



Standard Specification for Butt Heat Fusion Polyamide(PA) Plastic Fitting for Polyamide(PA) Plastic Pipe and Tubing¹

This standard is issued under the fixed designation F1733; 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 polyamide (PA) butt fusion fittings for use with polyamide pipe (IPS and Metric) 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.

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.*

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

- 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

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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.

- D4066 Classification System for Nylon Injection and Extrusion Materials (PA)
- D6779 Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA)
- F412 Terminology Relating to Plastic Piping Systems
- F2785 Specification for Polyamide 12 Gas Pressure Pipe, Tubing, and Fittings
- F2945 Specification for Polyamide 11 Gas Pressure Pipe, Tubing, and Fittings
- 2.2 *Federal Standard:*³
 - Fed. Std. No. 123 Marking for Shipment (Civil Agencies)
 - CFR Title 49 Part 192 Transportation of Natural and Other Gas By Pipeline: Minimum Federal Safety Standards
- 2.3 *Military Standard:*
 - MIL-STD-129 Marking for Shipment and Storage³
- 2.4 *National Sanitation Foundation Standard:*
 - Standard No. 14 for Plastic Piping Components and Related Materials⁴
 - NSF/ANSI 61 Drinking Water System Components – Health Effects Standard Overview

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 polyamide pipe and tubing.

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

³ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

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

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

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 F2945 for PA11 materials or Specification F2785 for PA12 materials.

5. Ordering Information

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

- 5.1.1 Polyamide 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, or schedule.
 - 5.1.3.3 Dimension ratio number or schedule number.

6. Materials

6.1 *Basic Materials*—This specification covers fittings made from polyamide plastics as defined in Specifications D4066 or D6779.

NOTE 1—The PA plastic fittings intended for use in the transport of potable water should be evaluated and certified as safe for this purpose by a testing agency acceptable to the local health authority. The evaluation should be in accordance with requirements for chemical extraction, taste, and odor, that are no less restrictive than those included in National Sanitation Foundation (NSF) Standard No. 14. The seal or mark of the laboratory making the evaluation should be included on the pipe and tubing.

6.2 *Compounds*—The polyamide fittings compounds shall meet the requirements for Group 3, Class 2, and Grade 3, or Group 4, Class 2 and Grade 3 as prescribed in Specifications D4066 or D6779.

NOTE 2—Fittings produced from compounds meeting the requirements of Group 3, Class 2, and Grade 3 (PA 323) are intended for use with pipe manufactured from compounds meeting the requirements of Group 3, Class 2, and Grade 3. Fittings produced from compounds meeting the requirements of Group 4, Class 2, and Grade 3 (PA 423) are intended for use with pipe manufactured from compounds meeting the requirements of Group 4, Class 2, and Grade 3. As per the recommendations of respective resin manufacturers, no cross fusion between PA 323 pipe and fittings and PA 423 pipe and fittings is permitted.

6.3 *Rework Material*—Clean rework material generated from the manufacturer’s own production may be used by the same manufacturer as long as the fittings produced conform to the 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) or copper tubing size (CTS) dimensions at area of fusion. These dimensions and tolerances shall be as shown in Table 1, Table 2, and Table 3 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 3.

TABLE 1 IPS Sizing System Outside Diameters and Tolerances for Fittings for Use with Polyamide Pipe, in.

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

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

TABLE 2 Metric Sizing System (ISO 161/1) Outside Diameters and Tolerances for Fit for Use with Polyamide 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.

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 3, Table 4, and Table 5 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.

7.2 *Pressure Test Requirements :*

TABLE 3 Diameter, Wall Thickness, and Tolerances for Fittings for Use with Polyamide 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 in. (6.4 mm) from fitting outlet extremity.

TABLE 4 IPS Sizing System Wall Thickness and Tolerance at the Area of Fusion for Fittings for Use with Polyamide 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.

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 6 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 failure 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 6 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 7. 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

TABLE 5 Metric Sizing System Wall Thickness and Tolerance at the Area of Fusion for Fittings for Use with Polyamide Pipe, (mm)^{A,B,C}

Nominal Pipe Size	Minimal Wall Thickness					
	DR 41	DR 32.5	DR 26	DR 21	DR 17	DR 11
90	3.5	4.3	5.3	8.2
110	...	3.4	4.2	5.2	6.5	10.0
160	...	4.9	6.2	7.6	9.4	14.5
200	...	6.2	7.7	9.5	11.8	18.2
250	...	7.7	9.6	11.9	14.7	22.7
280	...	8.6	10.8	13.3	16.5	25.5
315	...	9.7	12.1	15.0	18.5	28.6
355	...	10.9	13.7	16.9	20.9	32.3
400	...	12.3	15.4	19.0	23.5	36.4
450	...	13.8	17.3	21.4	26.5	...
500	...	15.4	19.2	23.8	29.4	...
560	...	17.2	21.5	26.7	32.9	...
630	...	19.4	24.2	30.0	37.1	...
710	...	21.8	27.3	33.8	41.8	...
800	...	24.6	30.8	38.1	47.1	...
900	...	27.7	34.6	42.9	...	...
1000	24.4	30.8	38.5	47.6	...	...
1200	29.3	36.9	46.2	...	...	...
1400	34.1	43.1	...	...	...	...
1600	39.0	49.2	...	...	...	...

^A Tolerance +20 %, -0 %.

^B For those SDR groups having overlapped 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.

uniform as commercially practicable in color, opacity, density, and other physical properties.

9. Sampling

9.1 Fittings made for sale under this specification shall be sampled at a frequency appropriate for the end use intended. When the fittings are to be installed under a system specification 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 ± 3.6 °F (23 ± 2 °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 ± 3.6 °F (23 ± 2 °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

Thickness section of Test 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:

10.5.2.1 Select the test temperature and pressures from one of the options offered in **Table 7**.

10.5.2.2 Select the test specimens at random and condition at the selected option test temperature. Test the fitting specimens with water, in accordance with Test Method **D1598** at the selected option, stress, and hours of testing.

NOTE 3—Other test mediums and test conditions than offered in **Table 7** may be used as agreed upon between the manufacturer and the purchaser.

10.5.2.3 Test six specimens at the selected option conditions and time.

10.5.2.4 Failure of two of the six specimens tested shall constitute failure of the test. Failure of one of the six specimens tested is cause for retest of six additional specimens. Failure of one of the six specimens in retest shall constitute failure of the test.

10.5.3 *Minimum Hydrostatic Burst Pressure for Fittings ½ to 12 in. and 90 to 315 mm, Nominal Diameter*—The test equipment, procedures, and failure definitions shall be as specified in Test Method **D1599**. The hydrostatic pressure shall be increased at a uniform rate such that the specimen fails between 60 and 70 s from start of the test. Minimum failure pressures are shown in **Table 6**.

10.5.4 *Minimum Hydrostatic Pressure for Fittings 14 to 48 in. and 355 to 1600 mm, Nominal Diameter*—The test equipment and procedures shall be as specified in Test Method **D1599**. The hydrostatic pressure shall be increased at a uniform rate such that the test pressure is reached within 60 to 70 s from the start of the test. No failure should occur in the sample during the test period.