Designation: D 2513 – 00

An American National Standard

Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings[1]

This standard is issued under the fixed designation D 2513; 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.

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

1. Scope

1.1 This specification covers requirements and test methods for material (see Appendix X1) dimensions and tolerances, hydrostatic burst strength, chemical resistance, and impact resistance of plastic pipe, tubing, and fittings for use in fuel gas mains and services for direct burial and reliner applications. The annexes provide specific requirements and test methods for each of the materials currently approved. If and when additional materials are available, specific annex requirements will be added. The pipe and fittings covered by this specification are intended for use in the distribution of natural gas. Requirements for the qualifying of polyethylene systems for use with liquefied petroleum gas are covered in Annex A1.

1.1.1 This specification does not cover threaded pipe. Design considerations are discussed in Appendix X2. In-plant quality control programs are specified in Annex A3 and Annex A4.

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

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

1.4 The following is an index of the annexes and appendixes in this specification:

Annex	Subject
A1	Polyethylene (PE) Pipe and Fittings
A2	Poly (Vinyl Chloride) (PVC) Pipe and Fittings
A3	In-Plant Quality Control for all materials up to 12 in.
A4	In-Plant Quality Control for PE materials between 14 and 24 in.
A5	Polyamide (PA) Pipe and Fittings
Appendixes	**Subject**
X1	New Materials
X2	Design Consideration

1.5 The following precautionary caveat pertains only to the test method portion, Section 6, 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

2.1.1 *Terminology:*

D 1600 for Abbreviated Terms Relating to Plastics[2]

F 412 Relating to Plastic Piping Systems[3]

2.1.2 *Test Methods for:*

D 543 Resistance of Plastics to Chemical Reagents[2]

D 638 Tensile Properties of Plastics[2]

D 1238 Flow Rates of Thermoplastics by Extrusion Plastometer[2]

D 1598 Time-to-Failure of Plastic Pipe Under Constant Internal Pressure[3]

D 1599 Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings[3]

D 2122 Determining Dimensions of Thermoplastic Pipe and Fittings[3]

D 2290 Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method[3]

D 2837 Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials[3]

F 1473 Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins[3]

2.1.3 *Practices for:*

D 618 Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 1898 Sampling of Plastics[4]

D 2657 Heat Fusion Joining of Polyolefin Pipe and Fittings[3]

D 2774 Underground Installation of Thermoplastic Pressure Piping[3]

F 699 Accelerated Conditioning of Polybutylene Pipe and Tubing for Subsequent Quality Control Testing[3]

2.1.4 *Specification for:*

F 1563 Tools to Squeeze-off Polyethylene (PE) Gas Pipe or Tubing[3]

[1] This specification is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.60 on Gas.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.04.

[4] Discontinued; see *1997 Annual Book of ASTM Standards*, Vol 08.01.

2.2 *ANSI Standards:*
B 16.40 Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems[5]
B 31.8 Gas Transmission and Distribution Piping Systems[5]
2.3 *Federal Specifications:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[6]
OPS Part 192 Title 49, Code of Federal Regulations[6]
2.4 *Military Standards:*
MIL-STD-129 Marking for Shipment and Storage[6]
MIL-STD-1235 (ORD) Single- and Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes
2.5 *Other Documents:*
National Fire Protection Association: NFPA 58, Storage and Handling Liquefied Petroleum Gases[7]

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified.

3.2 The gas industry terminology used in this specification is in accordance with ANSI B31.8 or 49 CFR Part 192, unless otherwise indicated.

3.3 The term *pipe* used herein refers to both pipe and tubing unless specifically stated otherwise.

3.4 *re-rounding equipment*—equipment used to reform the pipe and permanently reduce ovality to 5% or less.

3.5 *rounding equipment*—equipment, devices, clamps, etc., used to temporarily hold the pipe round while out-of-roundness measurements are made, or a joining procedure (heat fusion, electrofusion, or mechanical) is performed.

3.6 *standard thermoplastic material designated code*—the pipe material designation code shall consist of the abbreviation for the type of plastic (PE, PVC, or PA) followed by Arabic numerals which describe the short term properties in accordance with applicable ASTM standards, the hydrostatic design stress for water at 73.4°F (23°C) in units of 100 psi with any decimal figures dropped. Where the hydrostatic design stress code contains less than two figures, a zero is used before the number. Thus, a complete material designation code shall consist of two or three letters and four figures for plastic pipe materials. For example, PE 2406 is a grade P24 polyethylene with a 630 psi design stress for water at 73.4°F (23°C). The hydrostatic design stresses for gas are not used in this designation code.

3.7 *thermoplastic pipe dimension ratio (DR)*—the ratio of pipe diameter to wall thickness. It is calculated by dividing the specified outside diameter of the pipe, in inches, by the minimum specified wall thickness, in inches. The standard dimension ratio (SDR) is a common numbering system which is derived from the ANSI preferred number series R 10.

3.8 *toe-in*—a small reduction of the outside diameter at the cut end of a length of thermoplastic pipe.

