Designation: D 4804 – 03

Standard Test Method for Determining the Flammability Characteristics of Nonrigid Solid Plastics[1]

This standard is issued under the fixed designation D 4804; 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 These fire-test-response test methods describe small-scale laboratory procedures for determining the comparative burning characteristics of solid plastic materials that, due to specimen thinness and nonrigidity, may *distort* or shrink when tested using Test Method D 3801. A flame is applied to the base of specimens held in a vertical position and the extinguishing times are determined upon removal of the test flame.

1.2 The classification system described in Appendix X1 is intended for quality assurance and the preselection of component materials for products.

1.3 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.

NOTE 1—These test methods and ISO 9773 are technically equivalent.
NOTE 2—For rate of burning of nonrigid solid plastics in a horizontal position, formerly Test Method B of these test methods, see Test Method D 635, section 9.4.

1.4 *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.* For specific hazard statements, see Warning in 6.1.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

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

D 3801 Test Method for Measuring the Comparative Extinguishing Characteristics of Solid Plastics in a Vertical Position

D 5025 Specification for a Laboratory Burner Used for Small-Scale Burning Tests on Plastic Materials

D 5207 Practice for Confirmation of 20 and 125 mm Test Flames for Small-Scale Burning Tests on Plastic Materials

E 176 Terminology of Fire Standards

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ISO Standards:*

ISO 9773–98 Plastics—Determination of Burning Behaviour of Thin Flexible Vertical Specimens in Contact With a Small Flame Ignition Source[3]

3. Terminology

3.1 *Definitions*—For definitions of fire-related terms used in these test methods, refer to Terminology E 176.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *flame-impingement time*, *n*—the time in seconds that the flame from the burner is in contact with the specimen.

3.2.2 *flaming material*, *n*—flaming drips or particles from the specimen which ignite the dry, absorbent surgical cotton placed 300 mm below the test specimen.

3.2.3 *afterflame*, *n*—persistence of flaming of a material, after the ignition source has been removed.

3.2.4 *afterflame time*, *n*—the length of time for which a material continues to flame, under specified conditions, after the ignition source has been removed.

3.2.5 *afterglow*, *n*—persistence of glowing of a material, after cessation of flaming or, if no flaming occurs, after removal of the ignition source.

3.2.6 *afterglow time*, *n*—the length of time for which a material continues to glow under specified test conditions, after the ignition source has been removed or cessation of flaming, or both.

3.2.7 *flame*, *v*—to undergo combustion in the gaseous phase with emission of light.

[1] These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.30 on Thermal Properties.

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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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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

3.2.8 *glow*, *n*—visible light, other than from flaming, emitted by a solid undergoing combustion.

4. Summary of Test Method

4.1 These test methods consist of subjecting the lower end of vertically held specimens to a 20-mm test flame for two 3-s flame applications. The 200 by 50-mm specimens are preformed around a 13-mm diameter mandrel. The afterflame time is recorded after the first flame application and the afterflame and afterglow times are recorded after the second flame application. Information is also recorded on whether or not flaming material drips from the specimens.

5. Significance and Use

5.1 The test results represent the afterflame and afterglow times, in seconds, for a material under the conditions of the test.

5.2 The afterflame and afterglow times and other burning phenomena will vary with thickness. Test data should only be compared with data for material of comparable thickness. Useful information may be obtained from a plot of afterflame and afterglow times versus thickness.

5.3 The effect of material thickness, colors, additives, deterioration, and possible loss of volatile components is measurable.

5.4 The results serve as a reference for comparing the relative performance of materials and can be an aid in material selection.

5.5 In this procedure, the 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 may not be possible by or from this test method to predict changes in the fire-test-response characteristics measured; therefore, the results are valid only for the fire-test exposure conditions described in this test method.

6. Apparatus

6.1 *Test Chamber*—An enclosure or laboratory hood with a minimum capacity of 0.5 m^3, free of induced or forced draft during testing. An enclosed laboratory hood with a heat-resistant glass window and an exhaust fan for removing the products of combustion immediately after the tests are recommended. (**Warning—**Products of combustion may be toxic. Laboratory hoods may have induced drafts even with the exhaust fan off. A positive closing damper may be needed.

6.2 *Laboratory Burner*, constructed in accordance with Specification D 5025.

6.3 *Ring Stand*, with a clamp or the equivalent, adjustable for vertical positioning of specimens.

