



Designation: D229 – 19^{ε1}

Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation¹

This standard is issued under the fixed designation D229; 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.

^{ε1} NOTE—The title of Table 1 was editorially corrected in August 2019.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 These test methods cover procedures for testing rigid electrical insulation normally manufactured in flat sheet or plate form. They are generally used as terminal boards, spacers, voltage barriers, and circuit boards.

1.2 Use Test Methods **D619** (withdrawn) or Specification **D710** for tests applying to vulcanized fibre.

1.3 Some of the test methods contained in this standard are similar to those contained in IEC 60893-2, which applies to rigid industrial laminated sheets based on thermosetting resins for electrical purposes.

1.4 The test methods appear in the following sections:

Test	Sections	ASTM Test Method
Acetone extractable matter	82 to 83	D494
Arc resistance	47	D495
Ash	56 to 60	...
Bonding strength	49 to 54	...
Flammability methods I and II	61 to 74	...
Coefficient of linear thermal expansion	76	D696
Compressive strength	25	D695
Conditioning	4	D6054
Dissipation factor	34 to 40	D669
Dielectric strength	28 to 33	D149
Expansion (linear thermal)	75	D696
Flexural properties	12 to 24	D790
Hardness (Rockwell)	55	D785
Insulation resistance and resistivity	41 to 46	D257
Permittivity	34 to 40	D150
Resistance to impact	26	D256
Tensile properties	7 to 11	D638
Thickness	5 to 6	D374
Tracking resistance	48	D2132
Warp or twist	76 to 81	...
Water absorption	27	D570

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical

¹ These test methods are under the jurisdiction of ASTM Committee **D09** on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee **D09.07** on Electrical Insulating Materials.

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conversions to SI units that are provided for information only and are not considered standard.

1.6 This is a fire-test-response standard. See Sections **61** through **74**, which are the procedures for assessing ignitability and burning time under specific test conditions

1.7 *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.* Specific precautionary statements are given in **31.1** and **1.8**.

1.8 *This standard measures and describes the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

1.9 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.10 *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

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

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

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D374 Test Methods for Thickness of Solid Electrical Insulation (Metric) D0374_D0374M

D494 Test Method for Acetone Extraction of Phenolic Molded or Laminated Products

D495 Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

D570 Test Method for Water Absorption of Plastics

D617 Test Method for Punching Quality of Phenolic Laminated Sheets (Withdrawn 2003)³

D619 Test Methods for Vulcanized Fibre Used for Electrical Insulation

D638 Test Method for Tensile Properties of Plastics

D669 Test Method for Dissipation Factor and Permittivity Parallel with Laminations of Laminated Sheet and Plate Materials (Withdrawn 2012)³

D695 Test Method for Compressive Properties of Rigid Plastics

D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between –30°C and 30°C with a Vitreous Silica Dilatometer

D710 Specification for Vulcanized Fibre Sheets, Rods, and Tubes Used for Electrical Insulation

D785 Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D883 Terminology Relating to Plastics

D1674 Test Method for Testing Polymerizable Embedding Compounds Used for Electrical Insulation (Withdrawn 1990)³

D1711 Terminology Relating to Electrical Insulation

D1825 Practice for Etching and Cleaning Copper-Clad Electrical Insulating Materials and Thermosetting Laminates for Electrical Testing (Withdrawn 2012)³

D2132 Test Method for Dust-and-Fog Tracking and Erosion Resistance of Electrical Insulating Materials

D2303 Test Methods for Liquid-Contaminant, Inclined-Plane Tracking and Erosion of Insulating Materials

D3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus

D5032 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Glycerin Solutions

D6054 Practice for Conditioning Electrical Insulating Materials for Testing (Withdrawn 2012)³

E176 Terminology of Fire Standards

E197 Specification for Enclosures and Servicing Units for Tests Above and Below Room Temperature (Withdrawn 1981)³

2.2 *IEC Standard:*

IEC 60893–2 Specification for Rigid Industrial Laminated Sheets Based on Thermosetting Resins for Electrical Purpose, Methods of Tests⁴

2.3 *International Organization for Standardization (ISO) Standard:*

ISO 13943 Fire Safety: Vocabulary⁵

3. Terminology

3.1 *Definitions*—Rigid electrical insulating materials are defined in these test methods in accordance with Terminology **D883**. The terminology applied to materials in these test methods shall be in accordance with the terms appearing in Terminologies **D883** and **D1711**. Use Terminology **E176** and ISO 13943 for definitions of terms used in this test method and associated with fire issues. Where differences exist in definitions, those contained in Terminology **E176** shall be used.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 In referring to the cutting, application, and loading of the specimens, the following terms apply:

3.2.1.1 *crosswise (CW), adj*—in the direction of the sheet at 90° to the lengthwise direction.

3.2.1.1.1 *Discussion*—This is normally the weakest direction in flexure. For some materials, including the raw materials used for manufacture of materials considered herein, this direction may be designated as the cross-machine direction or the weft direction.

3.2.1.2 *edgewise loading, n*—mechanical force applied in the plane of the original sheet or plate.

3.2.1.3 *flatwise loading, n*—mechanical force applied normal to the surfaces of the original sheet or plate.

3.2.1.4 *lengthwise (LW), adj*—in the direction of the sheet which is strongest in flexure.

3.2.1.4.1 *Discussion*—For some materials, including the raw materials used for the manufacture of materials considered herein, this direction may be designated as the machine direction or the warp direction.

3.2.2 In referring to bonding strength, the following term applies:

3.2.2.1 *bonding strength, n*—the force required to split a prescribed specimen under the test conditions specified herein.

3.2.3 In reference to ignitability and burning time, the following terms apply:

3.2.3.1 *ignition time, n*—the elapsed time in seconds required to produce ignition under conditions of this test method.

3.2.3.2 *burning time, n*—the elapsed time that the specimen burns after removal of the ignition heat source under conditions of this test method.

4. Conditioning

4.1 The properties of the materials described in these test methods are affected by the temperature and moisture exposure

³ The last approved version of this historical standard is referenced on www.astm.org.

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

⁵ Available from International Organization for Standardization, P.O. Box 56, CH-1211, Geneva 20, Switzerland or from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.