Designation: D 1248 – 05

Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable[1]

This standard is issued under the fixed designation D 1248; 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.

1. Scope*

1.1 This specification provides for the identification of polyethylene plastics extrusion materials for wire and cable in such a manner that the seller and the purchaser 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 according to the types, classes, categories, and grades covered. It is not the function of this specification to provide specific engineering data for design purposes.

1.2 This specification does not allow for the use of recycled plastics (see Note 3).

1.3 The values stated in SI units are to be regarded as the standard.

1.4 The following safety hazards caveat pertains only to the test method portion, 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.*

NOTE 1—No ISO equivalent.

NOTE 2—This standard has undergone major revision from the reapproval of 1989 and now covers only polyethylene for wire and cable applications. For information regarding molding and extrusion materials, see Specification D 4976. For information regarding plastic pipe materials, see Specification D 3350.

NOTE 3—See Guide D 5033 for information and definitions related to recycled plastics.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

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

D 618 Practice for Conditioning Plastics for Testing

D 638 Test Method for Tensile Properties of Plastics

D 746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement

D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique

D 1531 Test Method for Relative Permittivity (Dielectric Constant) and Dissipation Factor by Fluid Displacement Procedure

D 1603 Test Method for Carbon Black in Olefin Plastics

D 1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D 1898 Practice for Sampling of Plastics

D 2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications

D 2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable

D 2839 Test Method for Use of a Melt Index Strand for Determining Density of Polyethylene

D 2951 Test Method for Resistance of Types III and IV Polyethylene Plastics to Thermal Stress-Cracking

D 3182 Practice for Rubber-Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D 3349 Test Method for Absorption Coefficient of Ethylene Polymer Pigmented with Carbon Black

D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

D 3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials

D 3892 Practice for Packaging/Packing of Plastics

D 4329 Practice for Fluorescent UV Exposure of Plastics

[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* 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.**

D 4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D 4976 Specification for Polyethylene Plastics Molding and Extrusion Materials
D 5033 Guide for the Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics
E 1131 Test Method for Compositional Analysis by Thermogravimetry
G 151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources
G 153 Practice for Operating Enclosed Carbon-Arc Light Apparatus for Exposure of Nonmetallic Materials
G 154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
G 155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials

2.2 *Federal Specification:*[3]

L-P-390 Plastic, Molding, and Extrusion Materials, Polyethylene and Copolymers (Low, Medium, and High Density)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *polyethylene plastics*, *n*—plastics or resins prepared by the polymerization of no less than 50 % ethylene and no less than 95 weight % of total olefins.

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 (0, I, II, III, IV) = density ranges (same, respectively, as Class 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 (5, 1, 2, 3, 4) = density ranges (same, respectively, as Type in Specification D 1248).

3.2.3.3 Grade (1, 2, 3, 4, 5) = melt index ranges (same as Category in Specification D 1248).

[3] Available from DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

4. Classification

4.1 This specification recognizes that polyethylene plastics are identified primarily on the basis of two characteristics, namely, density and flow rate (previously identified as melt index). The former is the criterion for assignment as to type, the latter for designation as to category. Other attributes important to the user for certain applications are covered by three general classes and by specifying in greater detail, by grades, a minimum number of key characteristics covered too broadly or not at all by the type, class, and category designations.

4.1.1 *Types*:

4.1.1.1 This specification provides for the identification of five types of polyethylene plastics extrusion materials for wire and cable by density in accordance with 10.1 and 12.1.1 and the requirements prescribed in Table 1 and Note 4, Note 5, and Note 10.

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 Type IV materials. Similarly, there are other polyethylene plastics of very high molecular weight having densities slightly less than 0.941 which in all other respects are more characteristic of Type III than of Type II materials.

NOTE 5—While the original Type III now has been divided into two ranges of density (Types III and IV), both are still described by the term *high density*.

4.1.1.2 Material supplied under these types shall be of such nominal density, within the ranges given, as agreed upon between the manufacturer and the purchaser subject to the tolerances specified in 4.1.1.3 (Note 10).

4.1.1.3 In view of production, sampling, and testing variables, a commercial lot or shipment for which a nominal density has been agreed upon between the seller and the purchaser shall be considered as conforming and commercially acceptable when the density value found on a sample from the lot or shipment falls within the tolerance range of ±0.004 of the nominal value.

4.1.1.4 If the nominal value is unknown or unspecified, classification shall be based on the tested value without tolerance consideration.