4. Materials

4.1 *General*—The plastic used to make pipe and fittings shall be virgin plastic or reworked plastic (see 4.2) as specified in the Annexes and shall have a Plastics Pipe Institute (PPI) long-term hydrostatic design stress and hydrostatic design basis rating.

4.2 *Rework Material*—Clean rework material of the same commercial designation, generated from the manufacturer's own pipe and fitting production shall not be used unless the pipe and fitting produced meet all the requirements of this specification.

NOTE 1—References and material descriptions for ABS, CAB, PB, PE2306, PE3306 and PE3406 have been removed from D 2513. Elimination of these materials does not affect the pipelines that are in service. They can still be used for gas distribution. The main reason for removing these materials from this standard is to reflect the current state of the art in gas distribution plastic piping.

5. Requirements

5.1 *General*—See the annexes for specific product requirements in addition to the following. Pipe shall be supplied in either coils or straight lengths. Any pipe supplied in coils must meet the same requirements before and after coiling.

5.2 *Workmanship*—The pipe and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusion, blisters, and dents, or other injurious defects. The pipe and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

5.3 *Pipe and Tubing Dimensions and Tolerances*:

5.3.1 *Dimension*—The dimensions shall be specified by wall thickness and outside diameter.

5.3.1.1 *Diameters*—The outside diameter shall meet the requirements given in Table 1 or Table 2 when measured in accordance with 6.5.

5.3.1.2 *Toe-In*—When measured in accordance with 6.5.1.1, the outside diameter at the cut end of the pipe shall not be more than 1.5 % smaller than the undistorted outside diameter. Measurement of the undistorted outside diameter shall be made no closer than 1.5 pipe diameters or 11.8 in. (300 mm), whichever distance is less, from the cut end of the pipe. Undistorted outside diameter shall meet the requirements of Table 1 or Table 2.

5.3.1.3 *Wall Thickness*—The wall thickness shall be as specified in Table 2 or Table 3 when measured in accordance with 6.5.1.2. The minimum wall thickness at any point of measurement shall be not less than the minimum wall thickness specified in Table 2 or Table 3.

5.3.1.4 *Wall Thickness Eccentricity Range*— The wall thickness eccentricity range shall be within 12 % when measured in accordance with 6.5.1.3.

5.3.1.5 *Ovality*—The ovality (cross section) of 3 in. IPS (88.9 mm) and smaller pipe shall not exceed 5 % when measured in accordance with 6.5.3. Measurements of coiled pipe shall be made on a sample cut from the coil, and in case of disagreement, conditioned per 6.3.

NOTE 2—Other factors, that is, installation compaction, static soil loading, and dynamic vehicular loads may increase the ovality; therefore, 5 % was chosen as the limit for the amount contributed by manufacturing,

[5] Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.
[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111 – 5094, Attn: NPODS.
[7] National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

TABLE 1 Outside Diameters and Tolerances for Plastic Pipe, in. (mm)

Nominal Pipe Size	Outside Diameter	Tolerance	Maximum Out-of-Roundness			
			SDR 32.5	SDR 26	SDR 21	SDR 17 SDR 13.5 SDR 11
½	0.840 (21.3)	±0.004 (±0.102)	...	...	0.03(0.762)	0.016(0.406)
¾	1.050 (26.7)	±0.004 (±0.102)	...	...	0.03(0.762)	0.02(0.508)
1	1.315 (33.4)	±0.005 (±0.127)	...	...	0.03(0.762)	0.02(0.508)
1¼	1.660 (42.1)	±0.005 (±0.127)	...	...	0.03(0.762)	0.024(0.61)
1½	1.900 (48.3)	±0.006 (±0.152)	...	...	0.06(1.524)	0.024(0.61)
2	2.375 (60.3)	±0.006 (±0.152)	...	...	0.06(1.524)	0.024(0.61)
2½	2.875 (73.0)	±0.007 (±0.179)	...	...	0.06(1.524)	0.03(0.762)
3	3.500 (88.9)	±0.008 (±0.203)	...	...	0.06(1.524)	0.03(0.762)
3½	4.000 (101.6)	±0.008 (±0.203)	...	...	0.1(2.5)	0.03(0.762)
4	4.500 (114.3)	±0.009 (±0.229)	...	...	0.1(2.5)	0.03(0.762)
5	5.563 (141.3)	±0.010 (±0.254)	...	...	0.1(2.5)	0.06(1.524)
6	6.625 (168.3)	±0.011 (±0.279)	0.12(3)	0.11(2.74)	0.1(2.5)	0.07(1.778)
8	8.625 (219.1)	±0.013 (±0.330)	0.24(6.1)	0.16(4.06)	0.12(3)	0.08(2.04)
10	10.750 (273.0)	±0.015 (±0.381)	0.24(6.1)	0.2(5.08)	0.14(3.58)	0.1(2.5)
12	12.750 (323.8)	±0.017 (±0.432)	0.28(7.12)	0.2(5.08)	0.14(3.58)	0.1(2.5)

TABLE 2 Plastic Tubing-Diameters, Wall Thicknesses, and Tolerances, in. (mm)

