**Designation: ~~D2737 – 21~~ D2737 – 22**

An American National Standard

# Standard Specification for Polyethylene (PE) Plastic Tubing[1]

This standard is issued under the fixed designation D2737; 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 U.S. Department of Defense.*

## 1. Scope*

1.1 This specification covers polyethylene (PE) plastic tubing in outside diameters and SDR's that are pressure rated for water. Included are requirements for PE compounds, and requirements and test methods for PE plastic tubing workmanship, dimensions, elevated temperature sustained pressure, burst pressure and marking.

NOTE 1—Refer to specification AWWA C901 and PPI Technical Note 49 (TN-49) for further information on pipe suitability for potable water end use applications. Oxidative Resistance Classification (CC# rating) information is available from NSF International.

1.2 The text of this specification references notes, footnotes, and appendixes which provide explanatory material. These notes and footnotes shall not be considered as requirements of the specification. Notes and footnotes in tables and figures, and Supplementary Requirements are 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.

NOTE 2—Joining PE plastic tubing with fittings that require flaring the tubing is not recommended because Practice D3140, the technique used to make the flare has been withdrawn (discontinued).

1.4 The following safety hazards caveat pertains only to the test methods portion, Section 7, 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin Based Pipe.

Current edition approved ~~Aug. 1, 2021~~Nov. 1, 2022. Published ~~August 2021~~November 2022. Originally approved in 1968. Last previous edition approved in ~~2020~~2021 as ~~D2737 – 12a~~D2737 – 21.~~(2020).~~ DOI: ~~10.1520/D2737-21.~~10.1520/D2737-22.

[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**

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
D1600 Terminology for Abbreviated Terms Relating to Plastics
D1603 Test Method for Carbon Black Content in Olefin Plastics
D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications
D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
D3140 Practice for Flaring Polyolefin Pipe and Tubing (Withdrawn 1999)[3]
D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
F412 Terminology Relating to Plastic Piping Systems
F2263 Test Method for Evaluating the Oxidative Resistance of Polyethylene (PE) Pipe to Chlorinated Water
G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

2.2 *APWA Standard:*[4]
APWA Uniform Color Code

2.3 *AWWA Standard:*[5]
C901 Polyethylene (PE) Pressure Pipe and Tubing, ¾ in. (19 mm) Through 3 in. (76 mm), for Water Service

2.4 *NSF Standards:*[6]
NSF/ANSI Standard No. 14 for Plastic Piping Components and Related Materials
NSF/ANSI/CAN Standard No. 61 for Drinking Water Systems Components—Health Effects

2.5 *PPI Standards:*[7]
PPI TR-3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe
PPI TR-4 HDB/SDB/PDB/MRS Listed Materials, PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe
PPI TN-49 Recommendations for AWWA C901 Service Tubes in Potable Water Applications



## 3. Terminology

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



## 4. Tubing Classification

4.1 *General*—This specification covers PE plastic tubing made from PE compounds in three standard dimension ratios and pressure rated for water. Pressure ratings for water are dependent on the PE compound in accordance with the following relationship:

$$PR = \frac{2 \times HDS}{(SDR + 1)} \tag{1}$$

where:

*PR* = pressure rating for water, 73 °F (23 °C), psi (kPa)
*HDS* = hydrostatic design stress for water at 73 °F (23 °C), psi (kPa)
*SDR* = standard dimension ratio

NOTE 3—PR and HDS must have the same units. See Appendix X1 for maximum pressure ratings for water.

4.2 This specification covers PE tubing in standard dimension ratios SDR 7.3, SDR 9, and SDR 11.

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from APWA, 1200 Main Street, Suite 1400 Kansas City, MO 64105-2100, https://www.apwa.net/
[5] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.
[6] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.
[7] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

## 5. Materials

5.1 *Polyethylene Compound*—Polyethylene compounds suitable for use in the manufacture of tubing under this specification shall meet thermoplastic materials designation codes PE2708 or PE3608 or PE4710, and shall meet Table 1 requirements for PE2708 or PE3608 or PE4710, and shall meet thermal stability, brittleness temperature and elongation at break requirements in accordance with Specification D3350. Oxidative Resistance Classification of CC3 is required in specific end use applications as per 5.3.

5.1.1 *Color and Ultraviolet (UV) Stabilization*—Polyethylene compounds shall meet Specification D3350 code C, D or E. In addition, Code C polyethylene compounds shall have 2 to 3 percent carbon black, and Code D or E polyethylene compounds shall have sufficient UV stabilizer to protect tubing from deleterious UV exposure effects during unprotected outdoor shipping and storage for at least eighteen (18) months.

NOTE 4—Pipe users should consult with the pipe manufacturer about the outdoor exposure life of the product under consideration. Evaluation of UV stabilizer in Code D or E PE compound using Practice D2565 or Practice G154 or Practice G155 may be useful for this purpose.

5.1.2 *Colors for solid color, an external color layer or color stripes*—In accordance with the APWA Uniform Color Code, blue shall identify potable water service; green shall identify sewer service; and purple (lavender) shall identify reclaimed water service. Yellow identifies gas service and shall not be used. The base resin that is used for an external color layer or color stripes shall be the same base resin as the body of the pipe in accordance with Table 1.

5.2 *Health Effects Requirements*—Products intended for contact with potable water, or when otherwise required, shall be evaluated, tested and certified for conformance with NSF/ANSI/CAN Standard No. 61 or the health effects portion of NSF/ANSI/CAN Standard No. 14 by a certifying organization acceptable to the authority having jurisdiction.



**TABLE 1 Polyethylene Compound Requirements**

| Requirement | Material Designation | | |
|---|---|---|---|
| | PE2708 | PE3608 | PE4710 |
| | Required Value | | |
| ~~Minimum HDB at 140 °F (60 °C), psi (MPa), in accordance with Test Method D2837 and PPI TR-3~~ | ~~800 (5.5)[A]~~ | ~~800 (5.5)[A]~~ | ~~800 (5.5)[A]~~ |
| Minimum HDB at 140 °F (60 °C), psi (MPa), in accordance with Test Method D2837 and PPI TR-3 | 800 (5.5)[A] | 800 (5.5)[A] | 1000 (6.9)[A] |
| HDS for water at 73 °F (23 °C) psi (MPa), in accordance with Test Method D2837 and PPI TR-3[A] | 800 (5.5) | 800 (5.5) | 1000 (6.9) |
| Melt flow rate in accordance with Test Method D1238 | ≤0.40 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 |
| Specification D3350 Cell Classification Property Requirement | | Required Value | |
| Density (natural base resin) | 2 | 3 | 4 |
| SCG Resistance | 7 | 6 | 7 |
| Color and UV Stabilizer Code[B] | C, D or E | C, D or E | C, D or E |
| Oxidative Resistance Classification in accordance with Test Method F2263[C] | C | C | C |

[A] Contact manufacturer or see PPI TR-4 for listed value.
[B] See 5.1.1.
[C] See 5.3 for when CC3 classification is required.

5.3 *Oxidative Resistance*—For pipe that is intended for use in the transport of potable water containing oxidizing disinfectants (for example, hypochlorous acid or chloramines), or when required by the application, customer or regulatory authority having jurisdiction, the PE compound shall have an oxidative resistance classification of CC3 in accordance with Specification D3350. The oxidative resistance classification of CC3 is used in conjunction with pipe dimensions in accordance with 6.2.1.1 and 6.2.2.1 to ensure the intended pipe service life is met with respect to oxidative resistance (see Note 45). When the pipe meets these requirements, it shall be marked CC3 in accordance with 9.1.8. When the pipe does not meet the compound and dimensional requirements as above it shall not be marked CC3. An oxidative resistance classification is not required for other potable water services that do not contain oxidizing disinfectants or when it is not required by the application, customer or regulatory authority having jurisdiction

NOTE 5—See www.plasticpipe.org for further information on potable water disinfectants in small diameter PE pipe and the use of oxidative resistance classification for specific applications.

NOTE 6—Pipe failure analysis for the oxidative resistance 5.3 is based on Type 2 failures and the brittle failure line extrapolation. See ASTM F2263 Standard Test Method for Evaluating the Oxidative Resistance of Polyethylene (PE) Pipe to Chlorinated Water for brittle failure definition and fig 1 for a pictorial lifetime representation.

5.4 *Rework Material*—Clean polyethylene compound from the manufacturer's own tubing production that met 5.1 through 5.2 as new PE compound is suitable for re-extrusion into tubing when blended with new PE compound having the same material designation and oxidative resistance classification. Tubing containing rework material shall meet all the requirements of this specification.

## 6. Requirements

6.1 *Workmanship*—The tubing shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other defects. The tubing shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. See 5.1.2.



6.2 *Dimensions and Tolerances:*

6.2.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in Table 2 when measured in accordance with 7.4.



6.2.1.1 Pipe for potable water service containing oxidizing disinfectants or that require an oxidative resistance classification as outlined in 5.3 Oxidative Resistance shall be pipe size ¾ or greater in accordance with Table 2 in order to meet the expected service life of the pipe in these specific conditions (see Note 45).

6.2.1.2 *Out-of-roundness*—Out of roundness shall be in accordance with Table 2 as extruded, but before coiling for packaging when measured in accordance with 7.4.

NOTE 7—Coiling may increase out-of-roundness, depending on the coiling method and coil dimensions.

6.2.2 *Wall Thicknesses*—The wall thicknesses and tolerance shall be as shown in Table 3 when measured in accordance with 7.4. Wall thickness shall be inclusive of all extruded concentric layers.

**TABLE 2 Outside Diameters and Tolerances for PE Plastic Tubing**

| Tubing Size | Outside Diameter, in. (mm) | Outside Diameter Tolerance, in. (mm) | Out-of-Roundness, in. (mm) |
|---|---|---|---|
| ½ | 0.625 (15.87 | ±0.004 (±0.10) | 0.030 (0.76) |
| ⅝ | 0.750 (19.05) | ±0.004 (±0.10) | 0.030 (0.76) |
| ¾ | 0.875 (22.23) | ±0.004 (±0.10) | 0.030 (0.76) |
| 1 | 1.125 (28.58) | ±0.005 (±0.13) | 0.030 (0.76) |
| 1¼ | 1.375 (34.93) | ±0.005 (±0.13) | 0.030 (0.76) |
| 1½ | 1.625 (41.23) | ±0.006 (±0.15) | 0.030 (0.76) |
| 2 | 2.125 (53.98) | ±0.006 (±0.15) | 0.030 (0.76) |

**TABLE 3 Wall Thickness and Tolerances for PE Plastic Tubing**

| | Wall Thickness, in.[A] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SDR 7.3 | | | | SDR 9 | | | | SDR 11 | | | |
| | in. | | (mm) | | in. | | (mm) | | in. | | (mm) | |
| Tubing Size, in. | Minimum | Tolerance | Minimum | Tolerance | Minimum | Tolerance | Minimum | Tolerance | Minimum | Tolerance | Minimum | Tolerance |
| ½ | 0.086 | +0.010 | (2.18) | (0.25) | 0.069 | +0.010 | (1.75) | (0.25) | 0.062 | +0.010 | (1.57) | (0.25) |
| ⅝ | 0.103 | +0.010 | (2.62) | (0.25) | 0.083 | +0.010 | (2.11) | (0.25) | 0.068 | +0.010 | (1.73) | (0.25) |
| ¾ | 0.120 | +0.012 | (3.05) | (0.30) | 0.097 | +0.010 | (2.46) | (0.25) | 0.080 | +0.010 | (2.03) | (0.25) |
| 1 | 0.154 | +0.015 | (3.91) | (0.38) | 0.125 | +0.012 | (3.18) | (0.30) | 0.102 | +0.010 | (2.59) | (0.25) |
| 1¼ | 0.188 | +0.019 | (4.78) | (0.48) | 0.153 | +0.015 | (3.89) | (0.38) | 0.125 | +0.012 | (3.18) | (0.30) |
| 1½ | 0.233 | +0.022 | (5.92) | (0.56) | 0.181 | +0.018 | (4.60) | (0.46) | 0.148 | +0.015 | (3.76) | (0.38) |
| 2 | 0.291 | +0.029 | (7.39) | (0.74) | 0.236 | +0.024 | (5.99) | (0.61) | 0.193 | +0.019 | (4.90) | (0.48) |

[A] 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. Wall thickness variation shall be in accordance with 6.2.3.

6.2.2.1 Pipe for potable water service containing oxidizing disinfectants or that require an oxidative resistance classification as outlined in 5.3 Oxidative Resistance shall be SDR 9 or 7 in accordance with Table 3 in order to meet the expected service life of the pipe in these specific conditions (see Note 4).

6.2.3 *Wall Thickness Variation*—The wall thickness variation shall not exceed 12 % when measured in accordance with 7.4.

6.2.4 *Thickness of Outer Layer*—For tubing produced by simultaneous multiple extrusion, the outer concentric layer shall be at least 0.020 in (0.5 mm) thick.

6.3 *Bond*—For tubing produced by simultaneous multiple extrusion, the bond between the layers shall be strong and uniform. It shall not be possible to cleanly separate any two layers with a probe or point of a knife blade at any point.



6.4 *Carbon Black*—Polyethylene tubing produced using Code C polyethylene compound in accordance with 5.1.1 shall contain 2 to 3% carbon black when tested in accordance with 7.5.

6.5 *Burst Pressure*—The minimum burst pressure for tubing shall be as given in Table 4, when determined in accordance with 7.6 using a minimum hoop stress of 2520 psi (17.4 MPa) for Table 1 density cell 2 polyethylene compound or 2900 psi (20.0 MPa) for Table 1 density cell 3 or 4 polyethylene compound. In addition, the failure shall be ductile.



6.6 *Elevated Temperature Sustained Pressure*—Elevated temperature sustained pressure tests for each polyethylene compound designation in accordance with Table 1 used in production at the facility shall be conducted twice annually in accordance with 7.7.

6.7 *Inside Surface Ductility for Tubing*—Tubing shall be tested for inside surface ductility in accordance with 7.8 or 7.9.

**TABLE 4 Minimum Burst Pressure for PE Plastic Tubing Pipe**

| SDR | Minimum Burst Pressure[A] psi (kPa) | | | |
|---|---|---|---|---|
| | PE2708 | | PE3608, PE4710 | |
| | psi | (kPa) | psi | (kPa) |
| 7.3 | 800 | (5517) | 921 | (6352) |
| 9 | 630 | (4345) | 725 | (5000) |
| 11 | 504 | (3476) | 580 | (4000) |

[A]Minimum burst pressure calculated in accordance with:

$$P_B \frac{2S}{\frac{D_o}{t} - 1}$$

where:

$P_B$ = burst test pressure, psi (kPa)
$S$ = minimum hoop fiber stress, psi. (kPa)
$S$ = 2520 psi (17 370 kPa) for Specification D3350 density cell 2 PE compound in accordance with Table 2.
$S$ = 2900 psi (20 000 kPa) for Specification D3350 density cell 3 and 4 PE compound in accordance with Table 2.
$D_o$ = measured average inside diameter, in. (mm)
$t$ = measured minimum wall thickness, in (mm).

Test temperature tolerance ~~±3.6 °F~~±4 °F (± 2 °C). Test pressure tolerance ± 5 psi (± 35 kPa);

NOTE 8—Tensile elongation testing in accordance with 7.9 provides a quantifiable result and is used for referee testing and in cases of disagreement.

## 7. Test Methods

7.1 *Conditioning*—Condition as specified in the test method. Where conditioning is not specified in the test method, condition the test specimens at 73 °F ± 4 °F (23 °C ± 2 °C) without regard to relative humidity for not less than 4 h prior to the test in accordance with Procedure A of Practice D618, or at 73 °F ± 4 °F (23 °C ± 2 °C) for not less than 1 h in accordance with Procedure D of Practice D618.

7.2 *Test Conditions*—Conduct tests in accordance with the conditions specified in the test method, or if not specified in the test method, at 73 °F ± 4 °F (23 °C ± 2 °C) without regard to relative humidity.

7.3 *Sampling*—The number and selection of samples shall be as specified in the test method, or if not specified in the test method, sample selection shall be as agreed upon by the purchaser and seller. In case of no prior agreement, any sample selected by the testing laboratory shall be deemed adequate.

7.3.1 *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 the tubing sample that is at least one pipe diameter away from an end closure. The entire marking shall be documented in testing records.

7.4 *Dimensions and Tolerances*—Use any length of tubing to determine the dimensions. Outside diameter, out-of-roundness, and wall thickness shall be measured in accordance with Test Method D2122.

7.4.1 *Outside Diameter*—Measure the outside diameter of the tubing in accordance with Test Method D2122. The average outside diameter is the arithmetic average of the maximum and minimum diameter at any cross section. The tolerance for out-of-roundness shall apply only to tubing prior to shipment.



7.5 *Carbon Black*—For all tubing manufactured with Code C polyethylene compound, determine in duplicate the carbon black content in accordance with Test Method D1603 or Test Method D4218.

7.6 *Burst Pressure*—The test equipment, procedures and failure definitions shall be as specified in Test Method D1599.



7.7 *Elevated Temperature Sustained Pressure Test*—Elevated temperature sustained pressure tests for each Table 1 material designation used in production of tubing in accordance with this specification at the facility shall be conducted in accordance with D1598, and Table 5 using water as the pressurizing medium. The "test sample" shall be three specimens of any tubing size or SDR. One Table 5 Condition for the applicable material designation shall be selected for the test.

7.7.1 For the selected Table 5 Condition, passing results are *(a)* non-failure for all three specimens at a time equal to or greater than the "minimum average time before failure", or *(b)* not more than one ductile specimen failure and the average time before failure for all three specimens shall be greater than the specified "minimum average time before failure" for the selected Table 5 Condition, or *(c)* successful retest in accordance with 7.7.3.

7.7.2 For the selected Table 5 condition, failure to meet this requirement is *(a)* brittle failure of any specimen when tested at Table 5 Condition 1 through 6, or *(b)* ductile failure of all three specimens.

7.7.3 *Provision for Retest for* Table 5 *Conditions 1 through 5*—If a second ductile failure occurs before the "minimum average time before failure", it is permissible to conduct one retest at a Table 5 Condition of lower stress and longer minimum average time before failure for the material designation. The retest sample shall be three additional specimens of the same tubing size and material designation from the same time frame as the test sample in accordance with 7.7. For the retest, any specimen failure before the "minimum average time before failure" at the retest condition constitutes failure to meet this requirement. For Table 5 Condition 6 no retest is permissible.

7.8 *Bend-back Test Method:*

7.8.1 Squarely cut four 1 ⅛ to 1 ⅜ in. (29 to 35 mm) wide rings from tubing. Condition the rings in accordance with 7.1.

**TABLE 5 Elevated Temperature Sustained Pressure Test[A] Requirements**

| Condition | Test Temperature, °F (°C) | PE2708, PE3608 | | PE4710 | |
|---|---|---|---|---|---|
| | | Test Pressure Hoop Stress, psi (kPa) | Minimum Average Time Before Failure, hours | Test Pressure Hoop Stress, psi (kPa) | Minimum Average Time Before Failure, hours |
| 1 | 176 (80) | 670 (4620) | 170 | 750 (5170) | 200 |
| 2 | 176 (80) | 650 (4480) | 340 | 730 (5020) | 400 |
| 3 | 176 (80) | 630 (4345) | 510 | 705 (4870) | 600 |
| 4 | 176 (80) | 610 (4210) | 680 | 685 (4715) | 800 |
| 5 | 176 (80) | 590 (4070) | 850 | 660 (4565) | 1000 |
| 6 | 176 (80) | 580 (4000) | 1000 | 640 (4415) | 1200 |

[A] Calculate internal test pressure in accordance with

$$P = \frac{2S}{\frac{D_o}{t}} - 1$$

where:

$P$ = test pressure, psi (kPa)
$S$ = test pressure hoop stress, psi. (kPa)
$D_o$ = measured average inside diameter, in. (mm)
$t$ = measured minimum wall thickness, in (mm)

Test temperature tolerance ± ~~3.6 °F~~4 °F (± 2 °C). Test pressure tolerance ± 5 psi (± 35 kPa); test pressure hoop stress values are rounded to the nearest 5 psi or 5 kPa.

Table 5 conditions are based on PE validation requirements in accordance with PPI TR-3 with Condition 6 being 85% of Condition 1 test pressure hoop stress and six times greater minimum average time before failure. Conditions 2 through 5 are linear stress and time interpolations between Conditions 1 and 6. The intent of multiple conditions is to maintain equivalent performance criteria, but provide for retest in the event of ductile failure. The test pressure hoop stress levels for Conditions 2-5 are linear interpolations for arbitrarily chosen time increments. An equivalent performance requirement, however, may be determined by arbitrarily choosing a test pressure hoop stress between Conditions 1 and 6 and linearly interpolating the minimum average time before failure. For example for PE3710 and PE4710 compound designations, at 670 psi test pressure hoop stress, the minimum average time before failure would be 927 hours:

$$927 = 200 + \left( (750 - 670) \times \frac{(1200 - 200)}{(750 - 640)} \right)$$



7.8.2 Split each ring longitudinally so that when reverse bent in accordance with 7.8.3, the pipe ID for each quadrant around the tubing will be tested.

7.8.3 In a well-lit area, perform the following procedure within 5 min: *(a)* Bend each split ring specimen so that the tubing inside surface is on the outside surface of the bend. *(b)* Using an apparatus such as a bench vise or other suitable equipment, close the legs of the specimen together. When the specimen legs are closed together, the top of the bend-back specimen shall extend above the point of closure by 3 ± ½ times the minimum wall thickness in accordance with Table 3. *(c)* With the unaided (naked) eye, visually examine the reverse-bent tubing ID surface.

7.8.4 Visible brittle cracking or crazing indicates failure.

7.9 *Elongation-at-Break Test Method:*

7.9.1 Five Test Method D638 Type III or Type IV specimens cut in the longitudinal direction from locations equally spaced around the circumference of the tubing shall be conditioned in accordance with 7.1 and tested in accordance with Test Method D638 at a cross-head separation speed of 2 in. (50.8 mm) min. If the specimen thickness must be reduced by machining, the tubing ID surface shall be left unaltered.

7.9.2 —The percent elongation at break for each test specimen shall exceed 400 %.

NOTE 9—Specimen machining that produces smooth surfaces and uniform thickness is necessary. Surface cuts or scratches and non-uniform thickness in the specimen gage length can detrimentally affect test results.

## 8. Retest and Rejection

8.1 Except as provided in 7.7.3, if the results of any test(s) do not meet the requirements of this specification, the test(s) shall be conducted again only by agreement between the purchaser and the seller. Under such agreement, minimum requirements shall not be lowered, changed, or modified, nor shall specification limits be changed. If upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.