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Standard Specification for Polyethylene Plastics Molding and Extrusion Materials[1]

This standard is issued under the fixed designation D 4976; 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.

ε[1] NOTE—Editorially corrected 11.2 to add missing text in July 2003.

INTRODUCTION

This specification is not intended for the selection of materials, but only as a means to call out plastic materials to be used for the manufacture of parts. The selection of these materials is to be made by personnel with expertise in the plastics field where the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered. This specification does not specify the source of the resin to be used for the fabrication of any given article.

1. Scope*

1.1 This specification provides for the identification of polyethylene plastics molding and extrusion materials in such a manner that the supplier and the user can agree on the acceptability of different commercial lots or shipments. The tests involved in this specification are intended to provide information for identifying materials in accordiangce witoh the groups, classes, and grades covered. It is not the function of this specification to provide specific engineering data for design purposes.

1.2 Other requirements may be necessary to identify particular characteristics important to specialized applications. These shall be agreed upon between the user and the supplier, by using the suffixes given in Section 1.3.

1.3 Ethylene plastic materials, being thermoplastic, are reprocessable and recyclable (see Note 1). This specification allows for the use of those ethylene plastic materials, provided that any specific requirements as governed by the producer and the end user are met.

NOTE 1—See Guide D 5033 for information and definitions related to recycled plastics.

1.4 The values stated in SI units are regarded as the standard.

1.5 The following precautionary caveat pertains to the test method portion only, Section 12, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 For information regarding plastic pipe materials see Specification D 3350. For information regarding wire and cable materials, see Specification D 1248. For information on polyethylenes with densities below 0.910 g/cm^3, see Classification D 5593.

NOTE 2—There is no similar or equivalent ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials

D 568 Test Method for Rate of Burning and/or Extent and Time of Burning of Flexible Plastics in a Vertical Position[3]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing

D 635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

D 638 Test Method for Tensile Properties of Plastics

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[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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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*, Vol 10.01. volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Discontinued. See the 1991 *Annual Book of ASTM Standards*, Vol 08.01.

[3] Withdrawn.

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

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D 883 Terminology Relating to Plastics
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1248 Specification for Polyethylene Plastics Molding and Extrusion Materials
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1531 Test Methods for Relative Permittivity (Dielectric Constant) and Dissipation Factor by Fluid Displacement Procedures
D 1600 Terminology for Abbreviated Terms Relating to Plastics
D 1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
D 1898 Practice for Sampling of Plastics[3]
D 2565 Practice for Operating Xenon Arc-Type Light-Exposure Apparatus With and Without Water for Exposure of Plastics
D 2951 Test Method for Resistance of Types III and IV Polyethylene Plastics to Thermal Stress-Cracking
D 3350 Specification for Polyethylene Plastics Pipe and Fitting Materials
D 3892 Practice for Packaging/Packing of Plastics
D 4000 Classification System for Specifying Plastic Materials
D 4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D 4883 Test Method for Density of Polyethylene by the Ultrasound Technique
D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics
D 5593 Classification for Thermoplastic Elastomers—Olefinic (TEO)
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
F 1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth on Polyethylene Pipes and Resins
G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
G 53 Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

2.2 *Military Standard:*
MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes[4]
2.3 *DOT Standard:*
Federal Motor Vehicle Safety Standard 302, Flammability of Interior Materials[5]

3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this specification, see Terminology D 883 and Terminology D 1600.