Nominal Tubing Size (CTS)	Outside Diameter	Tolerance	Minimum Wall Thickness	Wall Thickness Tolerance
¼	0.375 (9.52)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
⅜	0.500 (12.7)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
½	0.625 (15.9)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
½	0.625 (15.9)	±0.004 (±0.10)	0.090 (2.27)	+0.009 (+0.23)
½	0.625 (15.9)	±0.004 (±0.10)	0.104 (2.64)	+0.010 (+0.25)
¾	0.875 (22.2)	±0.004 (±0.10)	0.062 (1.58)	+0.006 (+0.15)
¾	0.875 (22.2)	±0.004 (±0.10)	0.077 (1.95)	+0.008 (+0.20)
¾	0.875 (22.2)	±0.004 (±0.10)	0.090 (2.27)	+0.009 (+0.23)
1	1.125 (28.6)	±0.005 (±0.13)	0.062 (1.58)	+0.007 (+0.18)
1	1.125 (28.6)	±0.005 (±0.13)	0.090 (2.27)	+0.011 (+0.28)
1	1.125 (28.6)	±0.005 (±0.13)	0.099 (2.51)	+0.012 (+0.31)
1	1.125 (28.6)	±0.005 (±0.13)	0.101 (2.56)	+0.012 (+0.31)
1	1.125 (28.6)	±0.005 (±0.13)	0.121 (3.07)	+0.015 (+0.38)
1¼	1.375 (34.9)	±0.005 (±0.13)	0.062 (1.58)	+0.007 (+0.18)
1¼	1.375 (34.9)	±0.005 (±0.13)	0.090 (2.27)	+0.011 (+0.28)
1¼	1.375 (34.9)	±0.005 (±0.13)	0.121 (3.07)	+0.015 (+0.38)
1¾	1.875 (47.6)	±0.006 (±0.15)	0.062 (1.58)	+0.007 (+0.18)

packing, in-plant storage, and shipping. For further information, see **(1)**.[8]

(1) Before or during installation, coiled pipe larger than 3 in. IPS (88.9 mm) shall be processed by the installer through re-rounding equipment that corrects ovality to 5% or less.

NOTE 3—Ovality is a packaging condition that occurs when roundable pipe is wound into a coil—the pipe flattens out as it is coiled. Ovality is corrected when joining equipment is applied to roundable pipe, or by field processing roundable pipe through re-rounding and straightening equipment during installation.

5.3.1.6 *Length*—The pipe shall be supplied in straight lengths or coils as agreed upon between the manufacturer and the purchaser. The length shall not be less than the minimum length agreed upon when corrected to 73°F (23°C).

5.3.1.7 When sizes other than those listed in Table 1, Table 2, or Table 3 are used, tolerances shall be: for outside diameter, use same tolerance of next smaller size; for wall thickness, use same tolerance percentage as shown in the tables.

5.3.2 *Fittings*—Fittings shall meet the requirements given in the applicable Annex.

5.4 *Chemical Resistance*—The pipe and fittings shall not increase in weight more than 0.5 % (1.0 % for toluene in methanol). Where the test specimen is a pipe ring, the material shall not change more than ±12 % in apparent tensile yield strength when measured in accordance with 6.9. Where the test specimen is a plaque, the material shall not change more than ±12 % in tensile strength at yield when measured in accordance with Test Method D 638. See Annex A5 for specific requirements for polyamide pipe.

NOTE 4—This pipe test is only an indication of what will happen as a result of short term exposure to these chemicals. For longterm results, additional testing is required.

5.5 *Sustained Pressure*—The pipe, fittings, or systems shall not fail as defined in Test Method D 1598, when tested in accordance with 6.6.

5.6 *Elevated Temperature Service*—Plastic piping materials intended for use at temperatures above 100°F (38°C) shall have the PPI hydrostatic design basis (HDB) determined at the specific temperature in accordance with Test Method D 2837. The 100 000-h intercept (long-term strength) shall be categorized in accordance with Table 4 and be listed as the "hydrostatic design basis of XXX psi at XXX °F (C°) for (compound name)."

NOTE 5—Many design factors for elevated temperature service cannot be covered in this specification. Users should consult applicable codes for limitations on pertinent maximum temperatures.

NOTE 6—In the absence of an HDB established at the specified temperature, the HDB of a higher temperature may be used in determining a design pressure rating at the specified temperature by arithmetic interpolation.

[8] The boldface numbers in parentheses refer to the list of references at the end of this standard.

TABLE 3 Wall Thicknesses and Tolerances for Plastic Pipe, in (mm)[A,B]