6.4 *Gas Supply*—A supply of technical-grade methane gas with suitable regulator and meter for uniform gas flow. Natural gas having an energy density of 37 ± 1 MJ/m^3 has been found to provide similar results. However, technical-grade methane gas shall be used as the referee gas in cases of dispute. Other fuel gases such as butane, propane, and acetylene have higher energy density and are not suitable.

6.5 *Timer*—Stopwatch or other suitable timing device capable of timing to the nearest 0.5-s.

6.6 *Cotton*—A supply of dry, absorbent 100 % cotton.

6.7 *Desiccator*, containing a suitable drying agent, capable of maintaining a relative humidity not exceeding 20 % at 23°C ± 2°C.

6.8 *Conditioning Room or Chamber*, capable of being maintained at 23 ± 2°C and a relative humidity of 50 ± 5 %.

6.9 *Conditioning Oven*—A full-draft circulating-air oven capable of being maintained at 70 ± 2°C.

6.10 *Specimen Mandrel Guide*, 13 ± 0.5-mm diameter rod.

6.11 *Micrometer*, capable of being read to 0.01 mm.

6.12 *Pressure-Sensitive Adhesive Tape*, of a commercially-available type.

6.13 *Weighing Scale or Balance*, having an accuracy and resolution of 0.01 g.

6.14 *Stainless steel or nichrome wire*, of diameter 0.2 mm to 0.5 mm.

7. Sampling

7.1 Unless otherwise agreed, material shall be sampled in accordance with good statistical practice.

8. Test Specimen

8.1 It is possible that the results of tests carried out on test specimens of different colors, thicknesses, densities, molecular masses, directions of anisotropy and types, or with different additives, fillers/reinforcements, will be different.

8.2 Test specimens in the minimum and maximum densities, melt flows and fillers/reinforcements contents shall be considered representative of the range, if the test results yield the same flame test classification. If the burning characteristics are not essentially the same for all specimens representing the range, evaluation is to be limited only to the materials in the densities, melt flows, and fillers/reinforcements contents tested, or additional test specimens in the intermediate densities, melt flows, and fillers/reinforcements contents are to be tested.

8.3 Uncolored test specimens and test specimens with the highest level of organic and inorganic pigment loading by weight are considered representative of the color range, if the test results yield the same flame test classification. When certain pigments are known to affect flammability characteristics, they are also to be tested. Test specimens to be tested are those that:

(a) contain no coloring

(b) contain the highest level of organic pigments

(c) contain the highest level of inorganic pigments

(d) contain pigments which are known to adversely affect flammability characteristics

8.4 All specimens shall be cut from a representative sample of the material (sheets or end-products). After any cutting operation, care shall be taken to remove all dust and any particles from the surface; cut edges shall have a smooth finish.

8.5 Standard specimens shall be 200 mm ± 5 mm long, 50 mm ± 2 mm wide and a maximum of 0.25 mm thick. Measure the thickness of each to the nearest 0.01 mm and note the measurements.

NOTE 3—Tests made on specimens of different thicknesses and made in different directions of anisotropy are not always comparable.

