UL 723

STANDARD FOR SAFETY

Test for Surface Burning Characteristics of Building Materials

UL Standard for Safety for Test for Surface Burning Characteristics of Building Materials, UL 723

Eleventh Edition, Dated April 19, 2018

Summary of Topics

This New Edition for the Standard for Safety for Test for Surface Burning Characteristics of Building Materials, UL 723, has been issued to include the Heptane Representative Curve.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated February 9, 2018.

No Text on This Page

UL 723

Standard for Test for Surface Burning Characteristics of Building Materials

First Edition – August, 1950
Second Edition – October, 1958
Third Edition – August, 1960
Fourth Edition – January, 1971
Fifth Edition – December, 1977
Sixth Edition – November, 1983
Seventh Edition – April, 1993
Eighth Edition – July, 1996
Ninth Edition – August, 2003
Tenth Edition – September, 2018

Eleventh Edition

April 19, 2018

This ANSI/UL Standard for Safety consists of the Tenth Edition, including revisions through April 19, 2018.

The most recent designation of ANSI/UL 723 as an American National Standard (ANSI) occurred on April 19, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

No Text on This Page

CONTENTS

INTRODUCTION

1 Scope

1.1 This method of test for surface burning characteristics of building materials is applicable to any type of building material that, by its own structural quality or the manner in which it is applied, is capable of supporting itself in position or being supported in the test furnace to a thickness comparable to its intended use.

1.2 The purpose of the test is to determine the comparative burning characteristics of the material under test by evaluating the spread of flame over its surface and the density of the smoke developed when exposed to a test fire, and thus to establish a basis on which surface burning characteristics of different materials are compared, without specific regard to all the end-use parameters that affect the surface burning characteristics.

1.3 This method of test is intended to register performance during the period of exposure, and not to determine suitability for use after the test exposure. Reference the requirements in the Standard for Fire Tests of Building Construction and Materials, UL 263, for procedures for determining the performance, under fire exposure conditions, of building constructions and materials when incorporated into a test structure and subjected to a standard exposing fire of controlled extent and severity.

2 General

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

PERFORMANCE

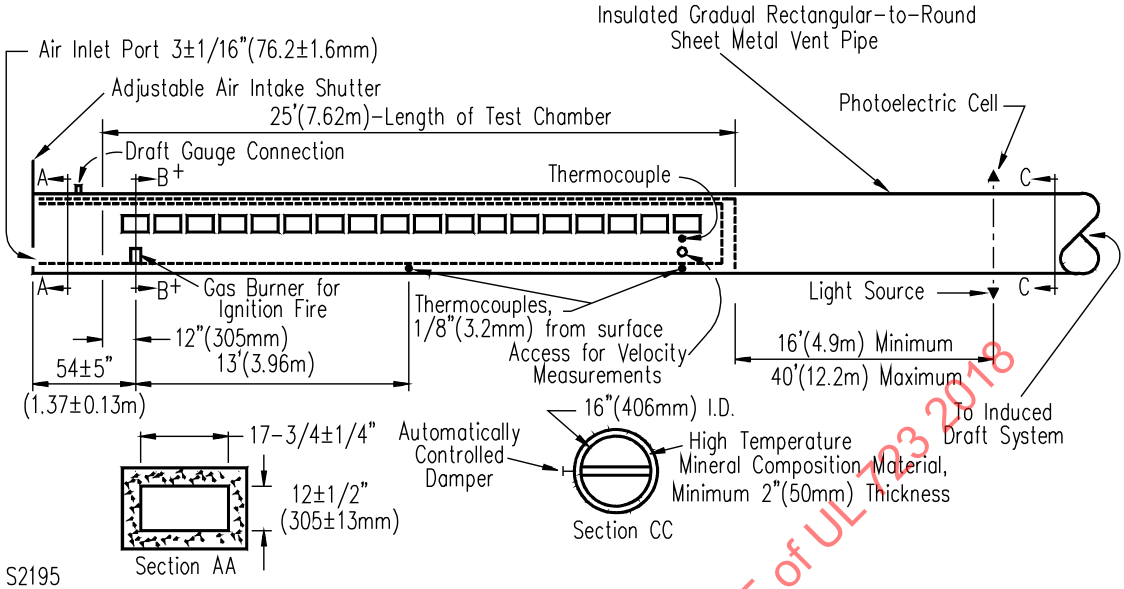
3 Fire Test Chamber

3.1 The fire test chamber, Figures 3.1 and 3.2, is to consist of a horizontal duct having an inside width of 17-3/4 ±1/4 in (451 ±6.3 mm) measured at the ledge location along the side walls and 17-5/8 ±3/8 in (448 ±9.5 mm) at all other points; (2) a depth of 12 ±1/2 in (305 ±12.7 mm) measured from the bottom of the test chamber to the ledge of the inner walls on which the sample is supported [including the 1/8-in (3.2-mm) thickness of woven fiberglass[a] gasketing tape], and a length of 25 ft (7.6 m). The sides and base of the duct are to be lined with insulating firebrick as illustrated in Figure 3.2. The insulating firebrick shall comply with 3.2. One side of the chamber is to be provided with double observation windows[b] with the inside pane flush mounted (see Figure 3.2). The exposed area of an inside pane is to be 2-3/4 ±1/4 by 11.5 plus 1 minus 2 in (69.9 ±6.4 by 279 plus 25 minus 50 mm). The centerline of the exposed area of the inside glass is to be in the upper half of the furnace wall, with the upper edge not less than 2-1/2 in (63 mm) below the furnace ledge. Each window is to be located such that not less than 12 in (305 mm) of the specimen width is observable. Multiple windows are to be located along the tunnel so that the entire length of the test sample is observable from outside the fire test chamber. The windows are to be pressure tight (see 5.2 and 5.3).

[a]McMaster-Carr No. 8817K35 1-1/2 by 1/8-in woven fiberglass tape or equivalent works for this purpose.