Nominal Pipe Size (IPS)	DR[C]	Minimum	Tolerance
1/2	[D]	0.062	+0.007
		(1.58)	(+0.178)
	11.0	0.076	+0.009
		(1.93)	(+0.229)
	9.33	0.090	+0.011
		(2.29)	(+0.279)
3/4	[D]	0.090	+0.011
		(2.29)	(+0.279)
	11.0	0.095	+0.011
		(2.41)	(+0.279)
	Sch	0.113	+0.014
	40	(2.87)	(+0.356)
1	[D]	0.090	+0.011
		(2.29)	(+0.279)
	13.5	0.097	+0.012
		(2.46)	(+0.305)
	11.0	0.119	+0.014
		(3.02)	(+0.356)
	9.9	0.133	+0.016
		(3.38)	(+0.406)
	9.33	0.140	+0.017
		(3.56)	(+0.432)
1¼	[D]	0.090	+0.011
		(2.29)	(+0.279)
	17.0	0.098	+0.012
		(2.49)	(+0.305)
	13.5	0.123	+0.015
		(3.12)	(+0.381)
	Sch	0.140	+0.017
	40	(3.56)	(+0.432)
	11.0	0.151	+0.018
		(3.84)	(+0.457)
	10.0	0.166	+0.020
		(4.22)	(+0.508)
	9.33	0.178	+0.021
		(4.52)	(+0.533)
	6.0	0.277	+0.033
		(7.04)	(+0.838)
1½	[D]	0.090	+0.011
		(2.29)	(+0.279)
	17	0.112	+0.013
		(2.85)	(+0.330)
	13.5	0.141	+0.017
		(3.58)	(+0.432)
	Sch	0.145	+0.017
	40	(3.68)	(+0.432)
	11	0.173	+0.021
		(4.39)	(+0.533)
2	21	0.113	+0.014
		(2.87)	(+0.356)
	17	0.140	+0.017
		(3.56)	(+0.432)
	Sch	0.154	+0.018
	40	(3.91)	(+0.457)
	13.5	0.176	+0.021
		(4.47)	(+0.533)
	11	0.216	+0.026
		(5.49)	(+0.660)
	9.33	0.255	+0.031
		(6.48)	(+0.787)
2½	21	0.137	+0.016
		(3.48)	(+0.406)
	17	0.169	+0.020
		(4.29)	(+0.508)

TABLE 3 *Continued*

Nominal Pipe Size (IPS)	DR[C]	Minimum	Tolerance
	13.5	0.213 (5.41)	+0.026 (+0.660)
	11	0.261 (6.63)	+0.031 (+0.787)
3	21	0.167 (4.24)	+0.020 (+0.508)
	17	0.206 (5.23)	+0.025 (+0.635)
	Sch 40	0.216 (5.49)	+0.026 (+0.660)
	13.5	0.259 (6.58)	+0.031 (+0.787)
	11.5	0.304 (7.72)	+0.036 (+0.914)
	11	0.318 (8.08)	+0.038 (+0.965)
	9.33	0.375 (9.53)	+0.045 (+1.143)
3½	21	0.190 (4.83)	+0.023 (+0.584)
	17	0.236 (5.99)	+0.028 (+0.711)
	13.5	0.296 (7.52)	+0.036 (+0.914)
	11	0.363 (9.22)	+0.044 (+1.118)
4	21	0.214 (5.44)	+0.026 (+0.660)
	19	0.237 (6.02)	+0.028 (+0.711)
	17	0.264 (6.71)	+0.032 (+0.813)
	13.5	0.333 (8.46)	+0.040 (+1.016)
	11.5	0.391 (9.93)	+0.047 (+1.194)
	11.0	0.409 (10.39)	+0.049 (+1.246)
	9.33	0.482 (12.24)	+0.058 (+1.473)
5	21.6	0.258 (6.55)	+0.031 (+0.787)
	21	0.265 (6.73)	+0.032 (+0.813)
	17	0.328 (8.33)	+0.039 (+0.991)
	13.5	0.413 (10.49)	+0.050 (+1.270)
	11	0.506 (12.85)	+0.061 (+1.549)
6	32.5	0.204 (5.18)	+0.024 (+0.610)
	26	0.255 (6.48)	+0.031 (+0.787)
	23.7	0.280 (7.11)	+0.034 (+0.864)
	21	0.316 (8.03)	+0.038 (+0.965)
	17	0.390 (9.91)	+0.047 (+1.194)
	13.5	0.491 (12.47)	+0.059 (+1.499)
	11.5	0.576 (14.63)	+0.069 (+1.753)
	11.0	0.602 (15.29)	+0.072 (+1.829)

TABLE 3 *Continued*

Nominal Pipe Size (IPS)	DR[C]	Minimum	Tolerance
8	32.5	0.265 (6.73)	+0.032 (+0.813)
	26	0.332 (8.43)	+0.040 (+1.016)
	21	0.410 (10.41)	+0.049 (+1.245)
	17	0.508 (12.90)	+0.061 (+1.549)
	13.5	0.639 (16.23)	+0.077 (+1.956)
	11.5	0.750 (19.05)	+0.090 (+2.286)
	11	0.785 (19.94)	+0.094 (+2.388)
10	32.5	0.331 (8.41)	+0.040 (+1.016)
	26	0.413 (10.49)	+0.050 (+1.270)
	21	0.511 (12.98)	+0.061 (+1.549)
	17	0.633 (16.08)	+0.076 (+1.930)
	13.5	0.797 (20.24)	+0.096 (+2.438)
	11.5	0.935 (23.75)	+0.112 (+2.845)
	11	0.978 (24.84)	+0.117 (+2.972)
12	32.5	0.392 (9.96)	+0.047 (+1.194)
	26	0.490 (12.45)	+0.059 (+1.499)
	21	0.608 (15.44)	+0.073 (+1.854)
	17	0.750 (19.05)	+0.090 (+2.286)
	13.5	0.945 (24.00)	+0.113 (+2.870)
	11.5	1.109 (28.17)	+0.133 (+3.378)
	11	1.160 (29.46)	+0.139 (+3.531)

[A] The sizes listed in Table 3 are those commercially available sizes used by the gas industry.

