APPENDIX

PROPOSED METHOD OF TEST FOR SURFACE FLAMMABILITY OF BUILDING MATERIALS USING AN 8-FT TUNNEL FURNACE[1, 2]

This is a proposed method and is published as information only. Comments are solicited and should be addressed to the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Scope

1. This method of test covers a procedure for measuring and comparing surface flame spread of various building materials, including protective and decorative coatings applied to these materials. The amount of smoke and heat produced in burning under this standard test condition is also measured. The results of the method may be used as an index to the fire hazard of such materials. The method is applicable to all building materials and composites that are capable of being mounted and supported within a 14-in. by 8-ft test frame so as to provide exposed surfaces over which flames may spread.

Apparatus

2. (*a*) The apparatus shall consist essentially of a gas-heated tunnel furnace about $10\frac{1}{2}$ ft long with a separate combustion chamber to accommodate a test specimen $13\frac{3}{4}$ in. wide by 8 ft long. General views of the exterior of the tunnel furnace and of the specimen combustion chamber are given in Figs. 1 and 2.[3]

(*b*) The furnace shall slope at a 6-deg angle from end to end and have three compartments: the firebox (item *2*, Fig. 1) extending the entire length of the furnace; the specimen combustion chamber (above the partition plate, item *5*, Fig. 2); and the hood and stack (items *6* and *7*, Fig. 1).

(*c*) A 12-gage, type 310 stainless steel partition (item *5*, Fig. 2) shall be located between the firebox and the combustion chamber. Thirty-three holes, $1\frac{19}{32}$ in. in diameter and $2\frac{9}{16}$ in. apart center to center, shall be located as shown in this partition. Meker burner tops shall be set into each of these holes. Asbestos paper washers $\frac{1}{32}$ in. thick shall be inserted within each of the Meker burner tops Nos. 14 through 33 to graduate the openings as follows:

Hole No.	Size, in.	Hole No.	Size, in.
1 to 13	23/16	24, 25	10/16
14, 15	16/16	26, 27	9/16
16, 17	14/16	28, 29	8/16
18, 19	13/16	30, 31	7/16
20, 21	12/16	32, 33	6/16
22, 23	11/16		

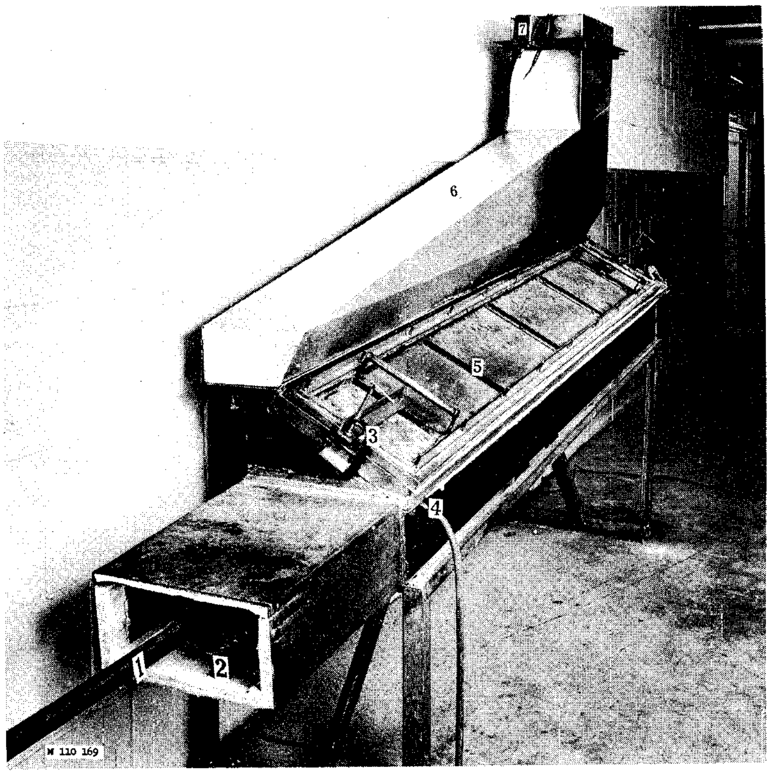
[1] This proposed method is under the jurisdiction of the ASTM Committee E-5 on Fire Tests of Materials and Construction.