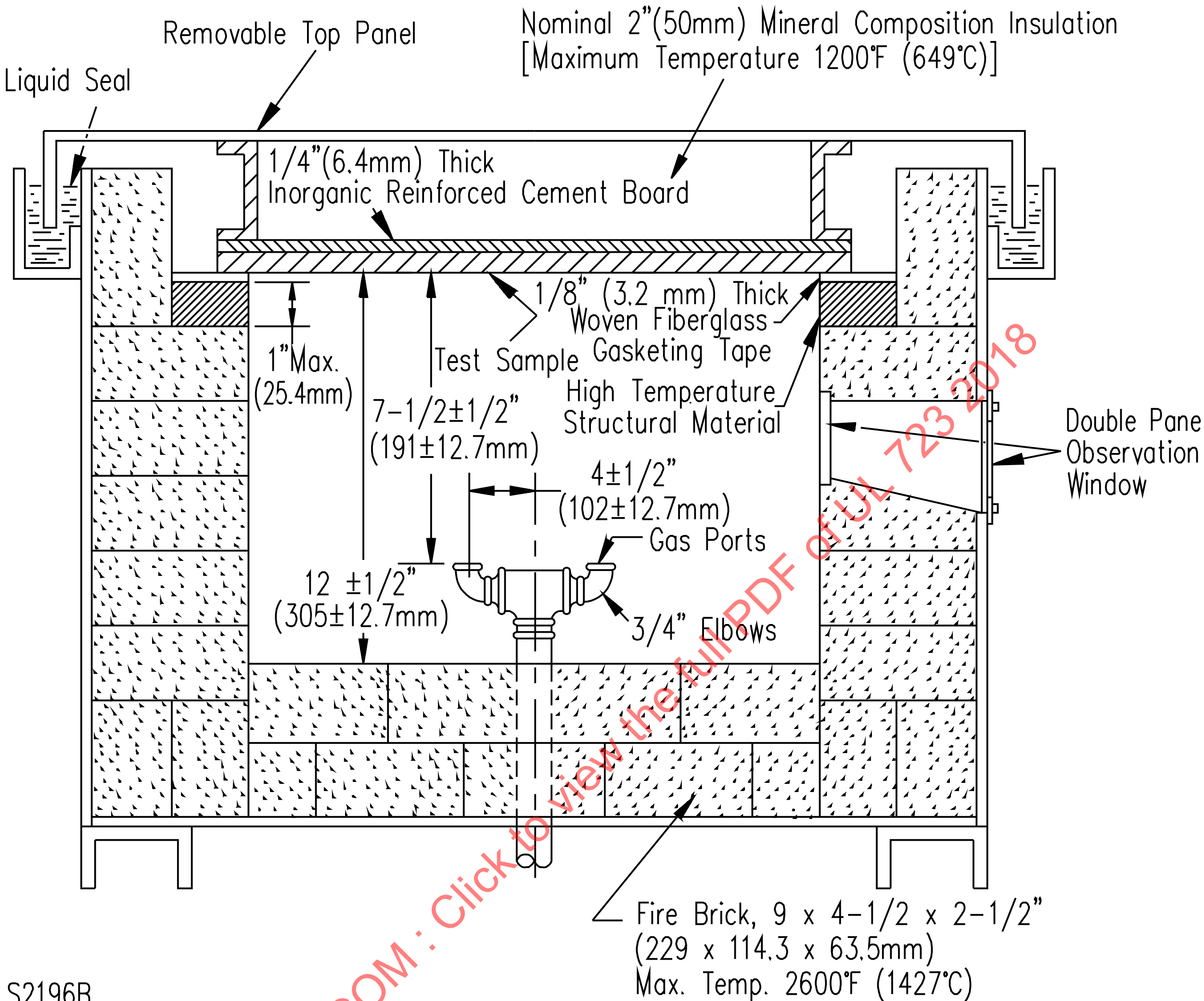
[b]Vycor, 100% silica glass, nominal 1/4-in (6.4-mm) thick or equivalent, works for the inside pane. Pyrex glass, nominal 1/4-in thick or equivalent, works for the outer pane.

Figure 3.1
Details of test furnace



+ – See Figure 3.2 for Section BB

Figure 3.2
Section BB



S2196B

3.2 With reference to 3.1, the insulating firebrick shall have the following properties, including Table 3.1:

a) A maximum recommended temperature of 2600°F (1424°C).

b) A bulk density of 48 + 3 lb/ft^3 (0.77 + 0.046 g/cm^3).

Table 3.1
Thermal conductivity of the insulating firebrick at mean temperature

Mean Temperature		Thermal Conductivity	
°F	(°C)	$Btu·in/hr·ft^2·°F$	W/m·°C
500	260	1.6	0.23
1000	538	1.9	0.27
1500	815	2.2	0.32
2000	1093	2.6	0.37

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

[a]High temperature furnace refractories such as Zicron work for this purpose.

3.4 To provide air turbulence for proper combustion, turbulence baffling is to be provided by positioning six A. P. Green, G-26, refractory fire bricks [long dimension vertical, 4-1/2 in (114-mm) dimension along the wall] along the side walls of the chamber at distances of 7, 12, and 20, ±0.5 ft (2.1, 3.6, and 6.1, ±0.2 m) on the window side and 4-1/2, 9-1/2, and 16, ±0.5 ft (1.3, 2.9, and 4.9, ±0.2 m) on the opposite side. The position of the fire bricks is to be measured from the centerline of the burners.