4.1.2 *Classes*—Each of the five types is subdivided into four classes according to composition and use as follows:

4.1.2.1 *Class A*—Natural color only, without any or with such antioxidant or other additives in such proportions as agreed upon between the seller and the purchaser.

4.1.2.2 *Class B*—Colors including white and black, without any or with such antioxidant or other additives in such proportions as agreed upon between the manufacturer and the purchaser.

TABLE 1 Classification of Polyethylene Plastics Extrusion Materials for Wire and Cable According to Type

Type	Nominal Density,[A] g/cm^3
0	<0.910
I	0.910 to 0.925
II	>0.925 to 0.940
III	>0.940 to 0.960
IV	>0.960

[A] Uncolored, unfilled material (see Note 10).

4.1.2.3 *Class C*—Black (weather-resistant), containing not less than 2 % carbon black of a kind and particle size (Note 6), dispersed by such means and to such degree, all as may be agreed upon between the seller and the purchaser; without any or with such antioxidant or other additives in such proportions as agreed upon between the seller and the purchaser.

NOTE 6—Carbon black 35 nm or less in average particle diameter is used as required in black electrical and jacketing materials (Grades E and J) to impart maximum weather resistance.

4.1.2.4 *Class D*—Colored (UV resistant), including black and white, with antioxidant and UV stabilizers to allow electrical insulation and jackets to meet the requirements outlined in 12.1.12. (**Warning—**The expected service lifetime of Class D materials is very dependent upon the specific material formulation including selected colorants. Contact your supplier for additional information regarding this issue.)

4.1.3 *Categories*:

4.1.3.1 The four classes of each type are divided into five categories on the basis of broad ranges of flow rate in accordance with the requirements prescribed in Table 2.

NOTE 7—Some Type II and Type III polyethylene plastics of very high molecular weight cannot be categorized by flow rate. Solution viscosity is recommended as a means of distinguishing such materials.

4.1.3.2 Material supplied under these categories shall be of such nominal flow rate, within the ranges given, as agreed upon between the seller and the purchaser subject to the tolerances specified in 4.1.3.3.

4.1.3.3 In view of production, sampling, and testing variables, a commercial lot or shipment for which a nominal flow rate has been agreed upon between the seller and the purchaser shall be considered as conforming and commercially acceptable when the flow rate value found on a sample from the lot or shipment falls within the tolerance range of ±20 % of the nominal flow rate.

4.1.3.4 If the nominal value is unknown or unspecified, classification shall be based on the tested value without tolerance consideration.

4.1.4 *Grades*:

4.1.4.1 If further definition is necessary, one of the grades given in Tables 3-5 shall be selected.

NOTE 8—Tables 4 and 5, are included to correspond with the grades specified in Federal Specification L-P-390.

NOTE 9—The grade shall be associated with the appropriate type, class, and category designations; for example, IA5-E4 or IC5-J3 as required. Other grades may be added as necessary by revision of this specification in established manner. Also, it is anticipated that additional requirements may be added under a given grade designation by future revision to provide more meaningful characterization of the material covered by such designation.

TABLE 2 Classification of Polyethylene Plastics Extrusion Materials for Wire and Cable According to Category

Category	Nominal Flow Rate, g/10 min (190°C, 2.16 kg load)
1	>25
2	>10 to 25
3	>1.0 to 10
4	>0.4 to 1.0
5	0.4 max

4.1.4.2 Instead of such selection, additional requirements specific to the application may be specified by the purchaser with the agreement of the seller.

5. Basis of Purchase

5.1 The purchase order or inquiry for these materials shall state the specification number, type, class, category, and, if needed, the appropriate grade, for example, D1248–IA5-E4.

5.2 Further definition may be agreed upon between the seller and the purchaser as follows:

5.2.1 Nominal density.

NOTE 10—For Class B, Class C, and Class D material, the nominal density of the base resin will be identified by the manufacturer upon request.

5.2.2 Nominal flow rate.

5.2.3 *Antioxidant(s) or Other Additive(s) and Proportions*:

5.2.3.1 *Class A*—As stated in 4.1.2.1,

5.2.3.2 *Class B*—As stated in 4.1.2.2,

5.2.3.3 *Class C*—As stated in 4.1.2.3, and

5.2.3.4 *Class D*—As stated in 4.1.2.4.

