Designation: E84 – 19

An American National Standard

Standard Test Method for Surface Burning Characteristics of Building Materials[1]

This standard is issued under the fixed designation E84; 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.

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

1. Scope*

1.1 This fire-test–response standard for the comparative surface burning behavior of building materials is applicable to exposed surfaces such as walls and ceilings. The test is conducted with the specimen in the ceiling position with the surface to be evaluated exposed face down to the ignition source. The material, product, or assembly shall be capable of being mounted in the test position during the test. Thus, the specimen shall either be self-supporting by its own structural quality, held in place by added supports along the test surface, or secured from the back side.

1.2 The purpose of this test method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame spread and smoke developed index are reported. However, there is not necessarily a relationship between these two measurements.

1.3 The use of supporting materials on the underside of the test specimen has the ability to lower the flame spread index from those which might be obtained if the specimen could be tested without such support. These test results do not necessarily relate to indices obtained by testing materials without such support.

1.4 Testing of materials that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed, results in low flame spread indices that do not relate directly to indices obtained by testing materials that remain in place.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 The text of this standard references notes and footnotes that provide explanatory information. These notes and footnotes, excluding those in tables and figures, shall not be considered as requirements of the standard.

1.7 *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.*

1.8 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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]

A390 Specification for Zinc-Coated (Galvanized) Steel Poultry Fence Fabric (Hexagonal and Straight Line)

C1186 Specification for Flat Fiber-Cement Sheets

C1288 Specification for Fiber-Cement Interior Substrate Sheets

C1396/C1396M Specification for Gypsum Board

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

D4444 Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters

E69 Test Method for Combustible Properties of Treated Wood by the Fire-Tube Apparatus

E160 Test Method for Combustible Properties of Treated Wood by the Crib Test [3]

[1] This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.22 on Surface Burning.

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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.

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

E162 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
E176 Terminology of Fire Standards
E286 Test Method for Surface Flammability of Building Materials Using an 8-ft (2.44-m) Tunnel Furnace (Withdrawn 1991)[3]
E2231 Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
E2404 Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) and Wood Wall or Ceiling Coverings, Facings and Veneers, to Assess Surface Burning Characteristics
E2573 Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics
E2579 Practice for Specimen Preparation and Mounting of Wood Products to Assess Surface Burning Characteristics
E2599 Practice for Specimen Preparation and Mounting of Reflective Insulation, Radiant Barrier and Vinyl Stretch Ceiling Materials for Building Applications to Assess Surface Burning Characteristics
E2688 Practice for Specimen Preparation and Mounting of Tapes to Assess Surface Burning Characteristics
E2690 Practice for Specimen Preparation and Mounting of Caulks and Sealants to Assess Surface Burning Characteristics
E2768 Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)
E2988 Practice for Specimen Preparation and Mounting of Flexible Fibrous Glass Insulation for Metal Buildings to Assess Surface Burning Characteristics

2.2 *NFPA Standards:*[4]

NFPA 262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces (2007)

2.3 *UL Standards*[5]

UL 1820 Standard for Safety for Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics (2004)
UL 1887 Standard for Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics (2004)
UL 2024 Standard for Safety for Optical Fiber and Communication Cable Raceway (2004)

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method refer to Terminology E176. The term flame spread index from Terminology E176 is of particular interest to this standard and is defined in 3.1.2.

3.1.2 *flame spread index, n*—a number or classification indicating a comparative measure derived from observations made during the progress of the boundary of a zone of flame under defined test conditions.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *smoke developed index, n*—a number or classification indicating a comparative measure derived from smoke obscuration data collected during the test for surface burning characteristics.

3.2.2 *surface flame spread, n*—the propagation of a flame away from the source of ignition across the surface of the specimen.

4. Significance and Use

4.1 This test method is intended to provide only comparative measurements of surface flame spread and smoke density measurements with that of select grade red oak and fiber-cement board surfaces under the specific fire exposure conditions described herein.