3.2 Historical usage and user group conventions have resulted in inconsistent terminology used to categorize and describe polyethylene resins and compounds. The following terminology is in use in ASTM specifications pertaining to polyethylene:

3.2.1 *Specification D 1248* :
3.2.1.1 Type (I, II, III, IV) = density ranges (same, respectively, as Classes 1, 2, 3, and 4 in Specification D 4976).
3.2.1.2 Class (A, B, C, D) = composition and use.
3.2.1.3 Category (1, 2, 3, 4, 5) = melt index ranges (same as Grade in Specification D 4976).
3.2.1.4 Grade (E, J, D, or W followed by one or two digits) = specific requirements from tables.
3.2.2 *Specification D 3350* :
3.2.2.1 Type (I, II, III) = density ranges (same as Types I, II, and III in Specification D 1248 and Classes 1, 2, and 3 in Specification D 4976).
3.2.2.2 Class = a line callout system consisting of "PE" followed by six cell numbers from Table 1 plus a letter (A, B, C, D, E) denoting color and UV stabilizer.
3.2.2.3 Grade = simplified line callout system using "PE" followed by density and slow crack growth cell numbers from Table 1.
3.2.3 *Specification D 4976*:
3.2.3.1 Group (1, 2) = branched or linear polyethylene.
3.2.3.2 Class (1, 2, 3, 4) = density ranges (same, respectively, as Types I, II, III, and IV in Specification D 1248).
3.2.3.3 Grade (1, 2, 3, 4, 5) = melt index ranges (same as Category in Specification D 1248).

4. Classification

4.1 Unreinforced polyethylene plastic materials are classified into groups ~~according to polymerization processes.~~ in accordance

[4] Annual Book of ASTM Standards, Vol 08.04. Available from ASTM Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS. ~~*Discontinued—See 1997 Annual Book*~~
[5] Available from United States Department of ~~AS~~ TM Transportation, National Highway Traffic Safety Administration, ~~V~~ Office of Public Affairs and Consumer Participation, 400 7th St., SW, Washington, DC 20590.

with molecular structure. These groups are subdivided into classes and grades as shown in Table PE (Basic Property Table).

TABLE PE Basic Requirement of Polyethylene Plastics

Group	Description	Class	Description	Grade	Flow ~~Rate[A]~~ Rate, D 1238, g/10 min	Tensile Strength~~s~~s at Yield~~B~~, D 638, min, MPa	~~El~~Nominal Strain at Break, D 638, min, %	~~Secant~~Flexural Modulus~~C~~, at 2 % Strain, D 790, min, MPa
1	Branched	1	low density	1	>25	8	70	100
			. . .	2	>10 to 25	8	90	125
			0.910–0.925	3	>1 to 10	8.5	100	125
			. . .	4	>0.4 to 1	9.5	300	125
			. . .	5	to 0.4	9.5	400	150
			. . .	0	. . .	. . .	. . .	. . .
		2	medium density	1	>25	8	40	200
			. . .	2	>10 to 25	11	50	200
			>0.925–0.940	3	>1 to 10	11	70	200
			. . .	4	>0.4 to 1	11	200	250
			. . .	5	to 0.4	12	400	300
			. . .	0	. . .	. . .	. . .	. . .
		0	. . .	0	. . .	. . .	. . .	. . .
2	Linear	1	low density	1	>25	10	300	300
			. . .	2	>10 to 25	10	300	325
			0.910–0.925	3	>1 to 10	10	300	350
			. . .	4	>0.4 to 1	10	400	350
			. . .	5	to 0.4	12	500	400
			. . .	0	. . .	. . .	. . .	. . .
		2	medium density	1	>25	14	90	500
			. . .	2	>10 to 25	14	100	500
			>0.925–0.940	3	>1 to 10	14	100	550
			. . .	4	>0.4 to 1	15	200	600
			. . .	5	to 0.4	19	400	600
			. . .	0	. . .	. . .	. . .	. . .
		3	high density	1	>25	17	10	400
			. . .	2	>10 to 25	17	50	400
			>0.940–0.960	3	>1 to 10	18	200	450
			. . .	4	>0.4 to 1	19	400	500
			. . .	5	to 0.4	20	600	600
			. . .	0	. . .	. . .	. . .	. . .
		4	high density	1	>25	24	10	500
			. . .	2	>10 to 25	24	10	600
			>0.960	3	>1 to 10	25	30	800
			. . .	4	>0.4 to 1	28	300	900
			. . .	5	to 0.4	28	400	1000
			. . .	0	. . .	. . .	. . .	. . .
0		0	. . .	0	. . .	. . .	. . .	. . .