3.5 The top is to consist of a removable noncombustible (metal and mineral composite) structure insulated with nominal 2-in (50.8-mm) thick mineral composition material as illustrated in Figure 3.2 and is to be of the size necessary to completely cover the fire test chamber and test sample. The mineral composition material is to have physical characteristics comparable to the following:

Maximum effective temperature – 1200°F (649°C);

Bulk density – 21 lb/ft^3 (336 kg/m^3);

Thermal conductivity at 300 to 700°F (149 to 371°C) – 0.50 – 0.71 $Btu·in/·hft^2·°F$ (0.072 – 0.102 W/m·K)

KpC[a] – 1 – 4 $Btu^2·in·ft^5·h·°F^2$ ($1 \times 10^4 - 4 \times 10^4$ $W^2·S·m^4·K^3$)

The entire top assembly is to be protected with flat sections of high density (nominal 90 lb/ft^3 or 1444 kg/m^3) 1/4-in (6.4-mm) fiber-cement board[b], maintained in an unwarped and uncracked condition through continued replacement. This protective board is not required to be either secured or unsecured to the furnace lid. When in place, the top is to be completely sealed against the leakage of air into the fire test chamber during the test.

[a]KpC is equal to the thermal conductivity times the density times the specific heat.

[b] fiber-cement board such as Manville Building Materials Corp. Flexboard II and Tunnel Building Products Sterling Board work for this purpose.

3.6 One end of the test chamber, designated as the ″fire end,″ is to be provided with two gas burners delivering flames upward against the surface of the test sample. The burners are to be spaced 12 in (305 mm) from the fire end of the test chamber and 7-1/2 ±1/2 in (190.5 ±12.7 mm) below the under surface of the test sample. An air intake shutter is to be located 54 ±5 in (1.37 ±0.1 m) upstream of the burner, as measured from the burner centerline to the outside surface of the shutter. Gas to the burners is to be provided through a single inlet pipe, distributed to each burner port through a tee-section. The outlet is to be a 3/4-in (19-mm) elbow. The plane of the port is to be parallel to the furnace floor, such that the gas is directed upward toward the specimen. Each port is to be positioned with its centerline 4 ±1/2 in (102 ±12.7 mm) on each side of the centerline of the furnace so that the flame is evenly distributed over the width of the exposed specimen surface. See Figure 3.2. The controls used to provide constant flow of gas to the burners during periods of use are to consist of a pressure regulator, a gas meter calibrated to read in increments of not more than 0.1 ft^3 (2.8 L), a manometer to indicate gas pressure in inches of water (Pa), a quick-acting gas shutoff valve, a gas metering valve, and an orifice plate in combination with a water manometer to assist in maintaining uniform gas-flow conditions. An air intake fitted with a vertically sliding shutter extending the entire width of the test chamber is to be provided at the fire end. The shutter is to be positioned so as to provide an air inlet port 3 ±1/16 in (76 ±2 mm) high measured from the floor level of the test chamber, at the air intake point.

3.7 The other end of the test chamber, designated as the ″vent end,″ is to be fitted with a gradual rectangular-to-round transition piece, not less than 20-in (508-mm) long with not less than 200 in^2 (1290 cm^2) cross-section at any point. The transition piece is to be, in turn, fitted to a flue pipe 16 inches (406 mm) in diameter. The vent pipe is to be insulated with at least 2 in (50.8 mm) of high temperature mineral composition material from the vent end of the chamber to the photometer location. The movement of air is to be by an induced draft system having a total draft capacity of at least 0.15-in water-column (37.4 Pa) with the sample in place, the shutter at the fire end open the normal 3 ±1/16-in (76 ±2 mm), and the damper in the fully-open position. A draft gauge tap, to indicate static pressure, is to be inserted through the top at the midwidth of the tunnel, 1 ±1/2 in (25 ±13 mm) below the ceiling, and 15 ±1/2 in (380 ±13 mm) downstream from the inlet shutter.

3.8 A photometer system[a] consisting of a light source and photocell is to be mounted on a horizontal section of the 16-in (406-mm) diameter vent pipe at a point where it will be preceded by a straight run of pipe [at least 12 diameters or 16 ft (4.9 m) but not more than 30 diameters or 40 ft (12.2 m)] from the vent end of the chamber, and with the light beam directed upward along the vertical axis of the ventpipe. A photoelectric cell whose output is directly proportional to the amount of light received is to be mounted over the light source and connected to a recording device for indicating changes in the attenuation of incident light resulting from the passage of smoke, particulate, and other effluent. The distance between the light source lens and the photocell lens is to be 36 ±4 in (914 ±102 mm). The cylindrical light beam is to pass through 3-in (76-mm) diameter openings at the top and bottom of the 16-in diameter duct, with the resultant light beam centered on the photocell.

[a]A photometer system that works for this purpose is Model No. 856RRV from Huygen Corp., Crystal Lake, IL.

3.9 Linearity of the photometer system is to be verified periodically by interrupting the light beam with calibrated neutral density filters. The filters are to cover the full range of the recording instrument. Transmittance values measured by the photometer, using neutral density filters, are to be within ±3% of the calibrated value for each filter.

3.10 An automatically-controlled damper is to be installed in the vent pipe downstream of the smoke-indicating attachment. The damper is to be provided with a manual override.

3.11 Other manual or automatic draft regulation devices are to be incorporated when required to maintain fan characterization and air flow control throughout test periods.

3.12 A No. 18 AWG (0.82 mm^2) thermocouple having 3/8 ±1/8 in (9.5 ±3.2 mm) of the junction exposed to the air is to be inserted through the floor of the test chamber so that the tip is 1 ±1/32 in (25.4 ±0.8 mm) below the top surface of the woven fiberglass gasketing tape and 23 ft ±1/2 in (7.09 m ±13 mm) from the centerline of the burner ports, at the center of the chamber's width.

3.13 Two No. 18 AWG (0.82 mm^2) thermocouples embedded 1/8 in (3.2 mm) below the floor surface of the test chamber are to be mounted in refractory or Portland cement, carefully dried to avoid cracking, at distances of 13 ft ±1/2 in (3.96 m ±13 mm) and 23-1/4 ft ±1/2 in (7.09 m ±13 mm), respectively, from the centerline of the burner ports.

