Designation: D2513 – 11ε1

An American National Standard

Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings[1]

This standard is issued under the fixed designation D2513; 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.

ε[1] NOTE—Sections 1.4, 4.4, and X1.3.1 were editorially corrected in March 2011.

1. Scope*

1.1 This specification covers requirements and test methods for material dimensions and tolerances, hydrostatic burst strength, chemical resistance, and rapid crack resistance of polyethylene pipe, tubing, and fittings for use in fuel gas mains and services for direct burial and reliner applications. 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 also covered.

1.1.1 This specification does not cover threaded pipe. Design considerations are discussed in Appendix X1. In-plant quality control programs are specified in Annex A1 and Annex A2.

1.1.2 See Specification F2619/F2619M for polyethylene piping for pressure or non-pressure oil and gas producing applications to convey fluids such as oil, dry or wet gas, multiphase fluids, and non-potable oilfield water.

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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

Annex	Subject
Annex A1	In-Plant Quality Control for all materials up to 12 in.
Annex A2	In-Plant Quality Control for PE materials 14 in. and larger.

Appendixes	Subject
Appendix X1	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]

2.1.1 *Terminology:*

D1600 Terminology for Abbreviated Terms Relating to Plastics

F412 Terminology Relating to Plastic Piping Systems

2.1.2 *Test Methods for:*

D638 Test Method for Tensile Properties of Plastics

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure

D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method

D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

F1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins

2.1.3 *Practices for:*

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

D618 Practice for Conditioning Plastics for Testing

D1898 Sampling of Plastics

D2774 Practice for Underground Installation of Thermoplastic Pressure Piping

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

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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.

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

F2620 Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

2.1.4 *Specification for:*

D2683 Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

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

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F1055 Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing

F1563 Specification for Tools to Squeeze-off Polyethylene (PE) Gas Pipe or Tubing

F2138 Specification for Excess Flow Valves for Natural Gas Service

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

2.2 *ANSI Standards:*

B 16.40 Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems[3]

B 31.8 Gas Transmission and Distribution Piping Systems[3]

2.3 *Federal Specifications:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[4]

OPS 49 CFR Part 192 Title 49, Code of Federal Regulations[4]

2.4 *Military Standards:*

MIL-STD-129 Marking for Shipment and Storage[4]

MIL-STD-1235 (ORD) Single- and Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes

2.5 *ISO Standards*[5]*:*

ISO 4437 Buried polyethylene (PE) pipes for the supply of gaseous fuels-Metric series-Specifications

ISO 9080 Thermoplastics Pipes for the Transport of Fluids—Methods of Extrapolation of Hydrostatic Stress Rupture Data to Determine Long-Term Hydrostatic Strength of Thermoplastic Pipe Materials

ISO 12162 Thermoplastic Materials for Pipes and Fittings for Pressure Applications—Classification and Designation—Overall Service (Design) Coefficient

ISO 13477 Thermoplastics pipes for the conveyance of fluids – Determination of resistance to rapid crack propagation (RCP) – Small scale steady-state test (S4 test)

ISO 13478 Thermoplastics pipe for the conveyance of fluids – Determination of resistance to rapid crack propagation (RCP) – Full-scale test (FST)

2.6 *Plastic Pipe Institute*[6]

PPI TR-33 Generic Butt Fusion Joining for Polyethylene Gas Pipe

PPI TR-41, Generic Saddle Fusion Joining Procedure for Polyethylene Gas Piping[6]

PPI TN-30/2006 Requirements for the Use of Rework Materials in Polyethylene Gas Pipe[6]

PPI TR-9 Recommended Design Factors and Design Coefficients for Thermoplastic Pressure pipe

2.7 *Other Documents:*[7]

National Fire Protection Association: NFPA 58, Storage and Handling Liquefied Petroleum Gases

3. Terminology

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

3.2 The gas industry terminology used in this specification is in accordance with ANSI B 31.8 or OPS 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, and so forth, 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 *pipe material designated code*—the pipe material designation code shall consist of the abbreviation for the type of plastic (PE) followed by Arabic numerals which describe the short term properties in accordance with applicable Specification D3350, 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 PE and four figures for PE materials. For example, PE2708 is a grade PE27 polyethylene with an 800psi 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 *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 (mm), by the minimum specified wall thickness, in inches (mm). 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 PE used to make pipe and fittings shall be PE or reworked PE (see 4.2 and 4.4) and shall have a

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

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

[5] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

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

[7] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

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. The use of these rework materials shall be governed by the requirements of 4.3 and PPI TN-30/2006 In pipe, rework materials shall be limited to a maximum of 30 % by weight.

NOTE 1—The requirements for rework materials herein are intended to incorporate prudent specifications to ensure that the potential for contamination in gas piping products, that meet this specification, is reduced to the extent possible. It is imperative to emphasize that rework materials have not been identified as the cause of any field failures. The requirements for rework materials were developed by the consensus of interested parties including product manufacturers, gas utility companies, and regulatory agencies.

4.3 *Documentation* —A documentation system to allow for traceability of raw materials including percentage and material classification (or designation, if applicable) of rework materials used in the manufacture of the pipe product meeting the requirements of this specification shall exist and be supplied to the purchaser, if requested.

4.4 *Classification*—Polyethylene materials suitable for use in the manufacture of pipe and fittings under this specification shall be classified in accordance with Specification D3350, and as shown in Table 1. PE 2606 and PE 2708 are medium density PE (MDPE) materials. PE 3608, PE 3710, PE 4608 and PE 4710 are high density PE (HDPE) materials. 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; the melt index classification must be 3 or 4; and so forth.

NOTE 2—References and material descriptions for PE2306, PE2406, PE3306, PE3406 and PE3408 have been removed from D2513. 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 PE gas distribution piping.

4.5 *Slow Crack Growth Resistance*—Use Test Method F1473 on compression molded plaques at a stress of 2.4 MPa based on the unnotched area and a test temperature of 80°C. Notch depth shall be in accordance with Table 1 in Test Method F1473. Materials shall meet the Slow Crack Growth Resistance requirements in Table 1.

4.6 *Additive Classes*—Polyethylene material compounds shall meet Specification D3350 code C or E. Code C material compounds shall have 2 to 3 percent carbon black. Code E material compounds shall be yellow with UV stabilizer.

4.7 *Thermal Stability*—The PE material shall contain sufficient antioxidant so that the minimum induction temperature shall be 428°F (220°C) when tested in accordance with Specification D3350. The sample shall be representative of the cross section of the pipe or fittings.

4.8 *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 D2837). This will be done in accordance with Test Method D2837 using one of the two following procedures:

4.8.1 Use the twelve data points from Conditions I and II obtained in 5.6.1 (Procedure I) of Test Method D2837 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.

4.8.2 When 5.6.2 (Procedure II) of Test Method D2837 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 6000 h.

NOTE 3—The long-term hydrostatic strength at 50 years in accordance with Test Method D2837 is not to be used for any pressure rating calculations. The MAOP is still calculated using the HDB obtained from Test Method D2837 long-term hydrostatic strength at 100 000 h.

4.9 *Resistance to Rapid Crack Propagation (RCP) for Material*—The PE material classification (formulation) used in the manufacture of pipe and fittings under this specification shall be tested for resistance to failure by RCP in accordance with the procedures set forth in ISO 13477 (S4 Test) or ISO 13478 (Full Scale Test (FST)). The data obtained shall be made available upon request without limitations on disclosure, and shall not subsequently be subject to disclosure limitations when used by others. The values obtained are applicable to all

TABLE 1 Specification D3350 Cell Classifications of Polyethylene Pipe and Fittings Materials

PE Material Designation Code:	PE 2606	PE 2708	PE 3608	PE 3710	PE 4608	PE4710
Physical Properties:						
Density	2	2	3	3	4	4
Melt index	3 or 4	3 or 4	4	4	4	4
Flexural modulus	3 or 4	3 or 4	4 or 5	4 or 5	4 or 5	4 or 5
Tensile strength	3 or 4	3 or 4	4 or 5	4 or 5	4 or 5	4 or 5
Slow crack growth resistance (PENT)	6	7	6	7	6	7
Hydrostatic design basis	3	3	4	4	4	4

pipes with the wall thickness of the pipe tested and all thinner wall pipes. In case of conflict, the RCP results of ISO 13478 shall apply.

NOTE 4—While S4 or FST testing of any combination of outside diameter and SDR is permitted in fulfillment of the requirement for testing PE material resistance to RCP, S4 testing of SDR 9 or SDR 11 PE pipe specimens is currently the most common industry practice.

NOTE 5—Caution should be exercised in applying the RCP test results obtained on one SDR or DR of pipe across a series of pipe SDR's or DR's produced from the same PE material classification (formulation). Industrial research to clarify the relationships between FST and S4 testing is ongoing at this time, particularly as it relates to the applicability of RCP test results obtained on one SDR or DR of pipe to other SDR's or DR's of pipe produced from the same PE material classification (formulation). Consult the resin manufacturer regarding the applicability of RCP test results across diameters or SDR's, or both. Additional information regarding the use of RCP data is presented in ISO 4437.

4.10 *Outdoor Storage Stability*—PE materials shall be Code C or E as defined in Specification D3350. Code C material shall contain 2 to 3 percent well dispersed carbon black, and due to the absorptive properties of the carbon black, is considered to be stabilized against deterioration from unprotected exposure to UV for not less than 10 years. Code E material shall be stabilized and protected against deterioration from unprotected UV exposure for not less than 3 years.

NOTE 6—The determination for outdoor storage resistance is often based on measuring the ductility properties of the pipe material exposed to artificial weathering. These requirements and test methods are based on expected UV exposure levels in North America. Alternate requirements and alternate determination methods may be appropriate in other regions of the world. As an example ISO 4437 standard requires a minimum resistance to an accumulation of 3.6GJ for non-black polyethylene materials.

4.11 *Qualification for LPG Service*—Materials that qualify for natural gas service and that carry a recommended HDB for 140°F in accordance with 5.7, also qualify for LPG service without the need for further testing.

NOTE 7—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.

5. Requirements

5.1 *General*—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 2 or Table 3 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 2 or Table 3.

5.3.1.3 *Wall Thickness*—The wall thickness shall be as specified in Table 3 or Table 4 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 3 or Table 4.

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.

TABLE 2 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)
14	14.000 (355.6)	±0.063 (±1.60)	0.308(7.82)	0.224(5.68)	0.154(3.91)	0.112(2.84)
16	16.000 (406.4)	±0.072 (±1.83)	0.352(8.94)	0.256(6.50)	0.176(4.47)	0.128(3.25)
18	18.000 (457.2)	±0.081 (±2.06)	0.396(10.05)	0.288(7.31)	0.198(5.02)	0.144(3.65)
20	20.000 (508.0)	±0.090 (±2.29)	0.44(11.1)	0.32(8.12)	0.22(5.58)	0.16(4.06)
22	22.000 (558.8)	±0.099 (±2.51)	0.484(12.29)	0.352(8.94)	0.242(6.14)	0.176(4.47)
24	24.000 (609.6)	±0.108 (±2.74)	0.528(13.41)	0.384(9.75)	0.264(6.70)	0.192(4.87)

TABLE 3 PE 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)

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 8—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, 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 9—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 2, Table 3 or Table 5 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.

5.4 *Minimum Hydrostatic Burst Pressure/Apparent Tensile Strength (Quick Burst)*——The pipe or system shall fail in a ductile manner when tested in accordance with Test Method D1599. For pipe sizes above 4-in. nominal diameter, the testing lab shall be allowed to replace the quick burst test (Test Method D1599) by the apparent ring tensile strength test (Test Method D2290). The minimum apparent tensile strength at yield when determined in accordance with 6.8 shall be 2520 psi (17.4 MPa).

5.5 *Short Term Pressurization for Sizes Above 12 in.*—Pipe and molded or fabricated fittings shall not fail when tested in accordance with Test Method D1599 with the hoop stress of 2500 psi for MDPE materials or 2900 psi for HDPE density materials. Hoop stress calculation shall be based on the DR of the fitting at the point of fusion. (**Warning—**Pressurization of pipe specimens above 12 in. nominal diameter being tested in accordance with 5.5 should not commence until it is certain that all entrapped air has been bled from the water-filled specimens.)