5.2.4 Contamination level (see 6.2).

5.2.5 Other supplementary definition, unless grade is sufficient and is identified (see 4.1.4.1 and 4.1.4.2).

5.3 Inspection (see 13.1).

6. Materials and Manufacture

6.1 The extrusion material for wire and cable shall be polyethylene plastic in the form of powder, granules, or pellets.

6.2 The extrusion materials for wire and cable shall be as uniform in composition and size and as free of contamination as can be achieved by good manufacturing practice. If necessary, level of contamination may be agreed upon between the seller and the purchaser.

6.3 Unless controlled by requirements specified elsewhere (see 4.1.4.1 and 4.1.4.2), the color and translucence of extruded pieces formed under conditions recommended by the manufacturer of the material, shall be comparable within commercial match tolerances to the color and translucence of standard molded or extruded samples of the same thickness supplied in advance by the manufacturer of the material.

7. Physical Requirements

7.1 Test specimens of the material prepared as specified in 10.1, and tested in accordance with 12.1, shall conform to the requirements prescribed by the material designation for type in Table 1, for class in 4.1.2, for category in Table 2, and for grade in Tables 3-5.

8. Sampling

8.1 A batch or lot shall be considered as a unit of manufacture and may consist of a blend of two or more production runs of material.

8.2 Unless otherwise agreed between the seller and the purchaser, the material shall be sampled in accordance with the procedure described in Practice D 1898. Adequate statistical sampling prior to packaging shall be considered an acceptable alternative.

TABLE 3 Detail Requirements for Molded Test Specimens

Property and Unit	Grade[A]									
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Tensile stress, min:[B]										
MPa	8	10	10	12	12	17	17	19	19	22
[psi]	[1200]	[1500]	[1500]	[1800]	[1800]	[2400]	[2400]	[2800]	[2800]	[3200]
Elongation, min, %[B]	300	400	400	500	500	400	400	400	400	400
Brittleness temperature, max, °C	–50	–60	–60	–75	–75	–45	–75	–75	–75	–75
Environmental stress-crack resistance,[C,D] min, f_{20} h	. . .	. . .	. . .	48	48	. . .	. . .	48	48	48
Thermal stress-crack resistance, h without cracking, min	. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	96	168
Dissipation factor,[E] max:										
Class A										
Before milling	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002
After milling	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003
Class B	0.001	0.0005	0.001	0.0005	0.001	0.0005	0.001	0.0005	0.001	0.0005
Class C	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005
Dielectric constant[E] max increase over nominal[F]:										
Class A	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01
Class B	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04
Class C	0.52	0.30	0.52	0.30	0.52	0.30	0.50	0.30	0.50	0.30
Volume resistivity, min, Ω·cm:										
Classes A, B	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}
Water immersion stability	[G]	[G]	[G]	[G]	[G]	[G]	[G]	[G]	[G]	[G]

	E11	J1	J3	J4	J5
Tensile stress, min:[B]					
MPa	22	10	12	19	22
[psi]	[3200]	[1500]	[1800]	[2800]	[3200]
Elongation, min, %	400	400	500	400	400
Brittleness temperature, max, °C	–75	–60	–75	–75	–75
Environmental stress-crack resistance,[C,D] min, f_{20} h	48	. . .	24	24	24
Thermal stress-crack resistance, h without cracking, min	168	. . .	. . .	. . .	. . .
Dissipation factor,[E] max:					
Class A					
Before milling	0.0005	. . .	. . .	. . .	. . .
After milling	0.0005	. . .	. . .	. . .	. . .
Class B	0.001	. . .	. . .	. . .	. . .
Class C	0.01	. . .	0.01	0.01	. . .
					. . .
Dielectric constant[E] max increase over nominal[F]:					
Class A	0.05	. . .	. . .	. . .	. . .
Class B	0.12	. . .	. . .	. . .	. . .
Class C	0.50	. . .	0.52	0.52	. . .
Volume resistivity, min, Ω·cm:					
Classes A, B	10^{15}	. . .	. . .	. . .	. . .
Water immersion stability	[G]	. . .	. . .	. . .	. . .