3.14 The room in which the test chamber in located is to have provision for a free inflow of air during test, to maintain the room at atmospheric pressure during the entire test run.

4 Test Specimens

4.1 The test specimen is to be at least 2 in (50.8 mm) wider than the interior width of the tunnel and a total of 24 ft ±1/2 in (7.3 m ±12.7 mm) in length. The specimen is to consist of a continuous, unbroken length, or of sections joined end-to-end. A 14 ±1/8-in (356 ±3.2-mm) length of uncoated No. 16 gage [nominal 0.060-in (1.52-mm) thick] sheet steel is to be placed on the specimen mounting ledge, in front of and under the specimen, in the upstream end of the tunnel. Specimens shall be representative of the materials for which classification is desired. Properties adequate for identification of the materials or ingredients, or both, of which the test specimen is made are to be determined and recorded.

4.2 Materials for which there is a standard practice to address specimen preparation and mounting as shown in 4.4 shall be tested as described in the appropriate standard practice.

4.3 The test specimen is to be conditioned to a constant weight at a temperature of 73 ±4°F (23 ±2.8°C) and at a relative humidity of 50 ±5% for a minimum of 24 h. Samples that are hygroscopic in nature, or those that are suspected to have significant mass loss or gain during conditioning are required to be conditioned to constant weight.

4.4 Preparation and mounting of test specimens shall be in accordance with the following mounting practices, as applicable. For all other specimens, refer to Appendix A for guidance on mounting methods.

a) The Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics, ASTM E2231 for pipe and duct insulation materials;

b) The Standard Practice for Specimen Preparation and Mounting of Paper or Vinyl Wall or Ceiling Coverings to Assess Surface, ASTM E2404 for paper, vinyl and textile wall and ceiling covering materials;

c) The Standard Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics, ASTM E2573 for site-fabricated stretch systems;

d) The Standard Practice for Specimen Preparation and Mounting of Wood Products to Assess Surface Burning Characteristics, ASTM E2579 for the following wood products: solid board, lumber and timber products, panel products, decorative wood products and shingles / shakes used as interior wall finish, interior ceiling finish and interior trim;

e) The Standard Practice for Specimen Preparation and Mounting of Reflective Insulation Materials and Radiant Barrier Materials for Building Applications to Assess Surface Burning Characteristics, ASTM E 2599 for reflective insulation, radiant barrier and vinyl stretch ceiling materials for building applications.

f) The Standard Practice for Specimen Preparation and Mounting of Tapes to Assess Surface Burning Characteristics, ASTM E2688 for tapes up to and including 8 inches (203.2 mm) in width; and

g) The Standard Practice for Specimen Preparation and Mounting of Caulks and Sealants to Assess Surface Burning Characteristics, ASTM E2690 for caulks and sealants intended to be applied up to and including 8 inches (203.2 mm) in width.

h) The Standard Practice for Specimen Preparation and Mounting of Flexible Fibrous Glass Insulation for Metal Buildings to Assess Surface Burning Characteristics, ASTM E2988 for flexible fibrous glass insulation for metal buildings.

5 Calibration of Test Equipment

5.1 A 1/4-in (6.4-mm) fiber-cement board is to be placed on the ledge of the furnace chamber. The removable top of the test chamber then is to be placed in position.

5.2 With the 1/4-in (6.4-mm) fiber-cement board in position on top of the ledge of the furnace chamber, and with the removable lid in place, a draft is to be established so as to produce a 0.15-in water-column (37.4 Pa) reading on the draft manometer, with the fire-end shutter open 3 ±1/16 in (76.2 ±1.6 mm), by manually setting the damper as a characterization of fan performance. Then the fire-end shutter is to be closed and sealed. The manometer reading is to increase to at least 0.375-in water-column (93.4 Pa), indicating that no excessive air leakage exists.

5.3 In addition, a supplemental leakage test is to be conducted periodically by sealing the fire shutter and exhaust duct beyond the photometer system and placing a smoke bomb in the chamber. The bomb is to be ignited and the chamber pressurized to 0.375 ±0.15-in water-column (93.4 ±37.0 Pa). All points of leakage, observed in the form of escaping smoke particles are to be sealed.

5.4 A draft reading is to be established within the range of 0.055 – 0.100-in water-column (13.7 – 25.0 Pa). The required draft gauge reading is to be maintained throughout the test by the automatically-controlled damper. The air velocity is to be recorded at seven points 23 ft (7.0 m) from the centerline of the burner ports and 6 ±1/4 in (168 ±6.4 mm) below the plane of the specimen mounting ledge. These points are to be determined by dividing the width of the tunnel into seven equal sections and recording the velocity at the geometrical center of each section. During the measurement of velocity, the turbulence bricks are to be removed and 24-in (670-mm) long straightening vanes are to be placed 16 to 18 ft (4.9 to 5.5 m) from the burners. The straightening vanes are to divide the chamber cross section into nine uniform sections. The air temperature is to be 73.4 ±5°F (23 ±2.8°C). The determinations are to be made using a velocity transducer[a]. The velocity, determined as the arithmetic average of the seven readings, is to be 240 ±5 fpm (1.22 ±0.025 m/s).