[2] Published as information, June, 1960.

[3] Detail drawings of this apparatus are available at a nominal cost from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

(*d*) The body of the furnace shall be constructed of 12-gage, low-carbon steel lined with high-grade asbestos millboard 1 in. thick. The hood and stack (item *6*, Fig. 1) shall be of 16-gage, low-carbon steel lined with asbestos millboard $\frac{1}{4}$ in. thick. The stack of the furnace shall be located beneath a ventilating hood with sufficient draft to remove accumulating smoke. There should be no direct connection between the stack and ventilating hood since the only draft within the furnace shall be that developed from the burning of the heating gas and test specimen.

(*e*) The temperature and smoke density of the combustion gases shall be measured in the stack. For the temperature measurement, two thermocouple junctions shall be embedded in a copper rod, $\frac{1}{2}$ in. in diameter and $17\frac{1}{8}$ in. in length, held horizontally in the stack (item *7*, Fig. 1). Temperatures of the thermocouple junctions shall be measured by a potentiometer. Smoke density shall be determined with a photoelectric

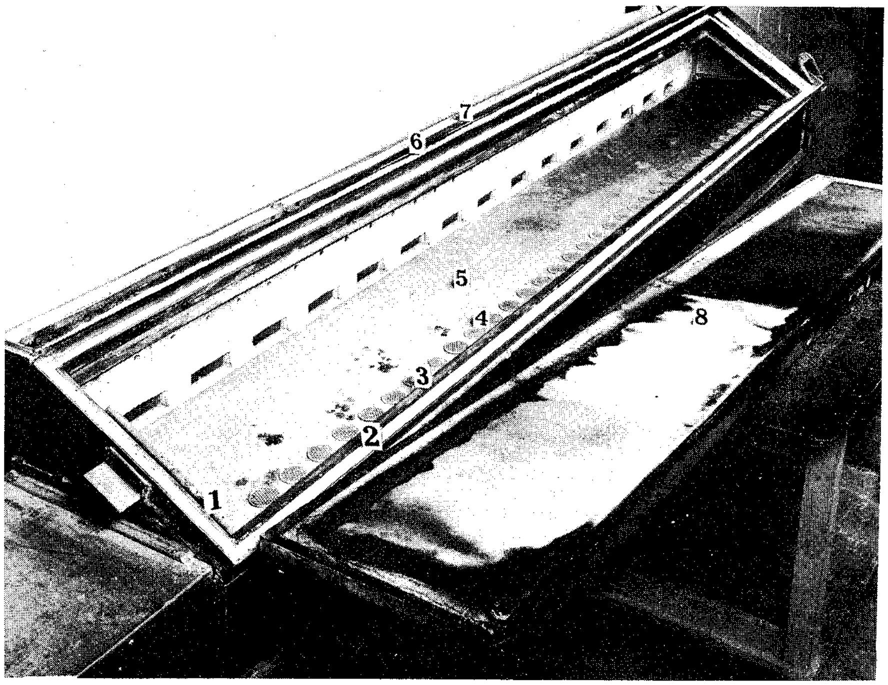


1—Gas supply to main burner.
2—Firebox.
3—Clamp to hold down cover over test specimen.
4—Gas supply to igniting burner.
5—Cover over test specimen.
6—Hood to collect combustion gases for temperature and smoke measurement.
7—Photoelectric cell for smoke density measurement.

Fig. 1.—Specimen Side of FPL 8-ft Tunnel Furnace.

type of smoke meter, which indicates the reduction in the intensity of a column of light passing horizontally through the stack (item 7, Fig. 1) to a photoelectric cell.

(*f*) The main burner (item *1*, Fig. 1) shall consist of a 1¼-in. T-head iron pipe in which are drilled two parallel rows of holes 90 deg apart. Each row shall have 53 holes, ⅛ in. in diameter with centers ¼ in. apart (Note 1). The burner shall be located in the firebox, with the holes 13 in. from the front end and the top of the pipe 2⅛ in. below the bottom surface of the steel partition. The igniting burner shall consist of a ¼-in. iron pipe in which have been drilled six holes ⅛ in. in diameter with centers 1 in. apart. The igniting burner shall be located ½ in. below and parallel to the face of the test panel and 1 in. from the lower end of the panel.