[A] The letters associated with these grades identify areas of potential applicability as indicated below:
E = Electrical Insulation (in some instances these materials also may serve as jacketing).
J = Jacketing (in some instances these materials also may serve as primary insulation).
[B] At break.
[C] f_{20} is the time required for failure of 20 % of the samples tested in accordance with Test Method D 1693 as further directed by 12.1.6.1-12.1.6.4 of this specification.
[D] Requirements for environmental stress-crack resistance apply only to Class B, Class C, and Class D compounds unless otherwise specified (see 5.2.5).
[E] At any frequency from 1 kHz through 1 MHz (see also 12.1.8.1-12.1.8.3).
[F] Dielectric constant is a function of density; hence, the nominal value will be different for each type. Based on published information, the nominal values for the five types covered by this specification are as follows: Type 0-2.28, Type I-2.28, Type II-2.31, Types III and IV-2.35 (Lanza, V. L., and Herrmann, D. B., *Journal of Polymer Science*, JPSCA, Vol 28, 1958, p. 622). To illustrate the manner in which the maximum limit for the dielectric constant of a particular, grade is determined, assume that a Type I, Class A material is to be supplied under Grade E2, then its maximum limit for dielectric constant will be 2.28 + 0.01 = 2.29.
[G] Dissipation factor and dielectric constant must not exceed the limits specified above after immersion of the test specimens in water as described in 10.1.11. However, because this test is lengthy, it need not be performed on every lot of material. Rather, the material is to be checked initially for compliance with this requirement and, after that, as often as necessary to assure continued compliance. This requirement is not applicable to weather resistant (Class C and Class D) compounds (see Note 12).

9. Testing

9.1 The requirements identified by the material designation and otherwise specified in the purchase order (see 5.1 and 5.2) shall be verified by tests made in accordance with the directions given in 12.1. For routine inspection, only those tests necessary to identify the material to the satisfaction of the purchaser shall be required. One sample shall be sufficient for testing each batch or lot provided that the average values for all of the tests made on that batch or lot comply with the specified requirements.

TABLE 4 Special Grades—Dielectric—Natural and Colors

	Very Low Density, Specification D 1248, Type 0	Low Density, Specification D 1248, Type I				Medium Density, Specification D 1248, Type II		High Density,[A] Specification D 1248, Types III & IV				
		Natural	Colors	Natural	Colors	Natural	Colors					
Grade	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
Tensile Stress, min:[B]												
MPa	6.9	9.7	9.7	9.7	9.7	12.4	12.4	19.3	19.3	24.1	24.1	27.6
[psi]	1000	[1400]	[1400]	[1400]	[1400]	[1800]	[1800]	[2800]	[2800]	[3500]	[3500]	[4000]
Elongation, min, %[B]	500	400	400	400	400	400	400	400	400	400	400	400
Brittleness temperature, max, °C	−60	−60	−55	−60	−55	−60	−55	−55	...	−55	...	...
Dielectric constant, max, 1 MHz	2.28	2.35	2.35	2.35	2.35	2.35	2.35	2.38	2.38	2.38	2.38	2.38
Dissipation factor, max, 1 MHz	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Environmental stress crack resistance, min:												
f_{20}h (100 % Igepal)	. . .	. . .	. . .	24	24	. . .	. . .	. . .	. . .	. . .	. . .	. . .
f_{20}h (10 % Igepal)	>24	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Thermal stress crack resistance, min, f_{45}h	. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	. . .	96	. . .	. . .
Milling stability	. . .	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
After milling, dissipation factor, max												
L-P-390, type, class, grade		IIL1	IIL2	IIL3	IIL4	IIM1	IIM2	IIH1	IIH2	IIH3	IIH4	IIH5

[A] Grades D7 through D11 apply to both natural and colors, including black.
[B] At break.