~~*A* Melt index = g/10 min at 190°C/2.16 kg.~~

~~*B* Type IV tensile bars at 500 mm/min (20 in./min) for materials with densities of 0.925 g/cm^3 and less; and 50 mm/min (2 in./min) for materials with densities greater than 0.925 g/cm^3.~~

~~*C* Secant Modulus at 2 % strain using Procedure B with 50.8-mm (2-in.) span on 3.18 × 12.7-mm (0.125 × 0.5-in.) specimens.~~

Cell Table A Detail Requirements~~*A*~~ for Polyethylene Plastics

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
~~1~~	~~Tensile Strength at Yield, Test Method D 638, MPaB, min~~	~~unspecified~~	~~4~~	~~8~~	~~12~~	~~16~~	~~21~~	~~30~~	~~35~~	~~. . .~~	~~specify value~~
1	Tensile Stress at Yield, Test Method D 638, MPa, min	unspecified	4	8	12	16	21	30	35	. . .	specify value
~~2~~	~~Elongation at Break, Test Method D 638, %, min~~	~~unspecified~~	~~25~~	~~50~~	~~200~~	~~400~~	~~600~~	~~800~~	~~1000~~	~~. . .~~	~~specify value~~
2	Nominal Strain at Break, Test Method D 638, %, min	unspecified	25	50	200	400	600	800	1000	. . .	specify value
~~3~~	~~Flexural Modulus, Test Methods D 790, MPa[A,C], min~~	~~unspecified~~	~~50~~	~~100~~	~~200~~	~~400~~	~~600~~	~~800~~	~~1000~~	~~. . .~~	~~specify value~~
3	Secant Flexural Modulus at 2 % Strain, D 790, MPa, min	unspecified	50	100	200	400	600	800	1000	. . .	specify value
~~4~~	~~Thermal stress-crack resistance, hours without cracking, min, Test Method D 2951~~	~~unspecified~~	~~24~~	~~48~~	~~96~~	~~168~~	~~. . .~~	~~. . .~~	~~. . .~~	~~. . .~~	~~specify value~~
4	Thermal stress-crack resistance, D 2951, hours without cracking, min	unspecified	24	48	96	168	. . .	. . .	. . .	. . .	specify value
~~5~~	~~Environmental stress-crack resistance,*D* min F_{50} h, Test Method D 1693~~	~~unspecified~~	~~24~~	~~48~~	~~96~~	~~168~~	~~336~~	~~672~~	~~1008~~	~~. . .~~	~~specify value~~
5	Environmental stress-crack resistance, D 1693, min F_{50}, h	unspecified	24	48	96	168	336	672	1008	. . .	specify value

~~*A* It is recognized that detailed test values may not predict nor even correlate with performance of parts molded of these materials.~~

~~*B* MPa × 145 = psi.~~

~~*C* Using test specimens with a nominal cross section of 3.2 × 12.7 cross section and a span of 50.8 mm.~~

~~*D* F_{50} is the time required for failure of 50 % of the specimens tested in accordance with the graphical method described in Test Method D 1693. Class 1 polyethylenes shall be tested in accordance with Test Method D 1693, Condition A. Classes 2, 3, and 4 shall be tested in accordance with Condition B. Igepal concentration for all conditions is 100 %. Mold samples in accordance with Procedure C of Practice D 4703, Annex A1 (cooling rate of 15 ± 2°C/min).~~