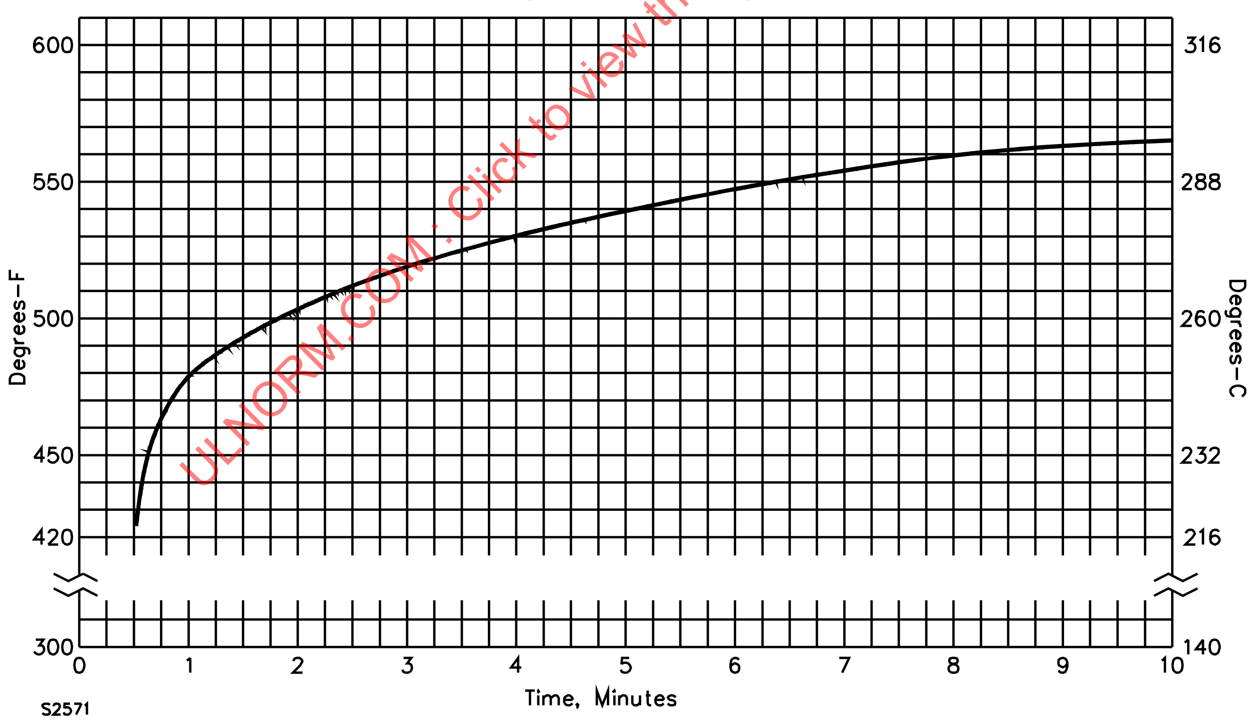
[a]A Thermo Systems Inc. Model 1610 velocity transducer (thermal anemometer or equivalent) using a readout device accurate to 0.001 V works for this purpose.

5.5 The air supply is to be maintained at 65 – 80°F (18.3 – 26.7°C) and the relative humidity at 45 – 65%.

5.6 The fire test chamber is to be supplied with natural (city) or methane (bottled) gas fuel of uniform quality with a heating value of nominally 1000 Btu/ft^3 (37.3 MJ/m^3). The gas supply is to be initially adjusted at approximately 5000 Btu/min (87.9 kW). The gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test are to be recorded. Unless otherwise corrected for, when bottled methane is employed, a length of coiled copper tubing is to be inserted into the gas line between the supply and metering connection to compensate for any errors in the flow indicated due to reductions in gas temperature associated with the pressure drop and expansion across the regulator. With the draft and gas supply adjusted as indicated in 5.4 and 5.6, the test flame is to extend downstream to a distance of 4-1/2 ft (1.4 m) over the specimen surface, with negligible upstream coverage.

5.7 The test chamber is to be preheated with the 1/4-in (6.4-mm) fiber-cement board and the removable top in place and with the fuel supply adjusted to the required flow. The preheating is to be continued until the temperature indicated by the floor thermocouple at 23-1/4 ft (7.09 m) is 150 ±5°F (66 ±2.8°C). During the preheat test, the temperatures indicated by the thermocouple at the vent end of the test chamber are to be recorded at 15-s intervals or less and compared to the preheat temperature shown in the time-temperature curve, Figure 5.1. The preheating is to establish the conditions that will exist following successive tests and to indicate the control of the heat input into the test chamber. If appreciable variation from the temperatures shown in the representative preheat curved is observed, adjustments in the fuel supply are to be made when required based on red-oak calibration tests.

Figure 5.1
Time-temperature curve – preheat



5.8 The furnace is to be allowed to cool after each test. When the floor thermocouple at 13 ft (4.0 m) indicates a temperature of 105 ±5°F (40.5 ±2.8°C), the next specimen is to be placed in position for test.

5.9 With the test equipment adjusted and conditioned as described in 5.2, 5.4, 5.5, and 5.7, a test or a series of tests are to be made, using nominal 23/32-in (18.2-mm) select-grade red-oak flooring as the sample, conditioned to 6 – 8% moisture content using one of the following two methods:

