



Standard Test Methods for Flammability of Treated Paper and Paperboard¹

This standard is issued under the fixed designation D 777; 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 approval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This is a fire-test-response standard.

1.2 These test methods cover the determination of flammability of paper and paperboards of all types no more than 1/16 in. (1.6 mm) in thickness, that have been treated to retard the spread of flame when ignited. Such papers are commonly designated as flame-retardant-treated.

1.3 These test methods may be used with, and may be used to distinguish between, paper and paperboard materials having a flame-retardant-treatment removed by leaching in water, and those whose flame-retardant-treatment is not removed by water leaching.

1.4 These test methods appear as follows:

	Section
Test Method A—Flammability of Treated Paper and Paperboard After Leaching for 4 h With 24°C Reagent Water	8.1
Test Method B—Flammability of Treated Paper and Paperboard Without Leaching	8.2

1.5 The primary intended use of Test Method A is with paper or paperboard materials having a flame-retardant treatment that is not removed by water leaching, or to specify the properties of such materials.

1.6 The primary intended use of Test Method B is with paper or paperboard materials having a flame-retardant treatment known to be removed under the leaching conditions specified in Test Method A, or where non-removal of the flame-retardant treatment by water leaching is not a desired or specified property.

1.7 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

1.8 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product²

D 685 Practice for Conditioning Paper and Paper Products for Testing²

D 1193 Specification for Reagent Water³

D 1968 Terminology Relating to Paper and Paper Products²

E 122 Practice for Calculating Sample Size to Estimate, with a Specified Tolerable Error, the Average for a Characteristic of a Lot or Process⁴

E 176 Terminology of Fire Standards⁵

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *char length, n*—the length of charred material in millimetres (or inches) removed from the specimen under the conditions of these test methods.

3.1.2 *flaming time, n*—the time in seconds a specimen continues to burn under the conditions of these test methods after removal of the burner flame.

3.1.3 *glowing time, n*—the time in seconds a specimen continues to glow under the conditions of these test methods after it has ceased to flame.

3.1.4 *Type I flame retarded, a*—paper or paperboard having flame-retardant treatment removed by leaching with water under the conditions described in these test methods.

3.1.5 *Type II flame retarded, a*—paper or paperboard having flame-retardant treatment not removed by leaching with water under the conditions described in these test methods.

3.2 For terms associated with fire issues use Terminology E 176.

¹ These test methods are under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and are the direct responsibility of Subcommittee D06.92 on Test Methods.

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² *Annual Book of ASTM Standards*, Vol 15.09.

³ *Annual Book of ASTM Standards*, Vol 11.01.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

⁵ *Annual Book of ASTM Standards*, Vol 04.07.

3.3 For terms associated with paper issues use Terminology D 1968.

4. Significance and Use

4.1 The utility of paper and paperboard for many functional and decorative purposes requires resistance to the spread of flame. These test methods are useful in both qualitative and quantitative measurement of the flame retardant property of paper and paperboard. Certain uses may also require a knowledge of the durability of the flame-retardant treatments applied to paper and paperboard when exposed to water. Judicious analysis of the test data may be useful for design purposes in applications and fabrication of materials requiring flame-resistant properties.

5. Apparatus

5.1 *Metal Cabinet*, (see Fig. 1), of sheet metal (or other noncombustible material), 305 by 355 mm (12 by 14 in.) at the base and 760 mm (30 in.) high, having a door provided with a transparent insert for observing the burning specimen. The top closure has a baffle plate 25 mm (1 in.) below the top. The top is vented by 16 holes of 12.5-mm (0.5-in.) diameter equally spaced. Each of the two sides of the cabinet is vented by eight holes 12.5-mm diameter with centers 25 mm above the base.

5.2 *Specimen Holder*, an inverted U-shaped metal clamp suspended from the center of the cabinet, to hold a specimen 70 mm (2.75 in.) wide and 210 mm (8.25 in.) long, with the long axis vertical. The specimen is clamped vertically for its entire length at a distance of 10 mm (0.375 in.) in from the edges, to expose an area of 50 by 210 mm (2 by 8.25 in.). The holder is preferably attached to the top so that it can be rotated from the outside, permitting both sides of the specimen to be observed.

5.3 *Test Flame*, supplied by a Bunsen or Tirrill gas burner having a tube 10-mm (0.375-in.) inside diameter centered beneath the lower edge of the clamped specimen and with the top of the tube 19 mm (0.75 in.) beneath it, adjusted with its air supply closed to give a flame 40 mm (1.6 in.) high. The burner is equipped with an extended handle and a track so that it may be slid into position after lighting.