1—Igniting burner.
2—Sand trough to seal cover.
3—Angle-iron bed on which specimen rests.
4—Holes in hot plate inset with Meker burner tops.
5—Hot plate over firebox.
6—Sand trough to seal edge of hood.
7—Slot for escape of combustion gases.
8—Specimen cover.

FIG. 2.—Specimen Combustion Chamber of FPL 8-ft Tunnel Furnace.

NOTE 1.—This burner is suitable for natural gas. For bottled and manufactured gases, the burner construction may have to be altered.

Test Specimens

3. The test specimens shall be 13¾ in. wide by 8 ft long and conditioned to constant weight at a temperature of 80 ± 10 F and a relative humidity of 30 ± 5 per cent.

Comparison Standards

4. (*a*) The red oak comparison standard, to which the index value of 100 is arbitrarily assigned, shall consist of plain-sawed, select-grade red oak flooring selected within the density range from 37.0 to 41.0 lb per cu ft. The flooring shall be nailed to a backing of plywood $\frac{1}{4}$ in. thick.

(*b*) The asbestos millboard comparison standard, to which the index value of 0 is arbitrarily assigned, shall be $\frac{1}{4}$ in. thick and of sufficiently high quality to withstand the test conditions without sagging.

Procedure

5. (*a*) Before installing a test specimen, measure the temperature of the top surface of the steel partition (item *5*, Fig. 2) at a point midway between the sides of the partition and the ends of the specimen opening. Measure the temperature by means of a thermocouple junction placed at the designated point and covered by an asbestos pad 0.4 in. thick and 6 in. square. If, after a period of at least 2 min, the temperature is not 85 ± 5 F, a preheating flame (such as from the main burner) or a cooling draft (such as from a fan) may be used in the firebox to obtain the desired temperature. If a preheating flame or cooling draft is used, it should be stopped before the thermocouple and pad are positioned.

(*b*) When the temperature of the partition is within the prescribed limits, lay the test specimen on the angle-iron frame (item *3*, Fig. 2) tilted 30 deg from the horizontal. Then lay the specimen cover (item *5*, Fig. 1) over the specimen in the same frame and clamp it in place.

(*c*) Adjust the gas to the main burner (item *1*, Fig. 1) to a rate computed to give 3400 Btu per min with a supply of primary air adequate to produce a blue flame, introduced by an atmospheric injector air-gas mixing unit.

(*d*) Obtain from the gas supplier the current heat value of the gas in British thermal units per cubic foot under selected conditions of temperature and pressure. Measure the temperature and pressure of the gas as it is fed into the main burner and use these values to compute the volume rate of flow for 3400 Btu per min in the firebox by the equation:

$$V = \frac{P_1 T_2 3400}{P_2 T_1 H}$$

where:

V = desired rate of gas flow in cubic feet per minute under conditions of use for 3400 Btu per min,

T_2 = absolute temperature of gas used, in degrees Kelvin (gas temperature in degrees Centigrade plus 273),

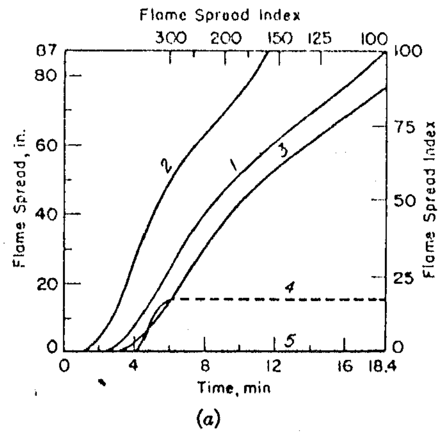
P_2 = absolute pressure of gas used, in millimeters of mercury (barometer pressure plus gage pressure), and

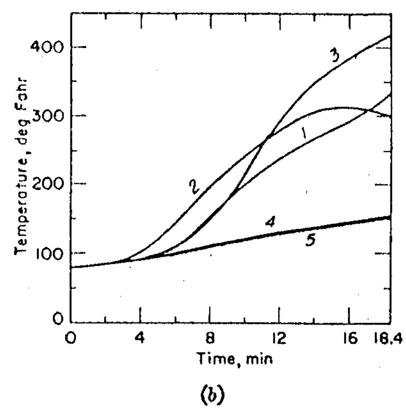
H = heat content of gas, in British thermal units per cubic foot under given conditions of P_1 millimeters of mercury and T_1 degrees Kelvin.