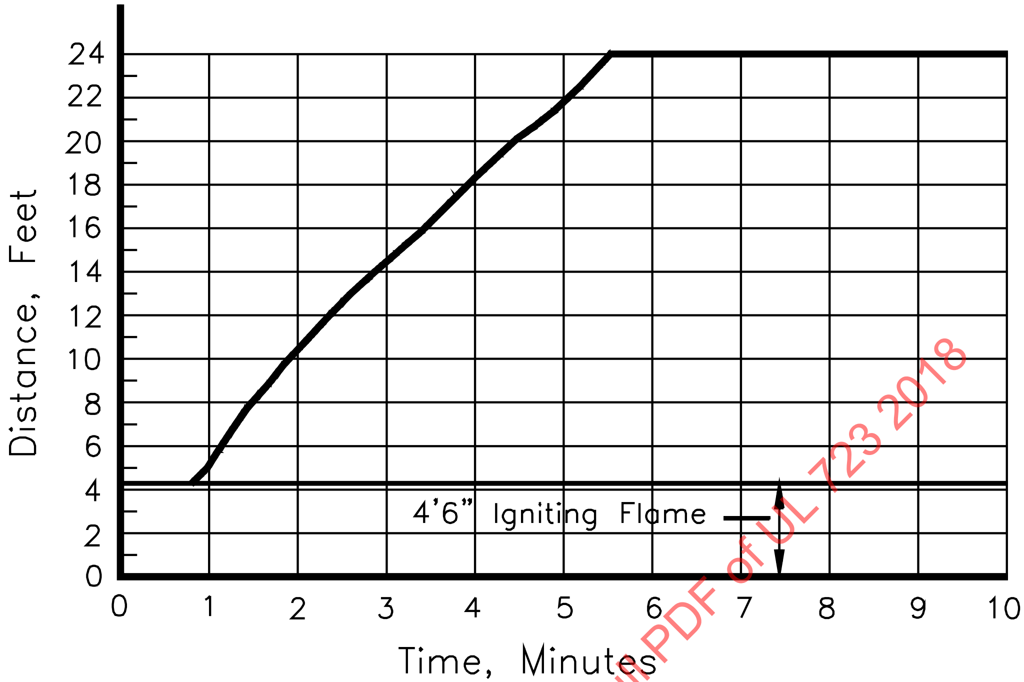
a) Oven Dry Method: As determined by the 221°F (105°C) oven dry method described in the Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials, ASTM D 4442-92(2003). From trimmed sections of the calibration decks, prepare a minimum of six specimens 4 +1/16 –0-in (100 +2 –0-mm) long. The specimens shall be free from visible irregularities of knots, decay, reaction wood, and resin concentration. Place the trimmed sections adjacent to the calibration decks in a conditioning atmosphere that will result in an average moisture content of 7 ±1.0%. Using either a conductance or dielectric type meter (calibrated per Test Methods D 4444 for red oak species), monitor moisture content until the desired level is reached. Subject the trimmed sections only to the secondary oven-drying method (Method B) in Test Methods D 4442 for the final determination of moisture content.

b) Moisture Meter Method: Place the calibration decks in a conditioning atmosphere that will result in an average moisture content of 7 ±1.0%. Using either a conductance or dielectric type meter (calibrated per Test Methods D 4444 for red oak species), monitor moisture content until the desired level is reached. The final determination of average moisture content of the test sample is to be determined as follows. Take 10 readings on each of the three red oak decks such that a representative sampling is obtained over the entire area of the deck. The moisture content of the test sample shall be an arithmetic average of the 30 readings.

5.10 Observations are to be made at distance intervals not in excess of 2 ft (0.6 m) and time intervals not in excess of 30 s and the time recorded when the flame reaches the end of the specimen, that is, 19-1/2 ft (5.9 m) from the end of the ignition fire. The end of the ignition fire for these requirements is designated as being 4-1/2 ft (1.4 m) from the burners. The flame is to reach the end point in 5-1/2 min ±15 s. Another means of judging when the flame has reached the end point for these requirements is when the vent-end thermocouple registers a temperature of 980°F (527°C). The temperature measured by the thermocouple near the vent end is to be recorded at least every 15 s during the test. The photoelectric-cell output is to be recorded immediately prior to the test and at least every 2 s during the test.

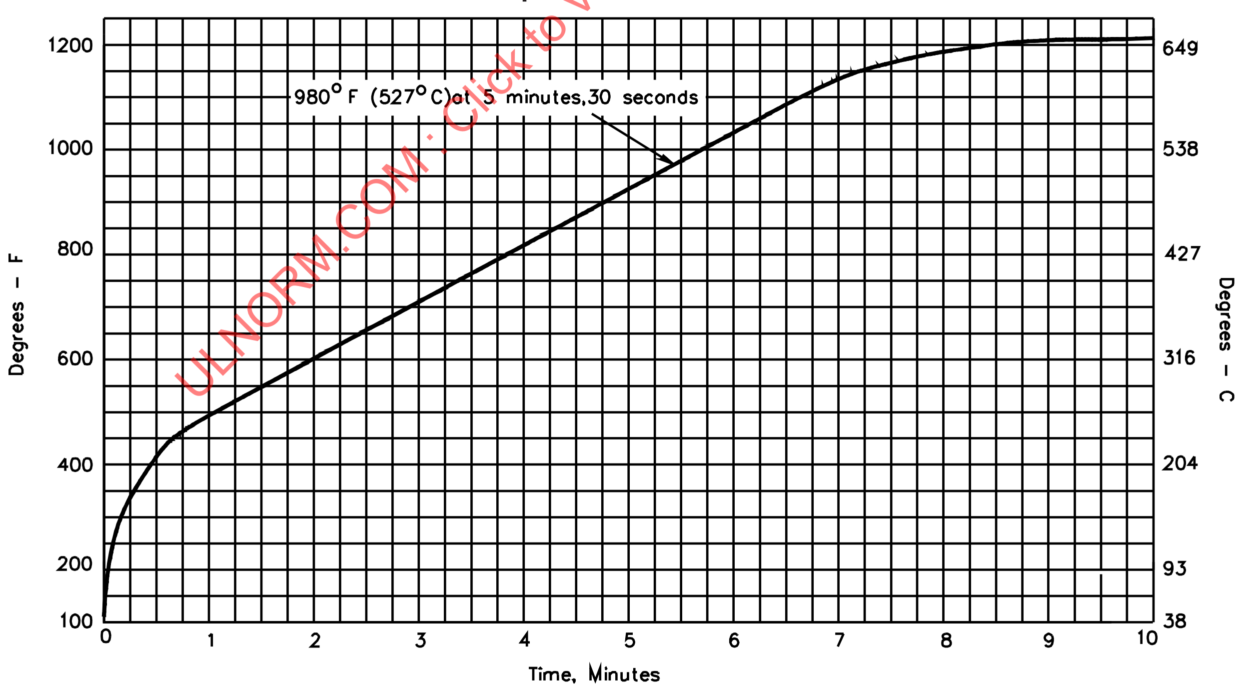
5.11 The flame-spread distance, temperature, and change in photoelectric cell readings are to be plotted separately for the duration of the test. Figures 5.2 – 5.4 are representative curves for red oak flame spread, time-temperature development, and smoke density, respectively. Flame spread distance is to be determined as the observed distance minus 4-1/2 ft (1.4 m).