Cell Table B Detail Requirements~~A~~ for Polyethylene Plastics

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
~~1~~	~~Tensile Strength at Yield, Test Method D 638, MPa[B], min~~	~~unspecified~~	~~4~~	~~8~~	~~12~~	~~16~~	~~21~~	~~30~~	~~35~~	~~...~~	~~specify value~~
1	Tensile Stress at Yield, D 638, MPa, min	unspecified	4	8	12	16	21	30	35	...	specify value
~~2~~	~~Elongation at Break, Test Method D 638, %, min~~	~~unspecified~~	~~25~~	~~50~~	~~200~~	~~400~~	~~600~~	~~800~~	~~1000~~	~~...~~	~~specify value~~
2	Nominal Strain at Break, D 638, %, min	unspecified	25	50	200	400	600	800	1000	...	specify value
~~3~~	~~Flexural Modulus, Test Methods D 790, MPa[A,C], min~~	~~unspecified~~	~~50~~	~~100~~	~~200~~	~~400~~	~~600~~	~~800~~	~~1000~~	~~...~~	~~specify value~~
3	Secant Flexural Modulus at 2 % Strain, D 790, MPa, min	unspecified	50	100	200	400	600	800	1000	...	specify value
~~4~~	~~Thermal stress-crack resistance, hours without cracking, min Test Method D 2951~~	~~unspecified~~	~~24~~	~~48~~	~~96~~	~~168~~	~~...~~	~~...~~	~~...~~	~~...~~	~~specify value~~
4	Thermal stress-crack resistance, D 2951, hours without cracking, min	unspecified	24	48	96	168	...	...	...	...	specify value
~~5~~	~~Slow Crack Growth Resistance, PENT-Test Method F 1473D, h, min~~	~~unspecified~~	~~0.3~~	~~1~~	~~3~~	~~10~~	~~30~~	~~100~~	~~300~~	~~...~~	~~specify value~~
5	Slow Crack Growth Resistance, PENT-Test Method F 1473, h, min	unspecified	0.3	1	3	10	30	100	300	...	specify value

~~A It is recognized that detailed test values may not predict nor even correlate with performance of parts molded of these materials.~~

~~B MPa × 145 = psi.~~

~~C Using test specimens with a nominal cross section of 3.2 × 12.7 cross section and a span of 50.8 mm.~~

~~D Molded Plaque, 80°C, 2.4 MPa, notch depth in Table 1 I of Test Method F 1473.~~

NOTE 3—An example of this classification system is as follows: The designation PE 112 would indicate PE, polyethylene as found in Terminology D 1600, 1 (group) branched, 1 (class) low density, 2 (grade) >25 melt index.

4.2 Cell Tables A or B shall be used to specify the physical property requirements that shall be shown by a five-digit designation. The designation shall consist of the letter A and the five digits comprising the cell numbers for the property requirements in the order they appear in Cell Table A.

4.2.1 Although the values listed are necessary to include the range of properties available in the existing materials, users should not infer that every possible combination of the properties exist or can be obtained.

NOTE 4—It is recognized that some high-density polyethylene plastics of very high molecular weight may have densities slightly less than 0.960, yet in all other respects they are characteristic of Class 4 materials. Similarly, there are other polyethylene plastics of very high molecular weight having densities slightly less than 0.941 that, in all other respects, are more characteristic of Class 2 than of Class 3 materials.

NOTE 5—Use the following terms in describing polyethylene plastics:

Class 1 (0.910 to 0.925) = low density,
Class 2 (>0.925 to 0.940) = medium density,
Class 3 (>0.940 to 0.960) = high density,
Class 4 (>0.960) = high density, and

While Class 3 has been divided into two ranges of density, (Classes 3 and 4), both are still described by the term “high density.”