TABLE 5 Special Grades—Weather Resistant—Black

	Very Low Density, Specification D 1248, Type 0	Low Density, Specification D 1248, Type 1				Medium Density, Specification D 1248, Type II			High Density, Specification D 1248, Types III & IV	
Grade	W0	W1	W2	W3	W4	W5	W6	W7	W8	W9
Tensile Stress, min:[A]										
MPa	6.9	9.7	9.7	9.7	9.7	12.4	12.4	12.4	19.3	24.1
[psi]	[1000]	[1400]	[1400]	[1400]	[1400]	[1800]	[1800]	[1800]	[2800]	[3500]
Elongation, min, %[A]	500	400	400	400	400	400	400	400	400	400
Brittleness temperature, max, °C	−60	−50	−50	−50	−50	−50	−50	−50	−55	−55
Dielectric constant, max, 1 MHz	2.28	2.50	2.75	2.75	2.80	2.50	2.75	2.80	2.75	2.75
Dissipation factor, max, 1 MHz	0.0005	0.003	0.007	0.007	0.01	0.003	0.007	0.01	0.005	0.007
Environmental stress crack resistance, min:										
f_{20}h (100 % Igepal)		. . .	. . .	24	. . .	. . .	. . .	. . .	. . .	. . .
f_{20}h (10 % Igepal)	>24	. . .	. . .	. . .	24	. . .	. . .	. . .	. . .	. . .
Thermal stress crack resistance, min, f_{45}h		. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	96
Milling stability										
After milling, dissipation factor, max		0.003	0.007	0.007	0.01	0.003	0.007	0.01	0.005	0.007
Carbon content, range, %	2.0-3.0	0.4-0.6	2.0-3.0	2.0-3.0	2.0-3.0	0.4-0.6	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Absorption coefficient, min	320	. . .	320	320	320	. . .	320	320	320	320
L-P-390, type, class, grade		IIIL1	IIIL2	IIIL3	IIIL4	IIIM1	IIIM2	IIIM3	IIIH1	IIIH2

[A] At break.

10. Specimen Preparation

10.1 Unless otherwise specified in 12.1, the test specimens shall be molded in accordance with Procedure C as found in Annex A1 of Practice D 4703.

11. Conditioning

11.1 *Conditioning*—Once specimens are molded, they shall be moved to a standard laboratory atmosphere or a controlled laboratory atmosphere. For 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*—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 tested 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 following test methods:

12.1.1 *Density*—Test Method D 1505 or alternative methods of suitable accuracy, such as Test Method D 2839 or Methods A or B of Test Methods D 792. Make duplicate determinations using two separate portions of the same molding or from two moldings. The molded specimen thickness shall be 1.9 ± 0.2 mm [0.075 ± 0.008 in.]. Condition only as specified in 11.1 and any departure from that conditioning shall be reported.

12.1.2 *Flow Rate*—Test Method D 1238, using Condition 190/2.16 unless otherwise directed (Note 11). Make duplicate determinations on the material in the form of powder, granules, or pellets. No conditioning is required.

NOTE 11—Although the flow rate of polyethylene plastics may be measured under any of the conditions listed for it in Test Method D 1238, only measurements made at Condition 190/2.16 (190°C, 2.16 kg load) 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 190/2.16 is Condition 190/10.0.

12.1.3 *Carbon Black Content*—Test Method D 1603 or E 1131. If Test Method D 1603 is used, it must be known that no inorganic pigments or fillers are present in the material. Make duplicate determinations from a sample of the material in the form of powder, granules, or pellets.

NOTE 12—If it is known or suspected that the material contains moisture, the sample should be dried prior to being tested, but otherwise no conditioning is required.

12.1.4 *Tensile Stress at Break and Elongation at Break*—Test Method D 638, except that speed of grip separation shall be 500 mm [20 in.]/min for Types 0 and I and 50 mm [2 in.]/min for Types II, III, and IV. Specimens shall conform to the dimensions given for Type IV in Test Method D 638 with their thickness to be 1.9 ± 0.2 mm [0.075 ± 0.008 in.]. Specimens shall be either die cut or machined to the specified dimensions. Bench marks or a high range extensometer shall be used for the determination of elongation at break. The initial distance between the bench marks or extensometer grips shall be 25.4 ± 0.4 mm [1.00 ± 0.02 in.]. The initial grip separation shall be 63.5 ± 5 mm [2.5 ± 0.2 in.]. 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.

12.1.5 *Brittleness Temperature*—Procedure A of Test Method D 746.

12.1.6 *Environmental Stress-Crack Resistance Test*—Test Method D 1693, with the following provisions:

12.1.6.1 Type 0 materials shall be tested under Condition B, as defined in Table 1 of Test Method D 1693.

12.1.6.2 Type I materials shall be tested under Condition A, as defined in Table 1 of Test Method D 1693.

12.1.6.3 Unless otherwise specified, test materials of Types II, III, and IV under Condition B, as defined in Table 1 of Test Method D 1693.

12.1.6.4 Test Grades E4, E5, E8, E9, E10, E11, and W3 in undiluted Igepal CO-630.[4] Test Grades J3, J4, J5, and W4 in a solution of 10 weight % Igepal CO-630 in water.

12.1.7 *Thermal Stress-Crack Resistance of Types III and IV Polyethylenes*—Test Method D 2951.