Figure 5.2
Representative time-distance curve for flame spread of red oak



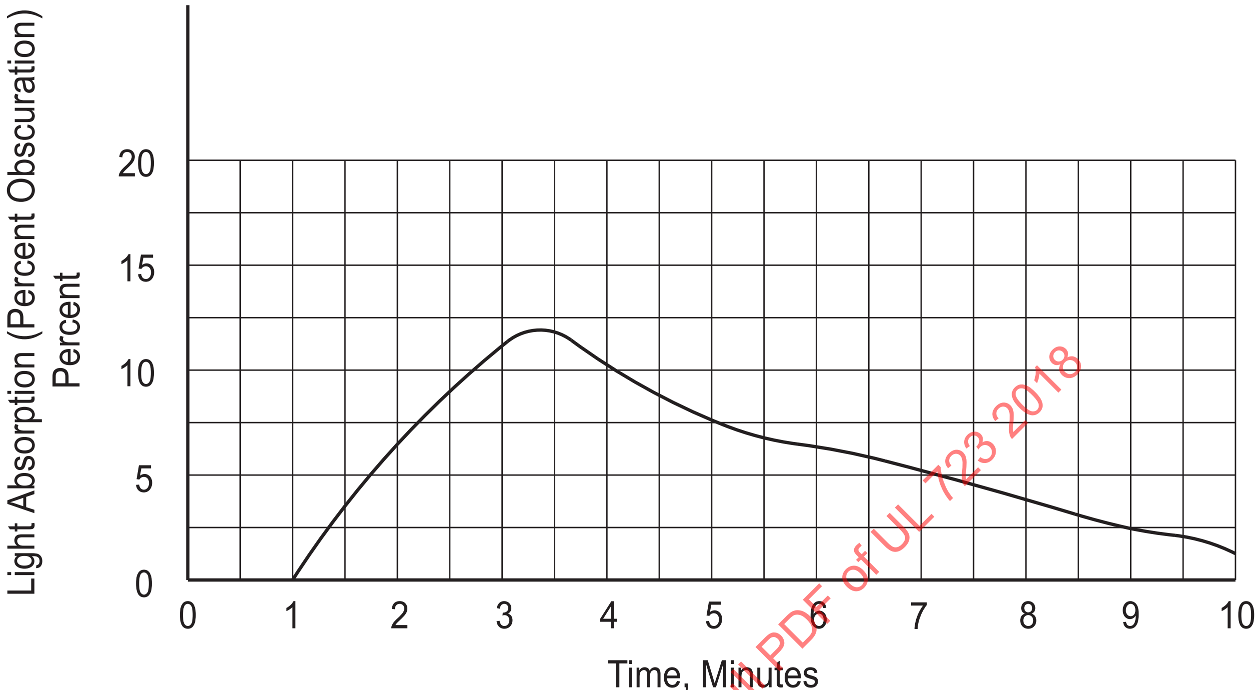
S2573

Figure 5.3
Time-temperature curve – red oak



S2572

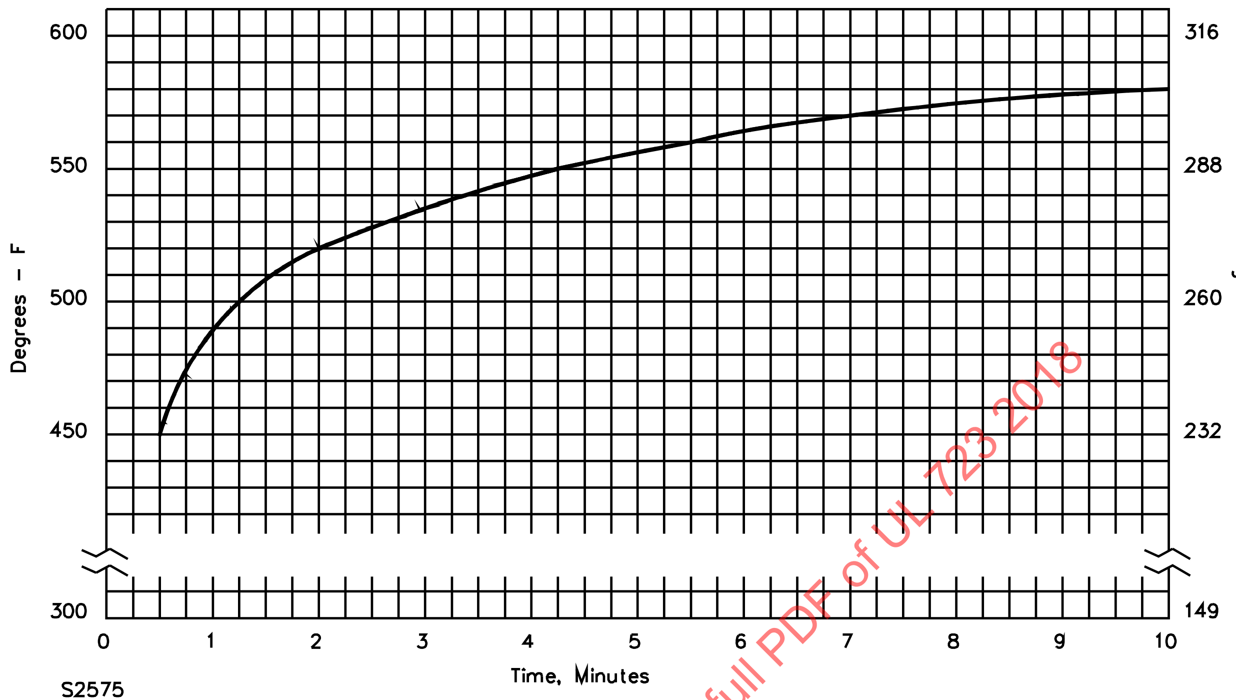
Figure 5.4
Smoke density – red oak



su0151

5.12 In addition to the calibration tests for red oak, a similar test(s) is to be conducted on samples of 1/4-in (6.4-mm) fiber-cement board. The results represent an index of zero for these requirements. The temperature readings are to be plotted separately for the duration of the test. Figure 5.5 is a representative curve for time-temperature development of inorganic reinforced cement board. The calibration tests using red oak flooring and cement board samples shall be permitted in either order.

