



Designation: D8354 – 21

Standard Test Method for Flammability of Electrical Insulating Materials Intended for Wires or Cables When Burning in a Vertical Configuration¹

This standard is issued under the fixed designation D8354; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

NOTE—The title of this test method was corrected editorially and the year date was changed on March 31, 2021.

1. Scope

1.1 This is a fire-test-response standard.

1.2 This fire test method is applicable to electrical insulation materials used for wires or cables. The materials are tested as plastic specimens on their own or installed on the wires or cables.

1.3 The ignition source is a gas burner fueled by methane or natural gas.

1.4 Use the values stated in SI units in referee decisions; see IEEE/ASTM SI-10. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.5 *This standard is used to measure and describe 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.*

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

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.*

1.8 *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.*

¹ This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.17 on Fire and Thermal Properties.

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2. Referenced Documents

2.1 *ASTM Standards:*²

D1711 Terminology Relating to Electrical Insulation

D2219 Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 60 °C Operation

D2220 Specification for Poly(Vinyl Chloride) Insulation for Wire and Cable, 75 °C Operation

D2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable

D3032 Test Methods for Hookup Wire Insulation

D5025 Specification for Laboratory Burner Used for Small-Scale Burning Tests on Plastic Materials

D5207 Practice for Confirmation of 20-mm (50-W) and 125-mm (500-W) Test Flames for Small-Scale Burning Tests on Plastic Materials

E176 Terminology of Fire Standards

2.2 *ISO Standard:*³

ISO 13943 Fire Safety – Vocabulary

2.3 *Federal Standard:*⁴

PPP-T-45D Federal Specification for Tape; Paper, Gummed (Kraft)

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms relating to electrical and electronic insulating materials, the definitions in this test method are in accordance with Terminology D1711. For terms relating to fire, the definitions in this test method are in accordance with Terminology E176 and ISO 13943. In case of conflict, the definitions given in Terminology E176 shall prevail.

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.

³ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

⁴ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

4. Summary of Test Method

4.1 In this test method, a test specimen of an electrical insulating material or a wire or cable test specimen is mounted vertically and ignited with a small burner, applying a 500 W flame, with five consecutive exposures of 15 s each.

4.2 The burner gas is methane or natural gas (see 6.5).

4.3 A kraft paper flame indicator flag is attached to the test specimen to assess vertical flame spread.

4.4 A cotton mat is placed under the test specimen to capture droplets falling from the test specimen and determine whether flaming ignition of the cotton occurs.

4.5 The report records the fraction of the flame indicator flag that has been burnt, whether flaming material has dropped from the test specimen and ignited the cotton mat and the time during which the test specimen continues flaming after the burner has been removed. Test A in Test Methods D3032 also requires reporting the burn length.

5. Significance and Use

5.1 This vertical flame test provides information regarding the flammability performance of electrical insulating materials.

5.2 This test method is used to assess the vertical flame test performance of electrical insulation materials used in wires or cables in Test Methods D2633 and D3032 (Test A), as well as in Specifications D2219 and D2220.

5.3 In this test method, the test specimens are subjected to one or more specific sets of laboratory test conditions. If different test conditions are substituted or the end-use conditions are changed, it is not always possible by or from this test to predict changes in the fire-test-response characteristics measured. The results are therefore valid only for the fire-test exposure conditions described in this procedure.

6. Apparatus

6.1 Test Chamber:

6.1.1 The test chamber shall be constructed of sheet metal, 300 ± 5 mm (12 ± 0.2 in.) in width, 350 ± 5 mm (14 ± 0.2 in.) in depth, 600 ± 5 mm (24 ± 0.2 in.) in height, and open at the top.

6.1.2 The test chamber shall contain a closable front door, hinged or sliding, with a glass window for observing the flame application, which provides a draft restricted, four-sided enclosure when the door is closed.

6.1.3 Three circular draft holes shall be located in a row, parallel to the lower edge of each of the two side panels. These draft holes shall be located approximately 25 mm (1 in.) above the bottom surface of the chamber and shall be 29 mm (1.13 in.) in diameter. These draft holes shall be free of obstructions to air flow.

6.2 Means for Holding Test Specimen Taut in Vertical Position:

6.2.1 The test chamber shall be provided with screws or tension clamps for securing the test specimen at the upper and lower ends, approximately centered in the chamber.