[B] The minimum is the lowest wall thickness of the pipe at any cross section. The maximum permitted wall thickness, at any cross section, is the minimum wall thickness plus the stated tolerance. All tolerances are on the plus side of the minimum requirement.

[C] The DR shown are designations commonly accepted by the gas industry and do not calculate exactly.

[D] These wall thicknesses are minimum and are not a function of the dimension ratios.

TABLE 4 Pipe Category

Property	Test Method	Category						
		A	B	C	D	E	F	G
Temperature, °F (°C)	. . .	100(38)	120(49)	140(60)	160(71)	180(82)	. . .	. . .
Hydrostatic design basis, psi (MPa)	D 2837	400(2.8)	500(3.4)	630(4.3)	800(5.5)	1000(6.9)	1250(8.6)	1600(11.0)
Melt index	D 1238	>0.5	0.2–0.5	0.01–0.3	<0.01[A]	. . .	. . .	. . .

[A] Typically melt flow measured under condition 190/21.6 is less than 4.01 g/10 min.

Examples: CDB − At 140°F (60°C) the HDB is 800 psi (5.5 MPa). The approximate melt index range is 0.2 to 0.5 g/10 min for this PE pipe.
DF − At 160°F (71°C) the HDB is 1250 psi (8.6 MPa). A melt index range is not given for non-PE materials.

5.7 *Minimum Hydrostatic Burst Pressure*—The burst re-

quirements for plastic pipe shall be as given in the appropriate annexes.

5.8 *Apparent Tensile Strength At Yield*— The minimum apparent tensile strengths at yield for plastic pipe are given in the annexes when determined in accordance with 6.8.

5.9 *Joints*:

5.9.1 *Solvent Cemented*—Joints of solvent cementable pipe and fittings shall be made in accordance with the user's written procedure.

5.9.2 *Heat Fusion*:

5.9.2.1 Heat fusion joints of thermoplastic pipe and fittings shall be made in accordance with Practice D 2657 and the user's written procedure.

5.9.2.2 PE butt fusion joining shall be between components (pipes, fittings, or valves) having the same SDR or DR. Butt fusion between unlike SDR or DR components shall be allowed only if it has been demonstrated that long term performance is not adversely affected. The minimum requirement to demonstrate long term performance shall be the validation procedure for PE in Test Method D 2837. The Hydrostatic Design Basis (HDB) of the PE material shall be validated using specimens containing butt fusion joints resulting from different SDRs or DRs. Pipe/pipe joints of the given PE material that pass shall validate pipe/pipe, pipe/fitting, or fitting/fitting joints of the same SDR ratio for that PE material.

5.9.3 *Mechanical*—Mechanical fittings shall be installed in accordance with the user's written procedures and the fitting manufacturer's installation instructions. The joint shall be tested in accordance with the specific design category as outlined in 6.10.

5.10 *Plastic Valves*—All plastic gas valves shall meet the requirements of ANSI Standard B 16.40.

6. Test Methods

6.1 *General*—The test methods in this specification cover plastic pipe and fittings to be used for gas distribution. Test methods that are applicable from other specifications will be referenced in the paragraph pertaining to that particular test.

6.2 *Sampling*—Take a representative sample of the pipe and fittings sufficient to determine conformance with this specification. About 40 ft (12 m) of pipe is required to perform all the tests prescribed. The number of fittings required varies, depending upon the size and type of fitting. A sampling plan shall be agreed upon by the purchaser and the manufacturer (see Practice D 1898).

6.2.1 *Pipe Test Specimens*—Not less than 50 % of the test specimens required for any pressure test shall have at least a part of the marking in their central sections. The central section is that portion of pipe which is at least one pipe diameter away from an end closure.

6.3 *Conditioning*—Unless otherwise specified, condition the specimens prior to test at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h, in accordance with Procedure A of Practice D 618 for those tests where conditioning is required and in all cases of disagreement.

6.4 *Test Conditions*—Conduct the test in the standard laboratory atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified.

6.5 *Dimensions and Tolerances*:

6.5.1 *Pipe*—Any length of pipe is used to determine the dimensions. Coiled pipe shall be measured in the natural springback condition, unless specified otherwise.

6.5.1.1 *Diameter*—Measure the diameter of the pipe in accordance with Test Method D 2122. The average outside diameter for nonroundable pipe is the arithmetic average of the maximum and minimum diameters at any cross section on the length of the pipe. For roundable pipe, out-of-roundness tolerance applies to measurements made while the pipe is rounded with the manufacturer's recommended equipment. Measure out-of-roundness within one-half pipe diameter or 2 in. (50 mm), whichever is closer, of the rounding equipment. See Test Method D 2122 for definitions of nonroundable and roundable pipe.