5. Suffixes

5.1 When using the call-out for the materials covered by this specification, the following suffixes may be used for specific requirements of the material for the application intended. In general, the suffix letter indicates the requirement needed; the first number (digit) indicates the test condition, and the second number (digit) indicates the specimen requirement. The suffixes are as follows:

5.1.1 *E* = Electrical requirements as designated by the following digits:

First Digit		
0	=	To be specified by user.
1	=	Specimens preconditioned 40 h at 23°C and 50 % relative humidity, then 14 days in distilled water at 23 ± 1°C.
Second Digit		
0	=	To be specified by user.
1	=	Volume resistivity, permittivity, and dissipation factor meet property limits as shown as follows. These are electrical limits usually applied to unreinforced polyethylene plastics when control of their electrical properties is required.

Electrical Properties:

	Test Methods	
Permittivity, max	D 1531	2.30
Dissipation factor, max	D 1531	0.001
Volume resistivity, min Ω-cm	D 257	1×10^{15}

Water immersion stability	D 1531	shall meet the dielectric constant and dissipation factor requirements

5.1.2 *F* = Flammability requirements[6] as designated by the following digits:

		First digit
0	=	To be specified by user.
1	=	Product is 3.05-mm thickness, min.
2	=	Product is 1.47-mm thickness, min.
3	=	Product is 0.71-mm thickness, min.
4	=	Product is 0.38-mm thickness, min.
5	=	Motor Vehicle Safety Standard 302.
		Second Digit
0	=	To be specified by user.
1	=	When burned horizontally in accordance with Test Method D 635, a material: (*a*) Does not have a burning rate exceeding 38.1 mm/min over a 76.2-mm span for specimens of 3.05 to 12.7-mm thickness; or (*b*) Does not have a horizontal burning rate exceeding 76.2 mm/min over a 76.2-mm span for specimens of less than 3.05-mm thickness; or (*c*) Ceases to burn, horizontally, before the 102-mm reference mark.
2	=	When burned vertically in accordance with Test Method D 568, the material: (*a*) Does not have any specimens that burn with flaming combustion for more than 30 s after two applications of the test flame: (*b*) Does not have a total flaming combustion time exceeding 250 s for 10 flame applications for each set of five specimens; (*c*) Does not have any specimens that burn with flaming or glowing combustion up to the holder clamp; (*d*) Has specimens that drip flaming particles that ignite the dry absorbent surgical cotton placed 305 mm (12 in.) below the test specimen; (*e*) Does not have any specimens with glowing combustion that persists for more than 60 s after the second removal of the test flame.
3	=	When burned vertically in accordance with Test Method D 568, the material: (*a*) Does not have any specimens that burn with flaming combustion for more than 30 s after either application of the test flame; (*b*) Does not have a total flaming combustion time exceeding 250 s for the 10 flame applications for each set of five specimens; (*c*) Does not have any specimens that burn with flaming or glowing combustion up to the holding clamp; (*d*) Does not have any specimens that drip flaming particles that ignite the dry absorbent surgical cotton located 305 mm (12 in.) below the test specimen; (*e*) Does not have any specimens with glowing combustion that persists for more than 60 s after the second removal of the test flame.
4	=	When burned vertically as described in Test Method D 568, the material: (*a*) Does not have any specimens that burn with flaming combustion for more than 10 s after either application of the test flame; (*b*) Does not have a total flaming combustion time exceeding 50 s for the 10 flame applications for each set of five specimens; (*c*) Does not have any specimens that burn with flaming or glowing combustion up to the holding clamp; (*d*) Does not have any specimens that drip flaming particles that ignite the dry absorbent surgical cotton located 305 mm (12 in.) below the test specimen; (*e*) Does not have any specimens with glowing combustion that persists for more than 30 s after the second removal of the test flame.
5	=	When burned vertically in accordance with Test Method D 568, the material: (*a*) Does not have any specimens that burn with flaming or glowing combustion for more than 60 s after the fifth flame;

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[6] By publication of this specification and its use of flammability ratings, ASTM ~~Standards, Vol 08.02.~~ does not suggest that their use in any way reflects hazards presented under actual fire conditions.

		(*b*) Does not have any specimens that drip particles.
6	=	Has a burn rate less than 100 mm/min.