6.2.2 Use a compact lower clamp designed to afford minimal interference with flaming or dripping particles flowing or falling downward along the test specimen during the flame test.

6.2.3 The lower clamp shall not prevent downward flowing or dropping material from direct contact with the cotton layer at the bottom of the chamber.

6.3 Burner:

6.3.1 The burner shall meet the requirements of Specification D5025.

6.3.2 The burner shall be designed to provide a flame that is 125 ± 10 mm ($4\frac{7}{8} \pm 0.4$ in.) long, with an intensity of 500 W (1700 BTU/h).

6.3.3 The burner shall be mounted at a 20° angle to the horizontal by mounting it on an angled wedge assembly, in accordance with 6.4.

6.4 Wedge Assembly:

6.4.1 The base of the burner shall be secured to a wedge assembly, which shall angle the barrel 20° from the vertical while the longitudinal axis of the barrel remains in a vertical plane (see Fig. 1).

6.4.2 The wedge assembly shall allow the repeated removal of the flame from a location on the test specimen and reapplication of the same flame to the same location on the test specimen.

6.4.3 The wedge assembly shall allow the removal of the flame source without moving the test specimen or disturbing the cotton mat (see 6.8).

6.5 Gas—The burner shall be provided either with methane gas, technical grade, 98.0 % minimum purity, or with natural gas. The heating value of either gas shall be 37 ± 1 MJ/m³ or 8.9 kcal (thermochemical) per cubic meter or 1000 BTU (thermochemical) per cubic foot, at 25 ± 1 °C (77 ± 2 °F) and 101 kPa (14.7 psi).

6.5.1 Adjust the burner barrel height, as indicated in Practice D5207 to confirm that the overall height of the gas flame is 125 ± 10 mm ($4\frac{7}{8} \pm 0.4$ in.) and that the blue inner cone is 40 ± 2 mm ($1\frac{5}{16} \pm 0.08$ in.) high. Use the same procedure for methane and for natural gas. A gas supply gauge pressure of 69 to 138 kPa (10 to 20 lbf/in.²) has been found to be adequate to maintain the required flame. A cylinder shall not be used when this range of pressure is no longer sustainable at room temperature.

6.5.2 Ensure that the burner flame does not change from blue to luminous without any change of the settings. If this occurs, it is an indication that the fuel-gas content of the cylinder is exhausted and that the gas cylinder is to be labeled as empty and returned for refilling.

6.6 Flame—Ensure that the overall flame remains blue and that the height of the blue inner cone is not less than 38 ± 2 mm (1.50 ± 0.08 in.). If the height of the flame is lower without any change in settings, it is likely that the contents of the gas cylinder are at low pressure and the cylinder shall be replaced.

6.7 Timing Device—The timing device shall be a stopwatch or other suitable timing device capable of time measurements to within 0.5 s.