12.1.8 *Dissipation Factor and Dielectric Constant*—Test Method D 1531 or Test Method D 150, with the former to be the referee method. The following additional instructions and the precautions of Note 12 shall be observed:

12.1.8.1 *Milling Stability*—This procedure is intended for application to materials to be used for electrical insulation. For such materials, the milling procedure described in 12.1.8.2 may be performed as a preconditioning step prior to the determination of dissipation factor and dielectric constant as provided in 12.1.8. Its purpose is to establish that a suitable antioxidant is present in adequate quantity. After being milled as prescribed, the material shall meet the dielectric requirements prescribed in Table 3.

12.1.8.2 Process approximately 400 g of material for 3 h ± 5 min on a two-roll laboratory mill meeting the requirements prescribed in Practice D 3182 at a temperature of 160 ± 5°C with the distance between the rolls so adjusted that the charge maintains a uniform rolling bank. Any other size two-roll laboratory mill may be used provided the charge is adequate to maintain a uniform rolling bank on the rolls and to furnish sufficient material for test specimens.

12.1.8.3 Due to the time-consuming nature of this preconditioning procedure, the frequency with which it is applied shall be established by sound statistical quality control practices by the individual manufacturer. However, the specified electrical tests shall be performed on every batch or run, using the normal conditioning procedure (11.1) plus the precautions of Note 12.

12.1.9 *Water Immersion Stability*—Immerse the test specimen in distilled water at 23 ± 2°C for 14 days after which remove, wipe dry, and immediately test for dissipation factor and dielectric constant in accordance with 12.1.8.

[4] This method is based on the use of Igepal CO-630, a trademark for a nonylphenoxy poly(ethyleneoxy)ethanol, which may be obtained from Rhone-Poulenc CN7500, Prospect Plains Road, Cranbury, NJ 08512-7500.

12.1.10 *Volume Resistivity*—Test Methods D 257, using the electrodes shown in Fig. 4 (Flat Specimen for Measuring Volume and Surface Resistances or Conductances) or Fig. 5 (Tubular Specimen for Measuring Volume and Surface Resistances or Conductances). Conditioning and test conditions shall be as specified in 11.1 and 11.2 plus the precautions of Note 13.

NOTE 13—Test specimens, particularly those molded of compounds containing carbon black, should be tested immediately after conditioning and their storage under humid conditions should be avoided.

12.1.11 *Absorption Coefficient*—Test Method D 3349.

12.1.12 *Weatherability for Colored Materials (Including White and Black*:

12.1.12.1 *Carbon Arc*—See Appendix X1 for this test.

12.1.12.2 *Xenon Arc*—The material shall retain a minimum of 50 % of its unexposed elongation after 4000 h (Note 14) of exposure in a xenon-arc apparatus. Prepare the specimens in accordance with Test Methods D 2633 for physical tests of insulations and jackets. Perform the tests in accordance with Practices D 2565, G 151 and G 155 using filters CIRA/C and an irradiance of 0.70 W/m^2/nm at 340 nm (Note 15). The exposure cycle consists of a light cycle of 10 h with 18 minutes water spray on the front surface during each 2 h period followed by a dark period of 2 h with continuous water spray on the back surface. The insulated black panel temperature is 70 ± 2°C with the light on and 55 ± 2°C with the light off. The dry bulb is adjusted to 48 ± 2°C during the light cycle and 55 ± 2°C during the dark cycle. The relative humidity requirements are 50 ± 5 % during the light cycle and 95 ± 5 % when the light is off.

NOTE 14—The 4000 h exposure period specified cannot be extrapolated to service life under environmental conditions without data to estimate an acceleration factor for the materials exposed. A study has been initiated by an ICEA/TWCSTAC working group to determine the acceleration factors for several formulations of polyethylene wire and cable materials.

NOTE 15—Longer periods of exposure will be required for older xenon-arc machines operated at irradiance of 0.35 W/m^2/nm at 340 nm.

12.1.12.3 *Fluorescent UV Condensation Device*—The material shall retain a minimum of 50 % of its unexposed elongation after 4000 h (Note 14) of exposure in a fluorescent UV condensation apparatus operated with fluorescent UVA-340 lamps. Prepare the specimens in accordance with Methods D 2633 for physical tests of insulations and jackets. Perform the tests in accordance with Practices G 151, G 154, and D 4329 using the following exposure conditions: 20 h exposure to UVA-340 fluorescent lamps with uninsulated black panel temperature maintained at the control point at 70 ± 3°C followed by 4 h darkness with condensation at an uninsulated black panel temperature maintained at the control point at 55 ± 3°C. Irradiance at the control point shall be maintained at 0.70 ± 0.05 W/(m^2.nm) at 340 nm when using the irradiance controlled apparatus.