(1) The pipe surface shall be free of gross imperfections such as, deep scratches, grooves, or high or low (flat) spots around the pipe circumference.

NOTE 7—Excessive out-of-roundness may be caused by manufacturing irregularities around the circumference of the pipe, such as deep scratches, gouges, flat spots, and high spots. Such defects could detrimentally affect joining. To simulate field joining of roundable pipe, out-of-roundness is checked by fitting a rounding device on the pipe, then measuring diameter.

6.5.1.2 *Wall Thickness*—Make a minimum of six measurements at each cross section in accordance with Test Method D 2122.

6.5.1.3 *Wall Thickness Eccentricity Range*— Measure in a manner such that the maximum, *A*, and the minimum, *B*, wall thickness at single points of each cross section measured are obtained. Calculate the wall thickness eccentricity range, *E*, in percent for each cross section as follows:

$$E = [(A - B)/A] \times 100 \quad (1)$$

6.5.1.4 *Length*—Measure pipe length and other linear dimensions with a steel tape or other device, accurate to ±1⁄32 in. (±1 mm) in 10 ft (3 m).

6.5.2 *Fittings*—Measure the dimensions of fittings in accordance with Test Method D 2122.

6.5.3 *Ovality*:

6.5.3.1 *Apparatus*—A micrometer or vernier caliper accurate to within ±0.001 in. (±0.02 mm).

6.5.3.2 *Procedure*—Take a series of outside diameter (OD) measurements at closely spaced intervals around the circumference to ensure that the minimum and maximum diameters have been determined.

6.5.3.3 *Calculation*—Calculate the percent ovality as follows:

$$\%\ \text{ovality} = \frac{\text{maximum OD} - \text{minimum OD}}{\text{minimum OD} + \text{maximum OD}} \times 200 \quad (2)$$

6.6 *Sustained Pressure Test*:

6.6.1 Select six test specimens of pipe or fittings at random, condition at the standard laboratory test temperature and humidity, and pressure test in accordance with Test Method D 1598.

6.6.1.1 Test specimens shall be prepared so that the minimum length of pipe on each side of the fitting is equal to 5 times the diameter of the pipe but in no case less than 12 in. (304 mm) for sizes less than 6 in. For sizes 6 in. and larger, the

minimum length shall be equal to 3 times the diameter or 30 in. (762 mm), whichever is shorter.

6.6.1.2 Pressures used shall be as shown in the annexes or as calculated (using the pipe's actual measured minimum wall thickness, outside diameter, and the applicable fiber stress shown in the annexes), whichever is greater. Piping intended for use at temperatures of 100°F (38°C) and higher shall be tested at both 73°F (23°C) and the maximum design temperature. The test fiber stress shall be the hydrostatic design basis (HDB) or 80 % of the 100 000-h intercept of the material, whichever is greater.

NOTE 8—Air, methane, or nitrogen may be substituted for water as the test medium.

6.6.2 Maintain the specimens at the pressures required, held to ±10 psi (0.07 MPa), for a period of 1000 h at the test temperature ±3.6°F (±2°C) as specified in 6.6.1.

6.6.3 Failure of two of the six specimens tested shall constitute failure in 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 in the test. Evidence of failure of the pipe shall be as defined in Test Method D 1598.

6.7 *Minimum Hydrostatic Burst Pressure (Quick Burst)*—The test equipment, procedures, and failure definitions shall be as specified in Test Method D 1599 and the annexes. Pressures shall be as shown in the Annexes or as calculated (using the pipe's actual measured minimum wall thickness, outside diameter, and the applicable fiber stress), whichever is greater.

6.8 *Apparent Tensile Properties*—The procedure and test equipment shall be as specified in Test Method D 2290, Procedure B. The speed of testing shall be 0.5 in. (12.7 mm)/min. Cut "ring" specimens from pipe. They shall be ½ in. (12.7 mm) wide with a ¼-in. (6.3-mm) wide reduced section. Test a minimum of five specimens. This method is applicable to all pipe of nominal ¾-in. (19.0-mm) outside diameter and larger.

6.9 *Chemical Resistance*—Determine the resistance to the following chemicals in accordance with Test Method D 543. Where available, the test specimen shall be a ring 2 in. SDR 11 pipe cut to the ring dimensions specified in 6.8. For materials that are not readily available as 2 in. SDR 11 pipe, the test specimen shall be a plaque of material ¼by 2 by 4 in. (6.3 by 50.8 by 101.6 mm) with a 1 in. (25.4 mm) wide reduced section.

Chemicals	Concentration (% by volume)
Mineral oil (USP)	100
Tertiary-butyl mercaptan	5 in mineral oil
Antifreeze agents (at least one shall be used):	
Methanol, or	100
Ethylene glycol	100
Toluene	15 in methanol

Test five specimens with each chemical. Weigh the specimens to the nearest 0.005 g and completely immerse them in the chemicals for 72 h. On removal from the chemicals, wipe the specimens with a clean dry cloth. Condition in air for 2 to 2¼ h and reweigh. Calculate the increase in weight to the nearest 0.01 % on the basis of initial weight. Test the specimen in tension in accordance with 6.8 within ½ h after weighing. Examine the weight and apparent tensile strength of each specimen for conformance to the requirement in 5.4.