5.1.3 *W* = Weatherability requirements as designated by the following digits:

		First Digit
0	=	To be specified by user.
1	=	Specimens exposed to xenon-arc type light source, in accordance with Practice D 2565, Type BH. Specimens shall be Test Method D 638, Type IV tensile bars.
2	=	Specimens exposed to carbon-arc type light source, in accordance with Practice G 23, Type DH. Specimens shall be Test Method D 638, Type IV tensile bars.
3	=	Specimens exposed to fluorescent-UV-condensation type light source, in accordance with Practice G 53. Specimens shall be Test Method D 638, Type IV tensile bars.
		Second Digit
0	=	To be specified by user.
1	=	200-h exposure.
2	=	500-h exposure.
3	=	1000-h exposure.
4	=	2000-h exposure.

5.1.3.1 The exposed specimens shall not exhibit surface changes (such as, dulling and chalking) or deep-seated changes (such as, checking, crazing, warping, and discoloration). The tensile strength after exposure must be no less than 50 % of the original.

5.1.4 *Z* = Other special requirements (for example, internal mold release agent) not covered by existing call-out capabilities may be assigned by the user. These shall be spelled out in detail and identified in sequence, that is, 01 UV-stabilized, 02 special color, and 03 etc.

5.2 Additional suffixes will be added to this specification as test methods and requirements are developed or requested, or both.

5.3 Additional suffixes that may be used are listed in Table 3 of Classification D 4000. These use the two-letter, three-digit suffix system as established for the classification system for plastic materials.

6. Basic Requirements

6.1 Basic requirements from property or cell tables, as they apply, are always in effect unless these requirements are superseded by specific suffix requirements, that always take precedence.

7. Chemical Composition

7.1 The plastic composition shall be uniform and shall conform to the requirements specified herein. The color and form of the material shall be as agreed upon between the supplier and the user. Specification changes due to the effects of colorants should be noted by both parties and, when necessary, covered by suffixes.

8. Other Requirements

8.1 Test specimens for the various materials shall conform to the requirements prescribed in Table PE and Cell Tables A and B, and to suffix requirements as they apply.

8.2 Observed or calculated values obtained from analysis, measurement or test, shall be rounded in accordance with the rounding method in Practice E 29 to the nearest unit in the last right-hand place of figures used in expressing the specified limiting value. The value obtained is compared directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison.

9. Sampling

9.1 Unless otherwise agreed upon between the user and the supplier, the materials shall be sampled in accordance with the sampling procedure in Practice D 1898. Adequate statistical sampling shall be considered an acceptable alternative. A batch or lot of resin shall be considered as a unit of manufacture as prepared for shipment and may consist of a blend of two or more production runs of material.

10. Specimen Preparation

10.1 Unless otherwise specified, test specimens shall be compression molded in accordance with Annex A1, Procedure C of Practice D 4703.

10.2 The ~~molded~~ specimen ~~thickness shall be 3.2 or 12.7 mm (0.125 or 0.5 in.) for modulus specimens~~ type and ~~1.9 ± 0.2 mm (0.075 ± 0.008 in.) for all other specimens. Conditioning~~ dimensions shall ~~be~~ comply ~~a~~ with thos ~~spe~~ descrifibed in ~~11.1.1 and any departure from that conditioning shall be reported.~~ the test method section. Die-cut specimens are recommended; however, machine-cut specimens are acceptable.

11. Conditioning

11.1 *Conditioning*— Once specimens are molded, they shall be moved to a standard laboratory atmosphere or a controlled laboratory atmosphere. For natural unfilled polyethylene plastics the controlled laboratory atmosphere shall be 23 ± 2°C. Test specimens, 7 mm or under in thickness, shall be conditioned for a minimum of 40 h immediately prior to testing. Test specimens over 7 mm in thickness shall be conditioned for 88 h. For filled and reinforced polyethylene plastics or polyethylene plastic blends, which contain a hydrophilic co-monomer, pigment, or modifier the specimens shall be conditioned in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity (see Practice D 618, Procedure A). For all materials to be conditioned for electrical testing, conditioning shall comply with the requirements of the standard test methods for electrical testing. In all cases the laboratory shall report both the temperature and humidity conditions during the conditioning period.

