)
	1¼ CTS	1.375 (34.92)	±0.013 (±0.34)	1.069 (27.16)	±0.005 (±0.12)	0.148 (3.76)

^A Defined as measured ¼ to ½ in. (6.4 to 12.7 mm) from fitting outlet extremity.

TABLE 6 IPS Sizing System Wall Thickness and Tolerance at the Area of Fusion for Fittings for Use with Polyethylene Pipe, in.^{A,B,C}

Nominal Pipe Size	Minimum Wall Thickness									
	SCH 40	SCH 80	SDR 21	SDR 17	SDR 13.5	DR 10	DR 11.5	SDR 11	DR 9.3	SDR 9
½	0.109	0.147	...	...	...	...	...	0.076	0.090	...
¾	0.113	0.154	...	...	...	...	...	0.095	0.113	0.117
1	0.133	0.179	...	...	...	...	...	0.119	0.142	0.146
1¼	0.140	0.191	...	...	...	0.166	...	0.151	0.179	0.184
1½	0.145	0.200	...	...	...	...	...	0.173	0.204	0.211
2	0.154	0.218	...	...	...	...	...	0.216	0.256	0.264
3	0.216	0.300	...	...	0.259	...	0.305	0.318	0.377	0.389
4	0.237	0.337	...	0.264	0.333	...	0.392	0.409	0.484	0.500
6	0.280	0.432	0.316	0.390	0.491	...	0.576	0.603	0.713	0.736
8	0.322	...	0.410	0.508	0.639	...	0.750	0.785	0.928	0.958
10	0.365	...	0.511	0.633	0.797	...	0.935	0.978	1.156	1.194
12	0.406	...	0.608	0.750	0.945	...	1.109	1.160	1.371	1.417
14	...	...	0.667	0.824	...	...	...	1.273	1.505	1.556
16	...	...	0.762	0.941	...	...	...	1.455	1.720	1.778
18	...	...	0.857	1.059	...	...	...	1.636	1.935	2.000
20	...	...	0.952	1.176	...	...	...	1.818	2.151	2.222
21.5	...	...	1.024	1.265	...	...	...	...	...	...
22	...	...	1.048	1.294	...	...	...	2.000	2.366	2.444
24	...	...	1.143	1.412	...	...	...	2.182	2.581	...
28	...	...	1.333	1.647	...	...	...	2.545	...	...
32	...	...	1.524	1.882	...	...	...	2.909	...	...
36	...	...	1.714	2.118	...	...	...	...	...	...
42	...	...	2.000	2.471	...	...	...	...	...	...
48	...	...	2.286	...	...	...	...	...	...	...

^A Tolerance +20 %, -0 %.

^B For those SDR groups having overlapping thickness requirements, a manufacturer may represent their product as applying to the combination (for example, 11.0/11.5) so long as their product falls within the dimensional requirements of both DR's.

^C For wall thicknesses not listed the minimum wall thickness may be calculated by the average outside diameter/SDR rounded up to the nearest 0.001 in.

Thickness section of Method **D2122** by use of a circumferential tape readable to the nearest 0.001 in. (0.02 mm).

10.4.2 Inside Diameter (CTS Fittings Only)—Use a stepped plug gage to determine the inside diameter of the CTS end of the fitting. The plug gage shall be of the go/no go type and shall have ½-in. (12.7-mm) land lengths cut to the minimum inside diameter and maximum inside diameter. A fitting is unacceptable (no go) if it fits snugly on the minimum inside diameter land of the gage or if it fits loosely on the maximum diameter land of the gage.

10.4.3 Wall Thickness—Make a series of measurements using a cylindrical anvil tubular micrometer or other accurate device at closely spaced intervals to ensure that minimum and

maximum wall thicknesses to the nearest 0.001 in. (0.02 mm) have been determined. Make a minimum of six measurements at each cross section.

10.5 Pressure Testing:

10.5.1 Preparation of Specimens for Pressure Testing—Prepare test specimens in such a manner that each, whether individual fittings or groups of fittings, is a system incorporating at least one length of pipe or tubing. Fuse all fitting outlets with the appropriate size pipe or tubing. At least one piece of pipe or tubing in the system shall have a minimum length equal to five pipe diameters.

10.5.2 Sustained Pressure Test: