



Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE)¹

This standard is issued under the fixed designation F2206; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification establishes requirements for fabricated fittings intended for use with outside-diameter controlled polyethylene pipe and tubing. These fittings are manufactured by heat-fusion joining shape-modified polyethylene components prepared from pipe, molded fittings, sheet, billet, or block. Included are requirements for materials, design, workmanship, minimum dimensions, marking, test methods, and quality control.

1.2 Pressure rating of the fabricated-fitting design is beyond the scope of this standard and shall be established by the fitting manufacturer. This specification includes requirements for both elevated temperature pressure-tests and short-term pressurization tests to demonstrate a reasonable level of performance of the fabricated-fitting design at the pressure rating established by the fitting manufacturer.

1.3 The pressure-tests requirements are specified by the fittings' equivalent (E) DR. The EDR specified is the DR of the piping system for which the fabricated fitting is intended to be butt-fused.

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

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

1.6 The following safety hazards caveat pertains only to the test methods portion, Section 9, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

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.

Current edition approved Dec. 1, 2014. Published January 2015. Originally approved in 2002. Last previous edition approved in 2011 as F2206 – 11. DOI: 10.1520/F2206-14.

2. Referenced Documents

2.1 ASTM Standards:²

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

D3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

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

F412 Terminology Relating to Plastic Piping Systems

F714 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

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

F2880 Specification For Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes 3/4 in. to 65 in.

F3034 Specification for Billets made by Winding Molten Extruded Stress-Rated High Density Polyethylene (HDPE)

2.2 Federal Standards:³

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

OPS Part 192 Title 49, Code of Federal Regulations

2.3 Military Standard:³

MIL-STD-129 Marking for Shipment and Storage

2.4 ANSI/NSF Standard:⁴

ANSI/NSF 61 for Drinking Water System Components—Health Effects

2.5 Plastic Pipe Institute:⁵

TR-4 Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB),

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 DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 <http://quicksearch.dla.mil/>

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.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

Pressure Design Basis (PDB) and Minimum Required Strength (MRS) for Thermoplastic 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 Definitions:

3.2.1 *butt-fusion end(s), n*—the butt end(s) of the fabricated fitting intended for field fusion by the installer.

3.2.2 *billet, n*—a mass formed from a single stress-rated polyethylene compound in the approximate shape of a thick-walled cylindrical shell. (See Specification **F3034**.)

3.2.3 *fabricated fitting, n*—a fitting constructed from manufactured polyethylene components or materials.

3.3 Abbreviations:

3.3.1 *DIPS*—ductile iron pipe size.

3.3.2 *DR*—dimension ratio.

3.3.3 *EDR*—equivalent dimension ratio. The DR of the pipe to which the fitting is to be joined.

3.3.4 *IPS*—iron pipe size.

3.3.5 *OD*—outside diameter.

4. Classification

4.1 *General*—This specification establishes requirements for fabricated fittings intended for butt-fusion joining to polyethylene pipe.

4.1.1 Fabricated fittings intended for use in the distribution of natural gas or other fuel gases shall also meet the requirements of Specification **D2513**.

5. Ordering Information

5.1 When ordering fittings under this specification include the following information:

5.1.1 Polyethylene compound (material designation or trade name).

5.1.2 Style of fitting (3 piece tee, 5 segment 90° ell, etc.).

5.1.3 Size:

5.1.3.1 Nominal size of end connections.

5.1.3.2 End configurations (for example, IPS or DIPS).

5.1.3.3 System DR.

6. Material

6.1 Polyethylene materials allowed for use in fittings produced in accordance with this specification shall be in accordance with the manufacturer's fabricated-fitting design specifications. In addition:

6.1.1 Polyethylene pipe used in the production of fittings in accordance with this specification shall meet the requirements of Specification **F714**, **D3035**, **F2619/F2619M** or **D2513**.

6.1.2 Molded PE fittings used in the production of fabricated fittings in accordance with this specification shall meet the requirements of Specification **D3261**.

6.1.3 Flange adaptors used in the production of fabricated fittings in accordance with this specification shall meet the requirements of Specification **F2880**.

6.1.4 Billet used in the production of fabricated fittings in accordance with this specification shall meet the requirements of Specification **F3034**.

6.1.5 Sheet, block or plate stock used in the production of fabricated fittings shall be produced from stress-rated polyethylene compounds listed in PPI's TR-4.

NOTE 1—Manufacturers should use appropriate quality assurance procedures to ensure that sheet, block and plate are free from voids, laminations, foreign inclusions, cracks, and other injurious defects.

7. Requirements

7.1 *Dimension and Tolerances*—Butt-fusion ends shall be produced from fittings or pipe conforming to Specification **D3261**, or by machining billet, block, sheet, plate, or pipe to the required dimensions.

7.1.1 *Diameter*—Nominal outside-diameter of the butt-fusion end shall conform to the IPS or DIPS dimension at area of fusion. Outer-diameter dimensions and tolerances at the area of fusion shall be as shown in **Table 1** or **Table 2**.

7.1.2 *Wall Thickness*—The minimum wall thickness of the butt-fusion end shall be in accordance with **Table 1** or **Table 2** when measured in accordance with Test Method **D2122**. Conditioning to standard temperature but not to standard humidity is required.

7.1.3 *Eccentricity*—The wall thickness variability of the butt-fusion end as measured and calculated in accordance with Test Method **D2122**, in any diametrical cross-section of the pipe shall not exceed 12 %.

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

7.1.5 *Laying Lengths*—Laying length dimensions shall be defined by the manufacturer.

7.1.6 *Special Sizes*—Where existing system conditions or special local requirements make other diameters or dimension 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 fitting performs in accordance with the requirements in this specification. For diameters not shown in **Table 1** or **Table 2**, the tolerance shall be the same percentage as that shown in the corresponding tables for the next smaller listed size. Minimum wall thickness at the butt-fusion end for these special sizes shall not be less than the minimum wall thickness specified for the pipe the fitting is designed to be used with.

7.2 *Physical Requirements*—Fabricated fittings using miter cut pipe stock shall be manufactured from pipe stock with a wall thickness that is at least 22% greater than that of the pipe to which the fitting is to be joined. (For example: An EDR11 fitting shall be made using DR9 pipe stock.)

7.3 *Pressure Test Requirements*—Design validation tests per **7.3.1** and **7.3.2** shall be conducted on “test samples” that are representative of:

—Each of three (3) size groupings - 12 in. (300 mm) and smaller, greater than 12 to less than 24 in. (300 to less than 600 mm), and 24 in. (600 mm) and larger.

—Each style of fitting (for example, 4 segment 90 Elbow, Straight Tee, etc.).

TABLE 1 IPS Sizing System: Butt-Fusion End Dimensions, in.

Size IPS	Average OD ^A	Minimum Wall Thickness ^B versus DR									
		7.3	9	9.3	11	13.5	15.5	17	21	26	32.5
2	2.38	...	0.26	...	0.22	0.18	...	0.14	...	...	...
3	3.500	0.479	0.389	0.376	0.318	0.259	0.226	0.206	0.167	0.135	0.108
4	4.500	0.616	0.500	0.484	0.409	0.333	0.290	0.265	0.214	0.173	0.138
5	5.563	0.762	0.618	0.598	0.506	0.412	0.359	0.327	0.265	0.214	0.171
6	6.625	0.908	0.736	0.712	0.602	0.491	0.427	0.390	0.315	0.255	0.204
8	8.625	1.182	0.958	0.927	0.784	0.639	0.556	0.507	0.411	0.332	0.265
10	10.750	1.473	1.194	1.156	0.977	0.796	0.694	0.632	0.512	0.413	0.331
12	12.750	1.747	1.417	1.371	1.159	0.944	0.823	0.750	0.607	0.490	0.392
14	14.000	1.918	1.556	1.505	1.273	1.037	0.903	0.824	0.667	0.538	0.431
16	16.000	2.192	1.778	1.720	1.455	1.185	1.032	0.941	0.762	0.615	0.492
18	18.000	2.466	2.000	1.935	1.636	1.333	1.161	1.059	0.857	0.692	0.554
20	20.000	...	2.222	2.151	1.818	1.481	1.290	1.176	0.952	0.769	0.615
22	22.000	...	2.444	2.366	2.000	1.630	1.419	1.294	1.048	0.846	0.677
24	24.000	...	2.667	2.581	2.182	1.778	1.548	1.412	1.143	0.923	0.738
26	26.000	...	...	2.796	2.364	1.926	1.677	1.529	1.238	1.000	0.800
28	28.000	...	...	3.011	2.545	2.074	1.806	1.647	1.333	1.077	0.862
30	30.000	...	...	3.226	2.727	2.222	1.935	1.765	1.429	1.154	0.923
32	32.000	...	...	...	2.909	2.370	2.065	1.882	1.524	1.231	0.985
34	34.000	...	...	...	3.091	2.519	2.194	2.000	1.619	1.308	1.046
36	36.000	...	...	...	3.273	2.667	2.323	2.118	1.714	1.385	1.108
42	42.000	...	...	...	...	...	2.710	2.471	2.000	1.615	1.292
48	48.000	...	...	...	...	...	3.097	2.824	2.286	1.846	1.477
54	54.000	...	...	...	...	...	...	3.176	2.571	2.077	1.662

^A Tolerance on OD is ± 0.45 %.

^B Eccentricity of wall shall not exceed 12 %.

TABLE 2 DIPS Sizing System: Butt-Fusion End Dimensions, in.

Size DIPS	Average OD ^A	Minimum Wall Thickness ^B versus DR						
		9	11	13.5	17	21	26	32.5
3	3.96	0.389	0.360	0.294	0.233	0.189	0.153	0.122
4	4.80	0.500	0.437	0.356	0.283	0.229	0.185	0.148
6	6.90	0.736	0.628	0.512	0.406	0.329	0.266	0.213
8	9.05	0.958	0.823	0.670	0.533	0.431	0.348	0.279
10	11.10	1.194	1.009	0.823	0.653	0.529	0.427	0.342
12	13.20	1.417	1.200	0.978	0.777	0.629	0.508	0.407
14	15.30	1.556	1.391	1.134	0.900	0.729	0.589	0.471
16	17.40	1.778	1.582	1.289	1.024	0.829	0.670	0.536
18	19.50	2.000	1.773	1.445	1.147	0.929	0.750	0.600
20	21.60	2.222	1.964	1.600	1.271	1.029	0.831	0.665
24	25.80	2.667	2.346	1.912	1.518	1.229	0.993	0.794
30	32.00	...	2.909	2.371	1.883	1.524	1.231	0.985
36	38.30	...	3.482	2.837	2.253	1.824	1.473	1.179
42	44.50	...	4.046	3.297	2.618	2.119	1.712	1.370
48	50.80	...	4.619	3.763	2.989	2.419	1.954	1.563

^A Tolerance on OD is ± 0.45 %.

^B Eccentricity of wall shall not exceed 12 %.

A single EDR sample shall be considered as representative of all of the wall thickness' produced in that size and style grouping. The EDR of the test fitting(s) shall be in the mid range of the wall thickness' typically produced for that size grouping. Fitting styles are characterized as elbows, tees, wyes, crosses, reducing tees, reducing laterals, branch saddles, mechanical joint adapters, and end caps.

7.3.1 Elevated Temperature Sustained Pressure Test—The “test sample” shall be three specimens. Each specimen shall have a minimum distance of three pipe diameters between end closure(s) and any miter joints in the fitting(s).

7.3.2 Short-term Pressurization Testing—Quick Burst of Non-Failure testing shall be conducted. The “test sample” shall be five specimens. Each specimen shall have a minimum

distance of three pipe diameters between end closure(s) and any miter joints in the fittings(s).

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.

8.2 The procedure used for the heat fusion in the fabrication process shall be written and qualified in accordance with the

requirements of OPS 49 CFR Part 192.283 “Plastic Pipe: Qualifying Joining Procedures.”

8.3 All personnel engaged in the heat fusion process shall be qualified in accordance with the requirements of OPS 49 CFR Part 192.285 “Plastic Pipe: Qualifying Persons to Make Joints.”

9. Test Methods

9.1 *General*—The test methods in this specification apply to fittings for use with pipe and tubing for gas, water, and other engineered piping systems.

9.2 *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.

9.3 *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.

9.4 *Dimensions and Tolerances:*

9.4.1 *Outside Diameter*—Measure the outside diameter of the fittings at the butt-fusion end in accordance with the Wall Thickness section of Test Method **D2122** by use of circumferential tape readable to the nearest 0.001 in. (0.02 mm). Other methods may be used if proven to be equivalent.

9.4.2 *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 thickness to the nearest 0.01 in. (0.2 mm) have been determined. Make a minimum of six measurements at each butt-fusion end.

9.5 *Pressure Testing:*

9.5.1 *Preparation of Specimens for Pressure Testing*—Test samples may be individual fittings or groups of fittings. The distance between end closures and the nearest miter joint in the

fitting or in adjacent fittings shall be equal to three pipe diameters, measured on the OD.

9.5.2 *Elevated Temperature Sustained Pressure Test:*

9.5.2.1 The “test sample” specimens shall be tested and evaluated in accordance with the procedures in 6.2 of Specification **F714**.

9.5.2.2 Failure of one of the three specimens shall constitute failure of the test.

9.5.3 *Short Term Pressurization Test:*

9.5.3.1 The “test sample” specimens shall be tested and evaluated in accordance with the procedures in 6.1 of Specification **F714**.

9.5.3.2 Failure of one of the five specimens shall constitute failure of the test.

10. Product Marking

10.1 Fittings shall be marked with the following:

10.1.1 This designation; “ASTM F2206,”

10.1.2 Manufacturer’s name or trademark,

10.1.3 Material designations (such as PE2606, PE3608, or PE4710),

10.1.4 Date of manufacture or manufacturing code, and

10.1.5 Nominal size and fitting EDR.

10.2 Where recessed marking is used, such marking shall have no injurious effect on the product’s performance.

11. Quality Assurance

11.1 When the product is marked with this designation, ASTM F2206, 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.

12. Keywords

12.1 fabricated fittings; polyethylene

SUPPLEMENTARY REQUIREMENTS

This requirement applies whenever a Regulatory Authority or user calls for the product to be used to convey or to be in contact with potable water.

S1. Potable Water Requirement

S1.1 Products intended for contact with potable water shall be evaluated, tested, and certified for conformance with ANSI/NSF Standard 61 by an acceptable certifying organization

when required by the regulatory authority having jurisdiction.

GOVERNMENT/MILITARY PROCUREMENT

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

S2. Responsibility for Inspection

S2.1 Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his 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 2—In federal contracts, the contractor is responsible for inspection.

S3. Packaging and Marking for U.S. Government Procurement

S3.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destina-

tion 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.

S3.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE 3—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.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2206–11) that may impact the use of this standard.

(1) Revision of Title from —Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock to —Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE).

(2) Revision of Scope (Section 1) to add billet to the list of materials useful for fabrication.

(3) Revision of Referenced Documents (Section 2) to add Specification F3034.

(4) Revision of Terminology (Section 3) to include a definition for billet.

(5) Revision of Classification (Section 4) to delete the non-mandatory statement in 4.1.1 and renumber sections that follow sequentially.

(6) Revision of Material (Section 6) to add billets manufactured in accordance to Specification F3034 to the list of polyethylene materials allowed for use in fittings produced in accordance with this specification and renumber sections that follow sequentially.

(7) Revision of Requirements (Section 7) to add billet to the list of materials useful for fabrication.

(8) Revision of Summary of Changes.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; http://www.copyright.com/