11.2 *Test Conditions*— Natural unfilled polyethylene plastics shall be tested in a controlled laboratory atmosphere of 23 ± 2°C. For filled and reinforced polyethylene plastics and polyethylene plastic blends, which contain a hydrophilic co-monomer, pigment, or modifier the specimens shall be conditioned in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity. For all materials to be tested for electrical properties, the laboratory shall comply with the requirements of the standard test methods for electrical testing. In all cases the laboratory shall report both the temperature and humidity conditions during testing.

11.3 *Dispute*—In cases of dispute, conditioning and testing shall be conducted in accordance with Procedure A of Practice D 618.

12. Test Methods

12.1 Determine the properties enumerated in this specification in accordance with the ASTM methods as they apply, unless otherwise stated in this specification.

12.1.1 *Flow Rate*—Test Method D 1238, using Condition 190°C/2.16 kg unless otherwise directed, (see Note 5). Make duplicate determinations on the material in the form of powder, granules, or pellets. No conditioning is required.

NOTE 6—Although the flow rate of polyethylene plastics may be measured under any of the conditions listed for it under 6.2 of Test Method D 1238, only measurements made at Condition 190°C/2.16 kg may be identified as "melt index."

This method of test serves to indicate the degree of uniformity of the flow rate of the polymer of a single manufacturer as made by an individual process and in this case may be indicative of the degree of uniformity of other properties. However, uniformity of flow rate among various polymers of various manufacturers as made by various processes does not, in the absence of other tests, indicate uniformity of other properties and vice versa.

The melt viscosity of polyethylene plastics, in common with that of most high polymers, is non Newtonian, that is, dependent on the rate of shear. The degree of departure from Newtonian behavior depends on the nature and molecular constitution of the individual sample. Additional characterization of the sample can be obtained if other conditions are used. Especially recommended as an adjunct to Condition 190°C/2.16 kg is Condition 190°C/10.0 kg or Condition 190°C/21.6 kg.

12.1.2 *Density*—Test Method D 1505 or alternate methods of suitable accuracy, as described in Method A or Method B of Test Methods D 792 or Test Method D 4883. Perform duplicate density determinations using two specimens taken from the same molding or one specimen taken from each of two moldings.

12.1.3 *Tensile Strengthss at Yield, El Nomingal Strain at Break—, Test Method D 638, except that 638*—The speed of grip separation shall be 500 mm (20 in.)/min for specimens of densities of 0.925 g/cm ^{3} or less and 50 mm (2 in.)/min for densities hi ghreater than 0.925 g/cm ^{3}. Specimens shall conform to the dimensions given for Type IV in Test Method D 638 with thickness of 1.9 ± 0.2 mm (0.075 ± 0.008 in.). Die-cut specimens are recommended; however, machine-cut specimens are acceptable. Percentage elongation at break shall include the cold-drawing distance. Test results for specimens that break outside the gage marks after extensive cold drawing need not be discarded unless the break occurs between the contact surfaces of a grip.

12.1.4 *Secant Flexural Modulus of Elasticity in Bending at 2 % Strain*—Test Methods D 790, using Procedure B, with a 51-mm (2-in.) span, and testing speed of 12.7 mm/min (0.5 in./min). Test each 3.2 by 12.7-mm (0.125 by 0.5-in.) specimen flatwise and calculate the average value of the secant modulus at 2 % strain in the outer fibers.

12.1.5 *Slow Crack Growth Resistance* —Use one method (Test Method D 1693 orEnvironmental Stress-Crack Resistance, Test Method F 1473) to classify this material property.