NOTE 1—For general use, either commercial natural gas, or liquefied propane gas is acceptable. If additional precision is required, a synthetic gas mixture of the following composition may be used: 55 ± 1 % hydrogen, 24 ± 1 % methane, 3 ± 1 % ethane, and 18 ± 1 % carbon monoxide. The gas should be supplied to the burner at a pressure of 17.2 ± 1.8 kPa (2½ ± ¼psi).

5.4 *Timer*, stopwatch or electric timer.

5.5 *Scale*, graduated in millimetres or 0.1-in. units.

6. Sampling

6.1 *Acceptance Sampling*—Acceptance sampling shall be in accordance with Method D 585.

6.2 *Sampling for Other Purposes*—The sampling and the number of test specimens depend on the purpose of the testing. Practice E 122 is recommended.

7. Test Specimens

7.1 For Type I flame-retarded paper or paperboard, cut from each test unit two test specimens in the machine direction (MD) and two in the cross direction (CD), with each specimen 70 mm (2.75 in.) wide and 210 mm (8.25 in.) long. Group the specimens into two sets consisting of one MD specimen and one CD specimen.

7.2 For Type II flame-retarded paper or paperboard cut from each test unit four test specimens in the machine direction (MD) and four in the cross direction (CD), with each specimen 70 mm (2.75 in.) wide and 210 mm (8.25 in.) long. Group the specimens into four sets consisting of one MD specimen and one CD specimen.

8. Procedure

8.1 *Test Method A—Flammability of Treated Paper and Paperboard After Leaching for 4 h With 24°C Reagent Water:*
8.1.1 *Leaching Procedure:*

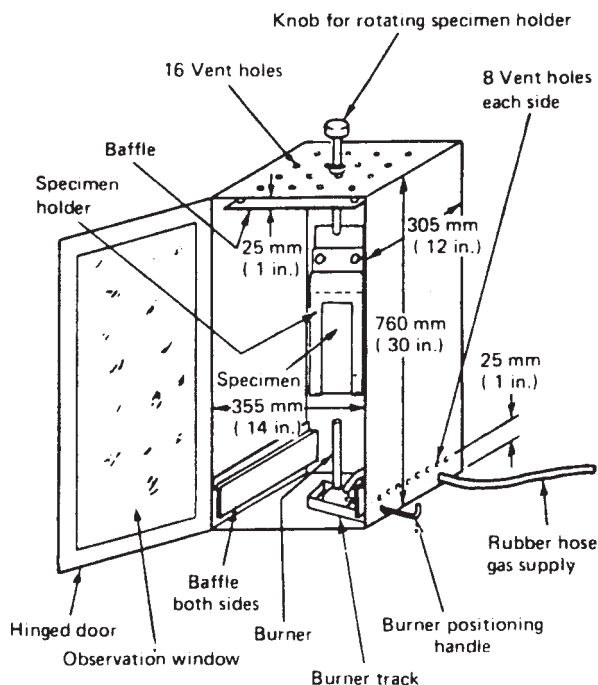
8.1.1.1 Place two of the four sets of specimens prepared in 7.2 into a 2000-mL beaker.

8.1.1.2 Fill the beaker containing the specimens with reagent water having a maximum conductivity of five microsiemens per centimetre or less. Reagent water, Type I through IV, in accordance with Specification D 1193 complies with this requirement. Adjust water temperature to 24 ± 1°C prior to use.

8.1.1.3 Cover the beaker with a wire mesh screen. Continue to add 24 ± 1°C reagent water at a rate of 12 L/h for a period of 4 ± 0.1 h through a glass tube of 6.35-mm (0.25-in.) inside diameter extending to the bottom of the beaker.

8.1.1.4 At the conclusion of the leaching period, remove the specimens from the beaker and blot off excess water with paper toweling.

8.1.1.5 Dry the specimens flat in an oven at 105 ± 3°C for 1 h.



NOTE 1—Not to scale; all dimensions ±1.6 mm (1/16 in.).

FIG. 1 Metal Cabinet

8.1.2 *Flaming Procedure:*

8.1.2.1 Condition each set of specimens prepared as described in 8.1.1, in 7.1, or the second set of two specimens prepared in 7.2 in an atmosphere in accordance with Method D 685. Preconditioning is not required.

8.1.2.2 Clamp a conditioned specimen in the holder and adjust the flame of the burner to a height of 40 mm.

NOTE 2—Varying the supply pressure of the gas while holding the flame height constant has no obvious effect on char length.⁶

8.1.2.3 Close the cabinet door, slide the burner so that the yellow flame is directly under the bottom edge of the clamped specimen for 12 s, then withdraw the flame. Record the flaming time (a); also the glowing time (b).

8.1.3 *Char Length Procedure (see Fig. 2):*

8.1.3.1 Remove the test specimen from the holder and hold the specimen horizontally. With a 6-mm diameter rod, gently tap the charred area, breaking away loose char.