4.2 This test method exposes a nominal 24-ft (7.32-m) long by 20-in. (508-mm) wide specimen to a controlled air flow and flaming fire exposure adjusted to spread the flame along the entire length of the select grade red oak specimen in 5½ min.

4.3 This test method does not provide for the following:

4.3.1 Measurement of heat transmission through the tested surface.

4.3.2 The effect of aggravated flame spread behavior of an assembly resulting from the proximity of combustible walls and ceilings.

4.3.3 Classifying or defining a material as noncombustible, by means of a flame spread index by itself.

5. Apparatus

5.1 *Fire Test Chamber*—See Figs. 1-5.

5.1.1 The fire test chamber is a rectangular horizontal duct with a removable lid. The inside dimensions are as follows:

Width:	17 ¾ ± ¼ in. (451 ± 6.3 mm) measured between the top ledges along the side walls, and 17 ⅝ ± ⅜ in. (448 ± 10 mm) at all other points.
Depth:	12 ± ½ in. (305 ± 13 mm) measured from the bottom of the test chamber to the top of the ledges on which the specimen is supported. This measurement includes the ⅛ in. (3.2 mm) thickness of the 1 ½ in. (38 mm) wide woven fiberglass gasket tape.
Length:	25 ft ± 3 in. (7.62 m ± 76 mm).

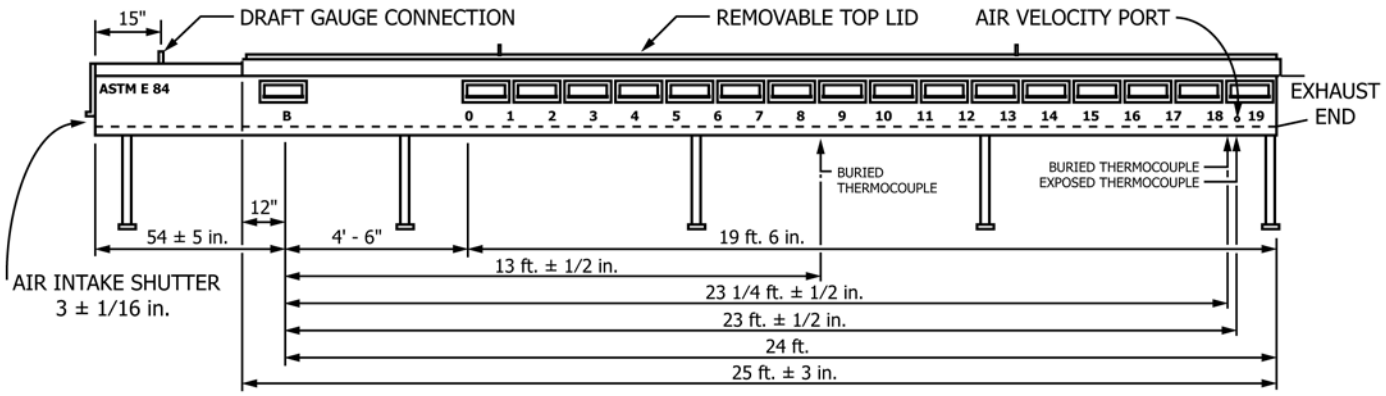
5.1.2 The sides and base of the chamber shall be lined with an insulating firebrick with the dimensions of 4 ½ in. by 9 in. by 2 ½ in. thick as illustrated in Fig. 2. The insulating firebrick shall have the following properties:

Maximum Recommended Temperature	2600°F (1427°C)	
Bulk Density	48 ± 3 lb/ft^3	(0.77 ± 0.046 g/cm^3)
Thermal Conductivity at Mean Temperature of	Btu•in./h•ft^2•°F	W/m•°C
500°F (260°C)	1.6	0.23
1000°F (538°C)	1.9	0.27
1500°F (815°C)	2.2	0.32
2000°F (1093°C)	2.6	0.37

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

[4] Available from National Fire Protection Association, 1 Battery March Park, Quincy, MA 02169.

[5] Available from Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062.