NOTE 9—**Caution**: Because of the possible toxicity of these reagents, refer to the Material Safety Data Sheet on each of these reagents before using or handling them.

6.10 *Categorization of Mechanical Joints*—The following test methods provide a uniform procedure for qualification or categorization of mechanical joints using short term pullout resistance tests and burst tests. The mechanical joint categories and test methods are as follows:

6.10.1 *Category 1*—A mechanical joint design that provides a seal plus a resistance to a force on the pipe end equal to or greater than that which will cause a permanent deformation of the pipe.

6.10.1.1 The apparatus and report shall be as specified in Test Method D 638. The test shall be conducted at ambient temperatures, that is, 67 ± 10°F (19.4 ± 5.6°C). The speed of the testing shall be 0.2 in. (5 mm)/min ± 25 %. Five specimens shall be prepared following the manufacturer's published installation instructions. Length of the specimens shall be such that the unreinforced distance between the grip of the apparatus and the end of the stiffener is at least five times the nominal outside diameter of the pipe size being tested. Apply a load until permanent deformation (yield) occurs in the unreinforced area of the piping.

6.10.1.2 Results obtained from the above method pertain only to the specific outside diameter, wall thickness, and compound of the piping used in the test and specific fitting design tested.

NOTE 10—The ability to restrain pipe to its yield as specified above does not guarantee that a properly installed joint will prevent pullout under actual long-term field conditions. Joints that cannot pass this test would be expected to pullout under actual long term field conditions. To date, this test is the best available for disqualifying unsound joints.

6.10.2 *Category 2*—A mechanical joint design that provides a seal only (see X2.5.5). A mechanical joint designed for this category excludes any provisions in the design or installation of the joint to resist any axial pullout forces; therefore, tensile tests are not required.

6.10.2.1 The test assembly shall meet the burst test requirements of 5.7 when tested in accordance with Test Method D 1599 with end closures designed in accordance with Test Method D 1599.

6.10.3 *Category 3*—A mechanical joint design that provides a seal plus a pipe restraint rating equivalent to the anticipated thermal stresses occurring in a pipeline (see Appendix X2.4). This category has a manufacturer's rated pipe end restraint less than the value required to yield the pipe as outlined in 6.10.1 (Category 1).

6.10.3.1 The procedures and testing shall be the same as outlined in 6.10.1 (Category 1) except the test tensile values shall meet the rated values published by the mechanical fitting manufacturer.

7. Marking

7.1 *Pipe*—All required marking shall be legible, visible, and permanent. To ensure permanence, marking shall be applied so it can only be removed by physically removing part of the pipe wall. The marking shall (1) not reduce the wall

thickness to less than the minimum value for the pipe, (2) not have any effect on the long-term strength of the pipe, and (3) not provide leakage channels when elastomeric gasket compression fittings are used to make the joints. These marking shall consist of the word GAS, the designation ASTM D 2513, the manufacturer's name or trademark, the normal pipe size including the sizing system used (IPS, CTS, or OD), DR or minimum wall thickness, material designation, and date of manufacture.

7.1.1 In addition to 7.1, the pipe marking shall include a coding that will enable the manufacturer to determine the location of manufacture, pipe production and resin lots, and any additional information which is agreed upon between the manufacturer and purchaser. The manufacturer shall maintain such records for fifty years or for the design service life of the pipe, whichever is longer.

7.1.2 All the markings in 7.1 and 7.1.1 shall be repeated at intervals not exceeding 5 ft (1.5 m). For indented printing, either the indented print line shall be in a color that contrasts with that of the pipe, or a separate print line shall be in a color that contrasts with the pipe. See Annex A1 and Annex A2 for additional specific marking requirements.

7.2 Pipe intended for natural gas service at elevated temperatures greater than 73°F (23°C) shall be marked with additional code letters from Table 4 (the first code letter to identify the temperature of pressure rating, the second code letter to identify HDB at highest rated temperature, and the third code letter to identify the melt index).

7.3 *Fittings*—Fittings shall be marked D 2513, as well as with the applicable fitting specification. All fittings shall be marked on the body or hub. The markings shall consist at least of the manufacturer's name or trademark, or both, the size, the symbol for the type of material, and the three-letter code from Table 4 (as described in Section 7.2). In addition, the fittings markings shall include code that will enable the manufacturer to determine the date of manufacture, the location of manufacture, fitting production and resin lots, and any additional information which may be agreed upon between the manufacturer and purchaser. The manufacturer shall maintain such records for 50 years or for the design service life of the fittings, whichever is longer.

NOTE 11—Section 7.3 is applicable to fusion type fittings only. The marking requirements in Section 7.3 are not applicable to mechanical fittings.

8. Quality Assurance

8.1 When the product is marked with this designation, D 2513, 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.

SUPPLEMENTARY REQUIREMENTS

GOVERNMENT/MILITARY PROCUREMENT

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

S1. *Responsibility for Inspection*—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 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 S00001—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. No. 123 for civil agencies and MIL-STD 129 for military agencies.

