



# Standard Specification for Crosslinkable Ethylene Plastics<sup>1</sup>

This standard is issued under the fixed designation D2647; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification covers a general classification system for crosslinkable ethylene plastics compounds (**Note 1**). The requirements specified herein are not necessarily applicable for use as criteria in determining suitability for the end use of a fabricated product.

**NOTE 1**—It is to be noted that this specification describes materials that are available commercially in their uncrosslinked form. Therefore, they are crosslinkable compounds despite the fact that measurement of the parameters used for their classification and specification will usually be carried out after curing has been effected.

1.2 Two types of compounds are covered, namely, mechanical types in which mechanical strength properties are of prime importance in applications, and electrical types in which electrical insulating or conducting properties also are of prime importance in applications.

1.3 The parameters used to classify and specify the mechanical types are ultimate elongation, elongation retention after aging, apparent modulus of rigidity, and brittleness temperature.

1.4 The parameters used to classify and specify the electrical types are ultimate elongation, elongation retention after aging, apparent modulus of rigidity, brittleness temperature, dielectric constant, dissipation factor, and volume resistivity.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification: *This specification 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 specification to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

**NOTE 2**—There is no known ISO equivalent to this standard.

<sup>1</sup> 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. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation  
D257 Test Methods for DC Resistance or Conductance of Insulating Materials  
D573 Test Method for Rubber—Deterioration in an Air Oven

D618 Practice for Conditioning Plastics for Testing  
D638 Test Method for Tensile Properties of Plastics  
D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

D883 Terminology Relating to Plastics  
D991 Test Method for Rubber Property—Volume Resistivity of Electrically Conductive and Antistatic Products  
D1043 Test Method for Stiffness Properties of Plastics as a Function of Temperature by Means of a Torsion Test  
D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics

D3892 Practice for Packaging/Packing of Plastics  
IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): (The Modernized Metric System)

2.2 Military Standard:  
MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes<sup>3</sup> (Obsolete 1995)

## 3. Terminology

3.1 *Definitions*: For definitions of plastics terms used in this specification, see Terminology D883.

3.2 *Abbreviations*: Units, Symbols, and Abbreviations—For units, symbols, and abbreviations used in this specification see IEEE/ASTM SI-10.

## 4. Classification

4.1 *Classification System*—Table 1 and Table 2 provide a classification system for these compounds so that the relations among them can be delineated and those that are commercially

<sup>2</sup> 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.

<sup>3</sup> Available from Defense Automation and Production Service, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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

**TABLE 1 Type I, Mechanical Compound Requirements**

Designation Order No.	Property	Cell Limits					
		0	1	2	3	4	5
1	Ultimate elongation, %	unspecified	<25	≥25	≥150	≥250	≥450
2	Minimum of 75 % retention of elongation after aging at the specified temperature for 168 h, °C (°F)	unspecified	121 (250)	150 (302)			
3	Apparent modulus of rigidity, MPa (psi)	unspecified	<70 (10 000)	≥70 (10 000)	≥275 (40 000)		
4	Brittleness temperature, °C (°F)	unspecified	<-75 (-103)	≤-54 (-65)	≤-40 (-40)	≤-29 (-20)	
5	Percent extract (measure of degree of cross-linking)	unspecified	<10	≥10	≥20	≥30	

**TABLE 2 Type II, Electrical Compound Requirements**

Designation Order No.	Property	Cell Limits					
		0	1	2	3	4	5
1	Ultimate elongation, %	unspecified	<25	≥25	≥150	≥250	≥450
2	Minimum of 75 % retention of elongation after aging at the specified temperature for 168 h, °C (°F)	unspecified	121 (250)	150 (302)			
3	Apparent modulus of rigidity, MPa (psi)	unspecified	<70 (10 000)	≥70 (10 000)	≥275 (40 000)		
4	Brittleness temperature, °C (°F)	unspecified	<-75 (-103)	≤-54 (-65)	≤-40 (-40)	≤-29 (-20)	
5	Percent extract (measure of degree of cross-linking)	unspecified	<10	≥10	≥20	≥30	
6	Dielectric constant	unspecified	≤2.50	>2.50	>3.50	>6.00	>8.00
7	Dissipation factor	unspecified	≤0.001	>0.001	>0.005	>0.01	>0.1
8	Volume resistivity, Ω·cm	unspecified	≥10 <sup>15</sup>	≥10 <sup>12</sup>	≥10 <sup>4</sup>	<10 <sup>4</sup>	

available can be readily specified. It is not the intent to indicate that all the combinations of properties possible are represented by commercial products or that they are technically possible at the present state of knowledge.

4.2 *Types*—This specification covers two general types of compounds: *Type I*—Mechanical types (Table 1), and *Type II*—Electrical types (Table 2).

4.3 *Grades*—A grade is designated by first indicating the type (I or II) followed by cell numbers for each property in the order in which they are listed in the tables. Where there is no interest in a property, a “0” is entered in place of a cell number.