Inch–Pound Units	SI Units
3 ± 1/16 in.	76.2 ± 1.6 mm
12 in.	304.8 mm
15 in.	381 mm
54 ± 5 in.	1.37 m ± 127 mm
4 ft. 6 in.	1.37 m
19 ft. 6 in.	5.94 m
13 ft. ± 1/2 in.	3.96 m ± 12.7 mm
23 1/4 ft. ± 1/2 in.	7.1 m ± 12.7 mm
23 ft. ± 1/2 in.	7.0 m ± 12.7 mm
24 ft.	7.32 m
25 ft. ± 3 in.	7.62 m ± 76.2 mm

FIG. 1 Test Furnace, Showing Some Critical Dimensions (Not a Construction Drawing)

5.1.3 One side of the chamber shall be provided with double observation windows[6] with the inside pane flush mounted (see Fig. 2). Exposed inside glass shall be 2 ¾ ± ⅜ by 11 + 1, −2 in. (70 ± 10 by 279 + 25 − 50 mm). The centerline of the exposed area of the inside glass shall be in the upper half of the furnace wall, with the upper edge not less than 2.5 in. (63 mm) below the furnace ledge. The window shall be located such that not less than 12 in. (305 mm) of the specimen width can be observed. Multiple windows shall be located along the tunnel so that the entire length of the test sample is observable from outside the fire chamber. The windows shall be pressure tight in accordance with 7.2 and 7.2.1.

5.1.4 The ledges shall be fabricated of structural materials[7] capable of withstanding the abuse of continuous testing. The ledges shall be level with respect to the length and width of the chamber and each other. The ledges shall be maintained in a state of repair commensurate with the frequency, volume, and severity of testing occurring at any time.

5.1.5 *Lid:*

5.1.5.1 The lid shall consist of a removable noncombustible metal and mineral composite structure as shown in Fig. 2 and of a size necessary to cover completely the fire test chamber and the test samples. The lid shall be maintained in an unwarped and flat condition. When in place, the lid shall be completely sealed to prevent air leakage into the fire test chamber during the test.

5.1.5.2 The lid shall be insulated with a minimal thickness of 2 in. (51 mm) castable insulation or mineral composite material having physical characteristics comparable to the following:

Maximum effective use temperature of at least:	1200°F (650°C)
Bulk density	21 lb/ft^3 (336 kg/m^3)
Thermal conductivity at 300 to 700°F (149 to 371°C)	0.50 to 0.71 Btu·in./h·ft^2·°F (0.072 to 0.102 W/m·K)

5.1.5.3 The entire lid assembly shall be protected with flat sections of nominal ¼-in. (6.3-mm) fiber-cement board meeting the properties of Annex A3. This protective board shall be maintained in sound condition through continued replacement. The protective board is to be secured to the furnace lid or place on the back side of the test specimen.

5.1.6 *Gas Burners:*

5.1.6.1 One end of the test chamber shall be designated as the "fire end". This fire end shall be provided with two gas burners delivering flames upward against the surface of the test sample (see Fig. 2). The burners shall be spaced 12 in. (305 mm) from the fire end of the test chamber, and 7 ½ ± ½ in. (190 ± 13 mm) below the under surface of the test sample. Gas to the burners shall be provided through a single inlet pipe, distributed to each port burner through a tee-section. The outlet shall be a ¾ in. NPT elbow. The plane of the port shall be parallel to the furnace floor, such that the gas is directed upward toward the specimen. Each port shall be positioned with its centerline 4 ± ½ in. (102 ± 13 mm) on each side of the centerline of the furnace so that the flame is distributed evenly over the width of the exposed specimen surface (see Fig. 2).

[6] Heat-resistant glass, high-silica, 100 % silica glass, nominal ¼-in. thick has been found suitable for the interior pane. Borosilicate glass, nominal ¼-in. thick has been found suitable for the exterior pane.

[7] High-temperature furnace refractory. Zirconium silicate, or water-cooled steel tubing have been found suitable for this purpose.