(*e*) Burn the gas in the igniting burner with no primary air at the rate of 85 Btu per min. The individual flames from the orifices in this burner play over the first 4 in. of an asbestos millboard specimen. Light both burners as simultaneously as possible, and start the stop watches at the instant of lighting.

(*f*) Watch the progress of the flame through the observation holes located along the side, with the line of sight towards the centerline of the specimen. As the flame front passes each observation hole, note the time and the distance traveled. Note temperatures and smoke densities every 30 sec. The observations should be plotted in graphs as shown in Fig. 3. The maximum length of travel of the flame on the specimen shall be 87 in. (Note 2). The average time for the flame to travel this distance on the red oak standard is the test period. It has been found to be 18.4 min.

depending on whether the flame has reached the end of the test specimen in a shorter or longer time than on red oak.





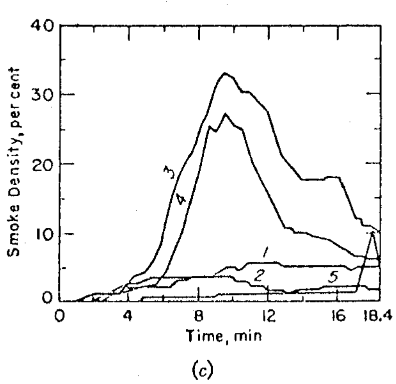


FIG 3.—Typical Curves of Tunnel Data from Tests on (*1*) Red Oak, (*2*) Fiberboard A, (*3*) Hardboard M_1, (*4*) Gypsum Wallboard G, and (*5*) Asbestos Millboard.

NOTE 2.—The exposed length of the specimen is 94½ in. The igniting flame plays over the first 4 in. The end point shall be taken at 91 in. from the first exposed part of the specimen or 87 in. from the igniting flame. The last exposed 3½ in. of specimen will therefore be disregarded.

Calculations

6. (*a*) *Flame Spread Index.*—Express the flame spread as an index relative to the rate on red oak standard with an index of 100 and on asbestos board with an index of 0. Express the flame spread index, I_s, in either of two ways (Fig. 3(*a*)),

(*1*) For flame spread faster than on red oak:

$$I_s = \frac{T_o}{T_s} \times 100$$

where:

T_o = time to reach end of red oak specimen, and

T_s = time to reach end of test specimen.

(*2*) For flame spread slower than on red oak:

$$I_s = \frac{D_s}{D_o} \times 100$$

where:

D_s = distance reached on test specimen in test period, and

D_o = distance reached on red oak in test period.

(*b*) *Fuel Contributed Index.*—Obtain the fuel contributed index, I_c, by planimetering the areas under the curves indicated in Fig. 3(*b*) and calculating the index value as follows:

$$I_c = \frac{A_s - A_a}{A_o - A_a} \times 100$$

where:

A_s = area under specimen curve,

A_a = area under asbestos curve, and

A_o = area under red oak curve.

(*c*) *Smoke Density Index.*—Obtain the smoke density index, I_d, by planimetering the curves indicated in Fig. 3(*c*), and calculating the index value as follows:

$$I_d = \frac{A_s - A_a}{A_o - A_a} \times 100$$

Report

7. The report shall include the following:

(*1*) Identification of the test panel, including manufacturer and code designation, and, when known, the thickness, density, and composition of the panel,

(*2*) Identification, when known, of the composition, thickness or weight retained, of any chemicals added or coating applied to the test panel,

(*3*) Moisture content of the panel at start of test,

(*4*) Flame spread index, fuel contributed index, and smoke index as calculated in Section 6, including flame travel, temperature, and smoke density data taken during the test, and

(*5*) Record of observations made during the test as to appearance of flame, char pattern, and any intumescence or disintegration of panel or applied coatings.