12.1.5.1 *Test Method D 1693*— The materials resistance shall meet the minimum requirement shown for the appropriate cell classification (in Cell Table A) when tested in accordance with Test Method D 1693.12 Polyethylene materials with densities less than or equal to 0.1.5.92–*5 shall be tested in accordance with Test Method D 1693, Condition A. Polyethylenes with densities greater than 0.925 shall be tested in accordance to Test Method D 1693, Condition B.*

NOTE 7—The specimen dimensions and notch depths are different for these two conditions.

Igepal concentration for all testing is 100%. F_{50} shall be reported. F_{50} is the time required for failure of 50 % of the specimen tested in accordance with the graphical method described in Test Method D 1693.

12.1.6 *Slow Crack Growth Resistance, Test Method F 1473*—The average failure time from two test specimens shall meet the minimum requirement shown (in Cell Table B) for the appropriate cell classification when tested in accordance with Test Method F 1473 at 80°C and at 2.4 MPa stress. Specimen shall be prepared in accordance with the procedures described in Test Method F 1473. A specimen with a nominal thickness of 10 mm shall be used. Test at least four specimens in case of a dispute.

12.1.7 *Thermal Stress Crack Resistance, Test Method D 2951*—Specimen dimensions shall be in accordance with Test Method D 2951. Each specimen being nominally 127 by 6.4 by 1.27 mm (5 by 0.25 by 0.05 in.)

13. Packaging and Package Marking

13.1 For packing, packaging, and package marking, the provisions of Practice D 3892 apply.

14. Keywords

14.1 molding and extrusion materials; polyethylene

SUPPLEMENTARY REQUIREMENTS

The following supplementary items may become part of this specification, when applicable, as agreed upon between the user and the supplier.

S1. Approval

S1.1 Material submitted by a new supplier must be approved by the user. Material or test specimens submitted by the supplier and intended for evaluation shall be accompanied by the supplier's laboratory test report.

S1.2 *New Sources*—The user may elect to temporarily accept shipment on the supplier's certification.

S2. Infrared Spectrophotometry or Thermal Analysis, or Both

S2.1 At the option of the user, infrared or thermal analysis, or both may be conducted on material/parts supplied to this specification. The curves established for initial approval shall constitute the reference standard and shall be kept on file at the user's laboratory. All samples shall produce curves that correspond to the reference standard within agreed upon tolerances when tested under the same conditions as those specified on the master set of curves.

S2.2 In the event such tests are to be designated as requirements to be tested by the supplier, this must appear on the part drawing or purchase contract, or both.

S3. Quality Assurance Provisions for Government/Military Procurement

S3.1 Selection of Acceptable Quality Level (AQL) and of Inspection Level (IL) shall be made with consideration of the specific use requirements. This is discussed in Sections 7 and 8 of Practice D 1898, with reference to MIL-STD-105. In the absence of contrary requirements, the following values shall apply:

Testing (polymer, unfabricated)	IL	AQL
	S-1	. . .

NOTE S00012—Inspection Level (IL) samples shall be drawn from the required number of units and pooled for preparation of molded samples for property evaluation.

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

D 4976 – 04:

(*1*) Made changes to Sections 4, 10, and 12 to clarify test specimen preparation, testing conditions and reported values.

D 4976 – 02:

(*1*) Added reference to Classification D 5593 in 1.6 and Referenced Documents section.

(*2*) Deleted all references to Class 5 (very low density polyethylene) in text, Table PE, and footnotes, (VLDPE to be classified in Classification D 5593.

D 4976 – 00a:

(*1*) Sections 11.1 and 11.2 have been modified, allowing removal of the humidity control requirement for materials that do not contain a hydrophilic comonomer, pigment, or modifier.

(*2*) Added 11.3.

D 4976 – 00b:

(*1*) Added 3.2.