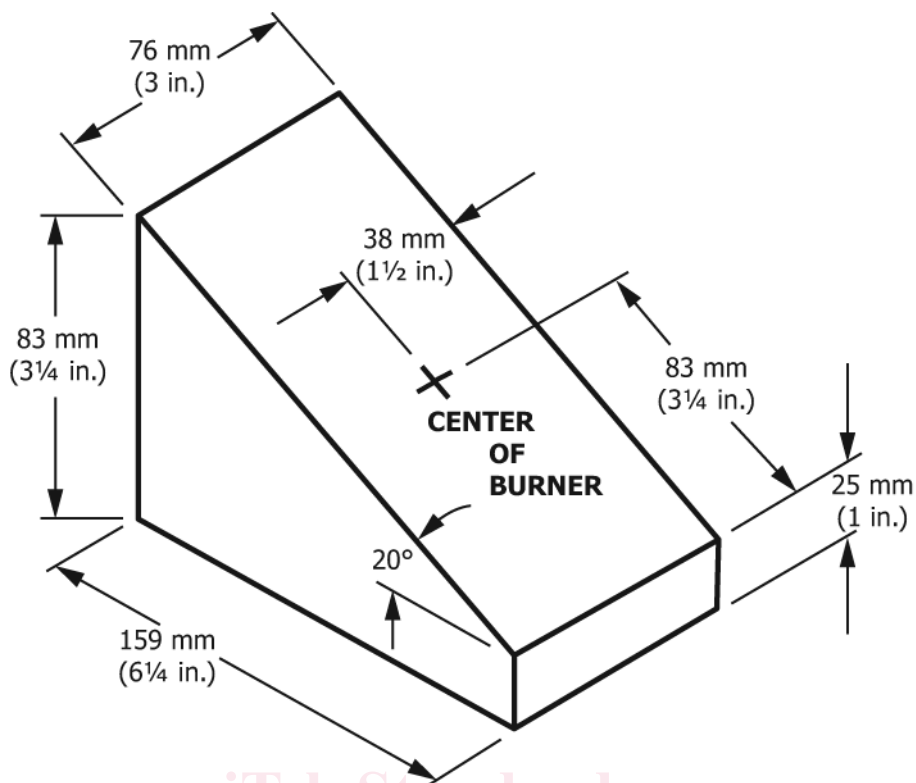


FIG. 1 Wedge Assembly

6.8 *Flame Indicator Flag*—A flame indicator flag shall be constructed of kraft paper, made from a commercially available plain cellulose paper tape. The tape shall have a nominal area density of 98 g/m^2 (60 lb/3000 ft^2), prior to gumming, and a nominal thickness of 0.13 mm (0.005 in.). It shall be gummed on one side, not reinforced, and not exposed to flame retardant treatment. The flag shall have a nominal 10 mm (0.39 in.) width and a nominal 40 mm (1.57 in.) length longer than the outside circumference of the test specimen.

NOTE 1—The paper used for the indicators is that known to the trade as 60-lb stock, and is material substantially the same as that described in Federal Specification PPP-T-45D.

6.9 *Cotton Mat*—The cotton mat shall consist of long-fiber, pure, dry, untreated, surgical grade cotton not more than 6 mm (0.25 in.) and not less than 4 mm (0.16 in.) thick. The cotton shall be kept in a desiccator containing anhydrous calcium chloride or another drying agent, maintained at a relative humidity not exceeding 20% , for a minimum of 24 h at a temperature of $23 \pm 3 \text{ }^\circ\text{C}$ ($73 \pm 5 \text{ }^\circ\text{F}$), until just prior to use.

7. Test Specimen

7.1 The test specimens shall consist of sections of electrical insulation materials or sections of insulated wire or cable. The test specimen shall have an approximate length of 560 mm (22 in.).

NOTE 2—Test A in Test Methods D3032 uses a test specimen length of approximately 600 mm (24 in.) in length but the additional length provides no purpose once the flame has spread upwards.

8. Procedure

8.1 *Conditioning*—Condition the test specimens in air at $23 \pm 2 \text{ }^\circ\text{C}$ ($73 \pm 4 \text{ }^\circ\text{F}$) and $50 \pm 5 \%$ relative humidity for at least 24 h prior to testing. The test specimens, the apparatus, and the surrounding air shall be in thermal equilibrium with one another at a temperature of $25 \pm 5 \text{ }^\circ\text{C}$ ($77 \pm 10 \text{ }^\circ\text{F}$) throughout the test.

8.2 *Test Environment*—Conduct the test in a chamber, enclosure, or laboratory hood free of induced or forced draft. If a ventilated hood is used, ensure that the air currents do not affect the test flame.

8.3 *Test Specimen Placement*—Clamp the test specimen with its longitudinal axis vertical within the test chamber. The test specimen shall be placed vertically and it shall be taut.

8.4 Flame Indicator Application:

8.4.1 Apply the flame indicator flag (6.7) to the test specimen so that the lower edge is $254 \pm 5 \text{ mm}$ ($10 \pm 0.2 \text{ in.}$) above the point at which the extended axis of the burner stem, once the burner is properly installed, intersects the test specimen surface.

8.4.2 Wrap the indicator once around the test specimen, with the gummed side toward the conductor and the ends pasted evenly together and projecting $19 \pm 1 \text{ mm}$ ($0.75 \pm 0.04 \text{ in.}$) from the test specimen on the opposite side of the test specimen to which the test flame is to be applied.

8.4.3 Moisten the gummed surface of the paper tab only to the extent that will permit proper adhesion.