8.1.3.2 Measure and record the maximum height of each void area, measured from the bottom edge of the specimen to the nearest 2.5 mm (0.10 in.).

8.2 *Test Method B—Flammability of Treated Paper and Paperboard Without Leaching:*

⁶ Markezich, A. R., et al., "The Effect of Certain Variables in the Vertical Flame Test," *JAATCC* 2, Vol 18, 1969, p. 309.

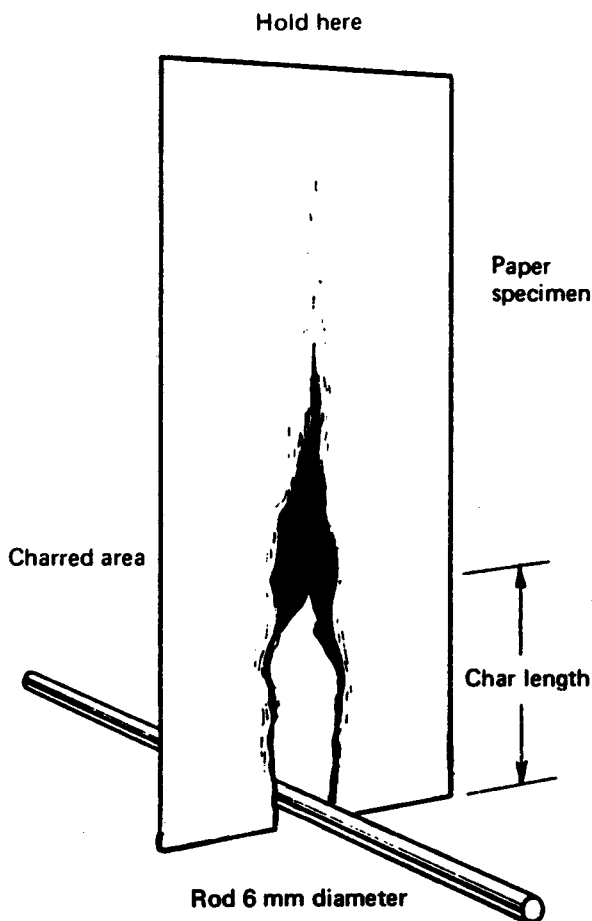


FIG. 2 Testing for Char Length

8.2.1 Perform this procedure as directed in 8.1 omitting 8.1.1 and beginning with 8.1.2 and continuing to the end of 8.1.3.

9. Interpretation of Results

9.1 A comparison of flaming time, glowing time, and char length on a series of samples using the same test method, either Test Method A or Test Method B, may indicate the relative effectiveness of the treatment which has been used to retard the spread of flame when ignited.

9.2 A comparison of flaming time, glowing time, and char length on a single sample tested by both Test Method A and Test Method B may indicate the degree to which the treatment which has been used to retard the spread of flame when ignited resists removal by water.

9.3 A comparison of test results on a series of samples tested by both Test Method A and Test Method B may indicate the relative degree to which these samples retain flame-resistant characteristics when subjected to leaching by water.

10. Report

10.1 Report the following information for the two specimens of each sample tested in each principle direction (machine direction and cross direction):

- 10.1.1 Test method used,
- 10.1.2 Gas type used (see Note 1),
- 10.1.3 Clip weight used, if other than specified in Note 2,
- 10.1.4 Flaming time: average and maximum,
- 10.1.5 Glowing time: average and maximum, and
- 10.1.6 Char length: average and maximum.

10.2 A suggested report format for numerical data (see 10.1.4, 10.1.5, and 10.1.6) is given in Fig. 3.

11. Precision and Bias

11.1 Precision:

11.1.1 *Flaming Time*—The precision of the procedures in these test methods is being determined.

11.1.2 *Glowing Time*—The precision of the procedures in these test methods is being determined.

11.1.3 *Char Length*—The precision of the procedure in these test methods, calculated as the critical limits between which two test results obtained as described in this procedure may be expected to fall 95 % of the time, and based on a limited round-robin conducted within the TAPPI organization consisting of five different papers tested in five different laboratories, is as follows: repeatability: 6 %, and reproducibility: 13 %.

11.2 *Bias*—The procedures in these test methods for measuring flammability of paper and paperboard have no bias

Flaming Time, s		Glowing Time, s		Char Length, mm	
Method A	Method B	Method A	Method B	Method A	Method B
4-h Water	Not Leached	4-h Water	Not Leached	4-h Water	Not Leached
Leach		Leach		Leach	
Average, max	Average, max	Average, max	Average, max	Average, max	Average, max

FIG. 3 Report Form



because the values of flaming time, glowing time, and char board length are defined only in terms of these test methods.

12. Keywords

12.1 char length; flame-retardant-treated; flame-retarded paper; flaming time; flammability; glowing time; paper; paper-

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