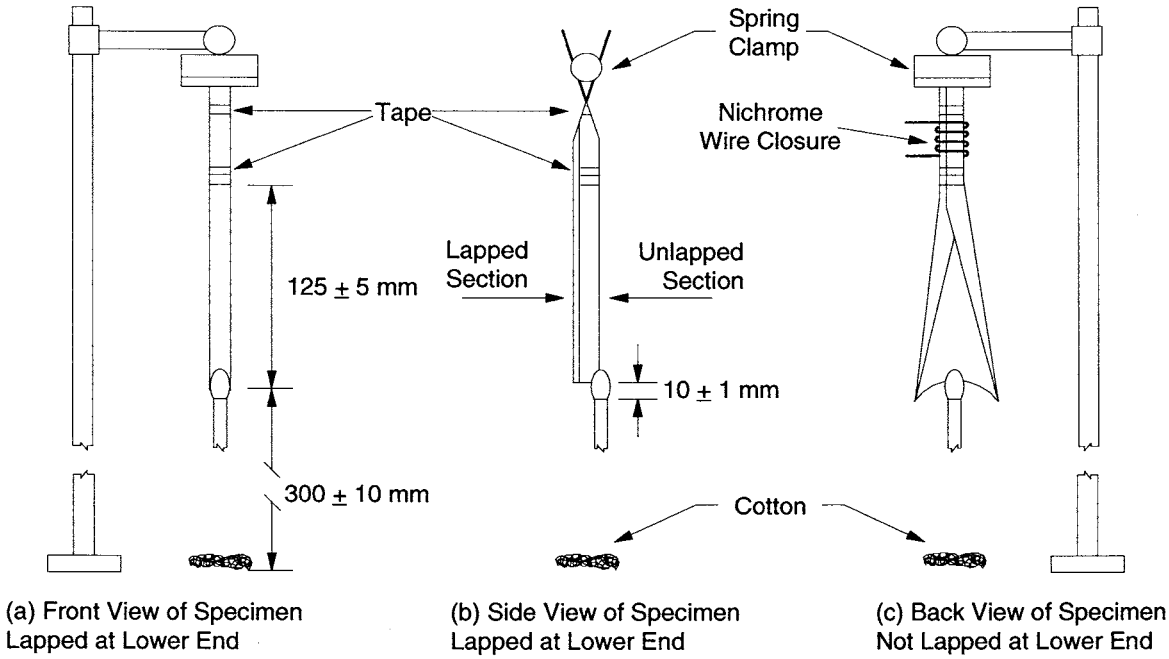

FIG. 1 Test Apparatus

8.6 Specimens shall be prepared by marking a line across the specimen width 125 mm ± 5 mm from one end (bottom) of the cut specimen. The longitudinal axis of the specimen shall be wrapped tightly around the longitudinal axis of the mandrel to form a lapped cylinder with the 12 mm line exposed. The overlapping portions of the specimens shall be secured within the upper 75 mm segment above the 125 mm mark and at the upper end of the tube with pressure-sensitive adhesive tape. The mandrel shall then be removed.

NOTE 4—For stiff specimens, the pressure-sensitive tape may be reinforced or replaced by nichrome wire wound around the top 75 mm of the specimen.

8.7 A minimum of 20 specimens shall be prepared. Prepare additional specimens for retest purposes, if necessary.

8.8 It is possible that different generic materials, although capable of being wrapped and taped around the mandrel, will exhibit varying degrees of flaring out of the untaped end, some of which will potentially result in nonlapped "U" type specimens. These various forms are considered acceptable to test if it is possible to form the upper end into the cylinder.

9. Conditioning

9.1 The cylindrical specimens may be prepared before or after the conditioning. Condition specimen sets as follows:

9.1.1 Condition one set of five specimens for at least 48 h at a temperature of 23 ± 2°C and a relative humidity of 50± 5 % prior to testing.

9.1.2 Condition a second set of five specimens in a circulating-air oven for a duration of 168 h at 70 ± 2°C and then cool in a desiccator over anhydrous calcium chloride for at least 4 h at room temperature prior to testing.

9.2 All specimens shall be tested in a laboratory atmosphere of 15 to 35°C and 45 to 75 % relative humidity.

10. Procedure

10.1 Conduct the burning test in a chamber, enclosure, or laboratory hood free of induced or forced draft.

10.2 Support a specimen from the upper 6 mm of the specimen, with the longitudinal axis vertical, by a heavy spring clamp, so that the upper end of the tube is closed to prevent any chimney effects during the test. The lower end of the specimen should be 10 ± 1 mm above the top of the burner tube and 300 ± 10 mm above a horizontal layer of 0.05 to 0.08 g of cotton thinned to an area approximately 50 × 50 mm and a maximum thickness of 61 mm (see Fig. 1, View (*a*)).

10.3 Place the burner remote from the specimen, ignite, and adjust it to produce a blue flame 20 ± 1 mm high. Obtain the flame by adjusting the gas supply and the air ports of the burner until a 20-mm yellow-tipped blue flame is produced. Increase the air supply until the yellow tip just disappears. Measure the height of the flame again, and if necessary, adjust the burner-gas supply to give the proper flame height. The test flame is to be calibrated using Practice D 5207 monthly, when the gas supply or equipment is changed or when test results are questioned.

10.4 Place the test flame centrally under the lower end of the unlapped section of the test specimen (Note 4) with the burner tube 10 ± 1 mm below the specimen for a flame-impingement time of 3 ± 0.55 s (see Fig. 1, View (*b*)). Withdraw the test flame at least 150 mm away and record the duration of afterflame, in seconds, of the specimen after the removal of the test flame. When flaming of the specimen ceases, immediately replace the test flame under the specimen. After this additional 3 ± 0.55-s flame impingement time, withdraw the test flame again. Record the duration of afterflame and afterglow times in seconds.

NOTE 5—For specimens that flare and are not lapped at the lower end,