NOTE S00002—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.

ANNEXES

(Mandatory Information)

A1. SUPPLEMENTAL REQUIREMENTS FOR GAS PRESSURE PIPE AND FITTINGS PRODUCED FROM POLYETHYLENE (PE) MATERIAL

A1.1 Scope

A1.1.1 This annex covers requirements for PE pipe and fittings. These requirements are in addition to those in the main body of this specification.

NOTE A1.1—Because Table 1, which covers nominal pipe sizes up to 12 in. is in the body of this specification, and Table A1.1 is in Annex A1, the user should be aware of the larger tolerance allowed the larger pipe.

A1.2 Referenced Documents

A1.2.1 *ASTM Standards*:

A1.2.1.1 *Test Methods for*:

D 1238 Flow Rate of Thermoplastics by Extrusion Plastometers[3]

A1.2.1.2 *Specification for*:

D 1248 Polyethylene Plastics Molding and Extrusion Materials[3]

D 2683 Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing[2]

D 3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing[2]

D 3350 Polyethylene Plastic Pipe and Fittings Materials[3]

F 1055 Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing[3]

A1.3 Materials

A1.3.1 *Classification*—Polyethylene materials suitable for use in the manufacture of pipe and fittings under this specification shall be classified in accordance with Specification D 3350, and as shown in Table A1.2. *Example*: for a polyethylene material having an HDB of 1250 psi (8.6 MPa), Cell Class 3, the base resin density must have a cell classification of 2 or 3; the melt index classification must be 1, 2, 3, 4, 5, or 6; etc.

A1.3.2 *Short and Long Term Properties*—Polyethylene pipe and fittings shall be made from PE materials which also satisfy the combinations of short- and long-term property requirements shown in Table A1.3.

A1.3.3 *Hydrostatic Design Basis (HDB) Substantiation*—The HDB for PE materials at 73°F (23°C) shall be substantiated by showing that the extrapolation of the stress regression curve is linear to the 438 000-h intercept (long-term hydrostatic strength at 50 years in accordance with Test Method D 2837). This will be done in accordance with Test Method D 2837 using one of the two following procedures:

A1.3.3.1 Use the twelve data points from Conditions I and II obtained in 5.6.1 (Procedure I) of Test Method D 2837 along with the 438 000-h intercept to solve for the three-coefficient rate process extrapolation equation. Then using this new model, calculate the mean estimated failure time for Condition III. When the log average time for six specimens tested at Condition III has reached this time, linear extrapolation of the 73°F (23°C) stress regression curve to 438 000 h is substantiated.

A1.3.3.2 When 5.6.2 (Procedure II) of Test Method D 2837 is used to validate the 73°F (23°C) HDB, linear extrapolation of the stress regression curve to 438 000 h is substantiated when the log average failure time of the test specimens at 176°F (80°C) surpasses 6 000 h.

NOTE A1.2—The long-term hydrostatic strength at 50 years in accordance with Test Method D 2837 is not to be used for any pressure rating calculations. The MAOP is still calculated using the HDB obtained from Test Method D 2837 long-term hydrostatic strength at 100 000 h.

A1.3.4 *Qualification for LPG Service*—Materials that qualify for natural gas service in accordance with A1.3.3 and that carry a recommended HDB for 140°F in accordance with 5.6, also qualify for LPG service without the need for further testing.

NOTE A1.3—The terms LPG and LPG gas are synonymous and only apply to a particular kind of fuel gas. For compositions and properties of LPG gases see NFPA 58, Appendix B.

A1.3.5 *Slow Crack Growth Resistance*—Test method is F 1473 on compression molded plaques. Stress is 2.4 MPa

TABLE A1.1 Outside Diameters and Tolerances, 14 in. and Larger Pipe

Nominal Pipe Size	Actual Outside Diameters, in. (mm)	
	Average	Tolerance
14	14.000 (355.6)	±0.063 (±1.60)
16	16.000 (406.4)	±0.072 (±1.83)
18	18.000 (457.2)	±0.081 (±2.06)
20	20.000 (508.0)	±0.090 (±2.29)
22	22.000 (558.8)	±0.099 (±2.51)
24	24.000 (609.6)	±0.108 (±2.74)

TABLE A1.2 Specification D 3350 Cell Classifications of Polyethylene Pipe and Fittings Materials

PE Material Designation Code:	PE 2406	PE 3408
Physical Properties:		
Density	2	3
Melt index	1, 2, 3, or 4	3, 4, or 5
Flexural modulus	3 or 4	4 or 5
Tensile strength	3 or 4	4 or 5
Slow crack growth resistance PENT	6	6
Hydrostatic design basis	3	4

TABLE A1.3 Short and Long Term Property Requirements

PE Material Designation Code	Short-Term in Accordance with D 3350	Long-Term in Accordance with D 2837[A]
PE 2406	Grade PE 24	HDB of 1250 psi for 73°F
PE 3408	Grade PE 34	HDB of 1600 psi for 73°F

[A] The hydrostatic design basis (HDB) shall be established using water or natural gas as the pressurizing fluid.