NOTE 10—The requirements in 5.3.1.1 and 5.3.1.3 are for laboratory proof testing only and should not be interpreted as applicable to on-site testing for acceptance of installed systems larger than 12 in. See appropriate installation standards or manufacturer's recommendations for field test procedures.

5.6 *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 D638.

NOTE 11—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.

5.7 *Melt Index*—Melt index is the flow rate of PE material when measured in accordance with Test Method D1238, condition 190/2.16 (formerly Condition E). Materials that record zero flow under condition 190/2.16 shall be measured in accordance with condition 190/21.6 (formerly condition F). The melt index of pipe/fitting shall meet the designated category in Table 5. The sample shall be representative of the cross section of the pipe or fitting and diced to an appropriate size by a method not producing heat.

5.8 *Sustained Pressure 73°F (23°C)*—The pipe or system shall not fail in less than 1000 h when tested in accordance with Test Method D1598. For MDPE material, the stress shall be 1320 psi, for HDPE materials, the stress shall be 1600 psi..

5.9 *Elevated Temperature Service*—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 D2837. The 100 000-h intercept (long-term strength) shall be categorized in accordance with Table 5 and be listed as the "hydrostatic design basis of XXX psi at XXX °F (C°) for (compound name)."

NOTE 12—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 13—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.

5.10 *HDB Validation for PE Pipe*—The 73°F (23°C) Hydrostatic Design Basis (HDB) of PE pipe shall be validated by the pipe producer using the PE validation procedure as outlined in Test Method D2837. For MDPE materials, the HDB of 1250

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

TABLE 4 Wall Thicknesses and Tolerances for Plastic Pipe, in (mm)[A,B]

Nominal Pipe Size (IPS)	DR[C]	Minimum	Tolerance
½	[D]	0.062 (1.58)	+0.007 (+0.178)
	11.0	0.076 (1.93)	+0.009 (+0.229)
	9.33	0.090 (2.29)	+0.011 (+0.279)
¾	[D]	0.090 (2.29)	+0.011 (+0.279)
	11.0	0.095 (2.41)	+0.011 (+0.279)
	Sch 40	0.113 (2.87)	+0.014 (+0.356)
1	[D]	0.090 (2.29)	+0.011 (+0.279)
	13.5	0.097 (2.46)	+0.012 (+0.305)
	11.0	0.120 (3.05)	+0.014 (+0.356)
	9.9	0.133 (3.38)	+0.016 (+0.406)
	9.33	0.140 (3.56)	+0.017 (+0.432)
1¼	[D]	0.090 (2.29)	+0.011 (+0.279)
	17.0	0.098 (2.49)	+0.012 (+0.305)
	13.5	0.123 (3.12)	+0.015 (+0.381)
	Sch 40	0.140 (3.56)	+0.017 (+0.432)
	11.0	0.151 (3.84)	+0.018 (+0.457)
	10.0	0.166 (4.22)	+0.020 (+0.508)
	9.33	0.178 (4.52)	+0.021 (+0.533)
	6.0	0.277 (7.04)	+0.033 (+0.838)
1½	[D]	0.090 (2.29)	+0.011 (+0.279)
	17	0.112 (2.85)	+0.013 (+0.330)
	13.5	0.141 (3.58)	+0.017 (+0.432)
	Sch 40	0.145 (3.68)	+0.017 (+0.432)
	11	0.173 (4.39)	+0.021 (+0.533)
2	21	0.113 (2.87)	+0.014 (+0.356)
	17	0.140 (3.56)	+0.017 (+0.432)
	Sch 40	0.154 (3.91)	+0.018 (+0.457)
	13.5	0.176 (4.47)	+0.021 (+0.533)
	11	0.216 (5.49)	+0.026 (+0.660)
	9.33	0.255 (6.48)	+0.031 (+0.787)
2½	21	0.137 (3.48)	+0.016 (+0.406)
	17	0.169 (4.29)	+0.020 (+0.508)
	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	0.265 (6.73)	+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	0.327 (8.31)	+0.039 (+0.991)
	13.5	0.412 (10.46)	+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	0.315 (8.00)	+0.038 (+0.965)
	17	0.390 (9.91)	+0.047 (+1.194)