## 5. General Requirements

5.1 The compound shall be in powder, pellet or granular form, as agreed upon between the seller and the purchaser.

5.2 The compound, after crosslinking, shall conform to the requirements given in Table 1 or Table 2, whichever is applicable, for the type and grade specified when tested in accordance with the procedures given in Sections 6, 7, and 8.

## 6. Sampling

6.1 Sampling shall be statistically adequate to satisfy the requirements of 9.4.

6.2 A batch or lot shall be constituted as a unit of manufacture as prepared for shipment and can consist of a blend of two or more “production runs.”

## 7. Specimen Preparation

7.1 Unless otherwise agreed upon between the seller and the purchaser, the test specimens shall be formed and cured in accordance with the compound manufacturer’s recommendations.

## 8. Test Methods

8.1 *Conditioning*—Condition the test specimen at  $23 \pm 2^\circ\text{C}$  ( $73.4 \pm 3.6^\circ\text{F}$ ) and  $50 \pm 10\%$  relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D618, for those tests where conditioning is required and in all cases of disagreement.

8.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of  $23 \pm 2^\circ\text{C}$  ( $73.4 \pm 3.6^\circ\text{F}$ ) and  $50 \pm 10\%$  relative humidity, unless otherwise specified in the test methods or in this specification.

8.3 *Ultimate Elongation*—Test Method D638, using three Type IV specimens tested at 500 mm/min (20.0 in./min). If any absolute value differs more than  $\pm 20\%$  from the average, two additional samples shall be tested, making a total of five specimens. The average value for these specimens shall be used for the classification.

8.4 *Elongation Retention After Aging*—Age three or five test specimens, conforming to Type IV of Test Method D638, in accordance with the number evaluated in 8.3. Use a circulating air oven at either  $121 \pm 2^\circ\text{C}$  ( $250 \pm 3.6^\circ\text{F}$ ) or  $150$

± 2°C (302 ± 3.6°F) in accordance with Test Method D573 and ensure that the hot air circulates freely around each specimen for 7 days (168 h). After 7 days, recondition the test specimens and measure the ultimate elongation in accordance with 8.3. Average the results and designate as A. Calculate the percentage elongation retention, as follows:

$$\text{Elongation retention, \%} = (A/I) \times 100 \quad (1)$$

where:

I = original elongation from 8.3.

8.5 *Apparent Modulus of Rigidity*—Condition and test specimens in accordance with 8.1 and 8.2 and measure in accordance with Test Method D1043.

8.6 *Brittleness Temperature*—Test Method D746.

8.7 *Dielectric Constant*—Test Method D150 at 1000 Hz (cycles per second) and 23 ± 1°C (73.4 ± 1.8°F).

8.8 *Dissipation Factor*—Test Methods D150 at 1000 Hz and 23 ± 1°C (73.4 ± 1.8°F).

8.9 *Volume Resistivity*—Test Methods D257. For precise evaluation of specimens below 10<sup>6</sup> Ω-cm, use Test Method D991 as an alternative.

8.10 *Degree of Crosslinking*—Test Methods D2765, with Method A to be used for referee tests.

## 9. Inspection and Certification

9.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

9.2 Lot acceptance inspection shall be the basis on which acceptance or rejection of the lot is made.

9.3 Periodic check inspection with reference to a specification based upon this classification system shall consist of the tests for all requirements of the material under the specification. Inspection frequency shall be adequate to ensure the material is certifiable in accordance with 9.4.

9.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested, and inspected in accordance with this classification system, and that the average values for the lot meet the requirements of the specification (line callout).

9.5 A report of the test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and the results of the most recent periodic-check inspection.

## 10. Packaging and Marking

10.1 *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.

10.2 *Marking*—Unless otherwise agreed between the seller and the purchaser, shipping containers shall be marked with the name of the material and its supplier, type and grade designation, and the quantity contained.

10.3 All packing, packaging, and marking provisions of Practice D3892 shall apply to this specification.

## 11. Keywords

11.1 crosslinkable; crosslinked; ethylene plastics; insoluble fraction; volume resistivity

## QUALITY ASSURANCE PROVISIONS FOR GOVERNMENT/MILITARY PROCUREMENT

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

S1. When specified in the contract or purchase order, sampling for inspection and testing shall be carried out in accordance with the recommendations of Practice D1898.

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 the Means and Standard Deviations and Comparison of Sampling Plans sections of the above document, with reference to Military Standard MIL-STD-105.

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
Test (products)	S-1	1.5
Testing (polymer, unfabricated)	S-1 <sup>A</sup>	—

<sup>A</sup> Samples shall be drawn from the required number of units, and pooled for preparation of molded samples for mechanical properties evaluation.

**SUMMARY OF CHANGES**

Committee D20 has identified the location of selected changes to this specification since the last issue, D2647 - 05a, that may impact the use of this specification. (May 1, 2010)

(1) Revised **Note 2, 6.1, 8.1, 8.2, and 8.5**

(2) Revised Sections **6 and 9.**

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