NOTE 16—The irradiance level in the unit that does not have irradiance control is reported to be 0.67± 0.12 W/(m^2.nm) at 340 nm at an operating temperature of 70°C. However, the degradation rate of polyethylene has been found to be more variable than in the irradiance controlled unit and may be as little as ⅓ of the rate in the latter unit. However, the non-irradiance control machine can still be used for relative weatherability comparison among different materials weathered at the same time.

NOTE 17—It should be noted that the irradiation spectra from different sources including carbon arc, xenon arc, and UV fluorescent equipment are not equivalent. Therefore, the effects of the exposures described in 12.1.12.1, 12.1.12.2, and 12.1.12.3 are not equivalent.

13. Inspection

13.1 Inspection of the material shall be made as agreed upon by the purchaser and the seller as part of the purchase contract.

14. Retest and Rejection

14.1 If any failure occurs, the materials may be retested to establish conformity in accordance with agreement between the purchaser and the seller.

15. Packaging and Package Marking

15.1 *Packaging*—The material shall be packaged in standard commercial containers, so constructed as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

15.2 *Package Marking*—Unless otherwise agreed between the seller and the purchaser, shipping containers shall be marked with the name of the material, type, and quantity contained therein, as defined by the contract or order under which shipment is made and the name of the manufacturer.

15.3 All packing, packaging, and marking provisions of Practice D 3892 shall apply to this specification.

16. Keywords

16.1 polyethylene classification system; polyethylene for wire and cable; polyethylene plastics; wire and cable insulations and jackets

QUALITY ASSURANCE PROVISIONS FOR GOVERNMENT/MILITARY PROCUREMENT

These requirements apply only to Federal/Military procurement, not domestic sales or transfers.

S1. Sampling for inspection and testing shall be carried out in accordance with the recommendations of Practice D 3636.

S2. 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 Practice D 3636.

S3. In the absence of contrary requirements, the following values shall apply:

	IL	AQL
Defects of appearance and workmanship	II	2.5
Defects of preparation for delivery	S-2	2.5
Testing (products)	S-1	1.5
Testing (polymer, unfabricated)	S-1[A]	. . .

[A] Samples shall be drawn from the required number of units, and pooled for preparation of molded samples for mechanical properties evaluation.

APPENDIX

(Nonmandatory Information)

X1. CARBON-ARC APPARATUS

X1.1 The radiation from a twin enclosed carbon-arc has no similarity to solar radiation. Therefore, this type of unit is not recommended as a laboratory accelerated weathering test to qualify materials for outdoor applications. Agreement of the parties involved may allow use of this device. However, no information is available on the relation between exposure times and service life under use conditions for wire and cable.

X1.2 If a twin enclosed carbon-arc apparatus must be used, the following will apply.

X1.3 The material shall retain a minimum of 50 % of its unexposed elongation after 4000 h (Note 14) of exposure in a twin enclosed carbon-arc apparatus, or a time agreed upon by the parties involved. Prepare the specimens in accordance with Test Methods D 2633 for physical tests of insulation and jackets. Perform the test in accordance with Practices G 151 and G 153 using an exposure cycle of 102 minutes light only at 63 ± 3°C (uninsulated black panel) and 55 ± 5 % relative humidity followed by 18 min of light plus water spray on the front surface of the specimen (air temperature not controlled).

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue, D 1248 - 04, that may impact the use of this standard. (March 1, 2005)

(*1*) Revised 12.1.4 to clarify the method of measuring elongation at break.

Committee D20 has identified the location of selected changes to this standard since the last issue, D 1248 - 02, that may impact the use of this standard. (March 1, 2004)

(*1*) Added a new Section 11.
(*2*) Deleted the existing paragraphs 11.1.1 and 11.1.2.
(*3*) Renumbered existing Section 11 to Section 12.
(*4*) Renumbered all subsequent sections accordingly.
(*5*) Changed the title of paragraph 12.1.4 to "Tensile Stress at Break and Elongation at Break."
(*6*) Changed "Tensile Strength" to "Tensile Stress" and added a new footnote "At Break" to both Tensile Stress and Elongation in Tables Table 3, Table 4, and Table 5.