Figure 5.5
Time-temperature curve – fiber-cement board



5.13 As an optional calibration tests in addition to tests using red oak and fiber-cement board, a series of tests are permitted to be conducted using heptane, following the fiber-cement board test. The smoke density area generated by the heptane tests may be used in lieu of red oak smoke density areas to calculate the Smoke Developed Indices as described in 7.1.6.

5.14 With the test equipment adjusted and conditioned as described in 5.2, 5.4, 5.5, and 5.7, a series of tests are to be made, using 295 g ±5 g of HPLC Grade, submicron filtered heptane[a]. The heptane is to be poured into a round, 16 gauge stainless steel pan with an inside diameter of 8.875 in. ±0.125 in. and an inside depth of 1.625 in. ±0.125 in.

[a]Fisher Scientific Catalogue no. H 350-4 HPLC grade n-heptane has been found suitable for this purpose.

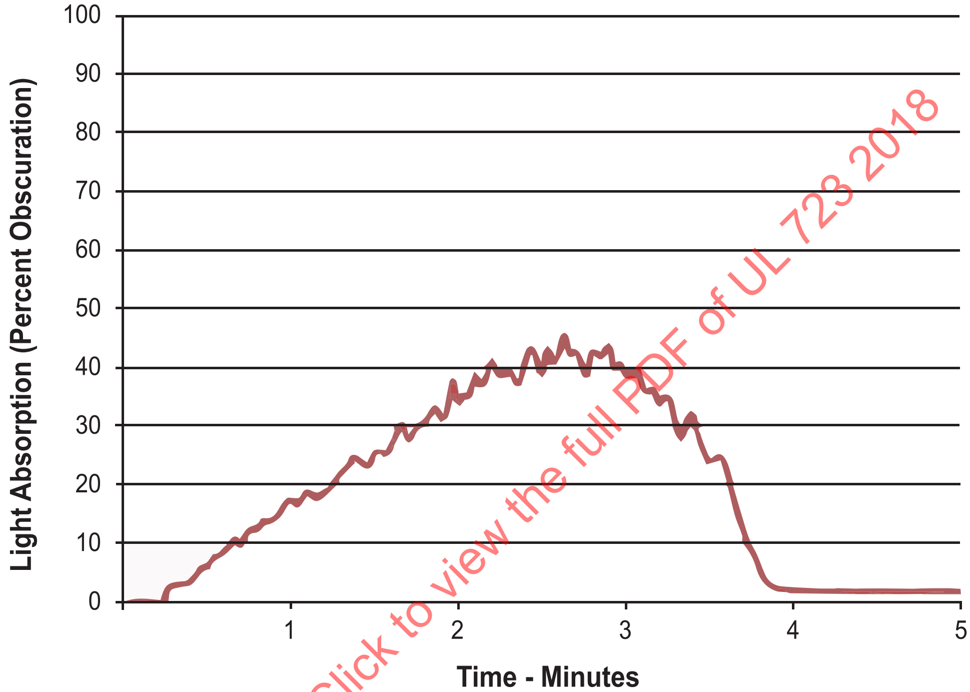
5.15 The pan is to be placed on the furnace floor, 24 in. ± 0.5 in. downstream from the centerline of the burners. The pan is to be covered with a piece of nominal 12 in. by 12 in. High Density Polyethylene (HDPE) plastic food wrap (cling wrap) to minimize evaporation while awaiting the calibration test to begin.

5.16 With the tunnel lid closed in the test position, and the specified draft established, the test is to be initiated by ignition of the plastic food wrap (cling wrap) and heptane using a spark igniter or similar method. The standard gas burners are not energized for these tests.

5.17 The heptane is to be allowed to burn until consumed, and the test terminated at 5:00 minutes. The photoelectric-cell output is to be recorded immediately prior to the test and at least every 2 s during the test.

5.18 The temperature, duration of flaming and change in photoelectric-cell readings are to be recorded for the duration of the test. Figure 5.6 is a representative curve for the smoke density of 295 g of heptane.

Figure 5.6
Smoke Density - 295g Heptane



su3190

5.19 Two tests are to be conducted for the series and the results averaged and reported.

5.20 A complete new calibration as described in Section 5 shall be performed after major repairs, such as re-bricking, have been made. If there have been no major repairs, a new calibration for both red oak and fiber-cement board shall be conducted after 200 tests, or every 12 months, whichever comes first.

5.21 Smoke-developed indices (SDI) of products under test may be calculated using red oak smoke density areas or heptane smoke density areas.

5.22 When using red oak to calculate SDI, add the data from the new red oak smoke calibration to a data set containing at least the last four calibrations in order to maintain a running average of at least five calibrations. When fewer than five calibrations have been performed on new equipment, average the available number of calibrations to achieve the running average.

5.23 When using heptane to calculate SDI, add the average of the two heptane smoke calibration tests to a data set containing at least the last four calibrations in order to maintain a running average of at least five calibrations. When fewer than five calibrations have been performed on new equipment, average the available number of calibrations to achieve the running average.

6 Test Procedure

6.1 With the furnace draft operating, the test specimen is to be placed on the test chamber ledges which have been completely covered with nominal 1/8-in (3.2-mm) thick by 1-1/2-in (38.1-mm) wide woven fiberglass gasketing tape. The specimen is to be placed as quickly as is practical. The removable top is to be placed in position over the specimen.

6.2 The completely mounted specimen is to remain in position in the chamber with the furnace draft operating for 120 ±15 s prior to application of the test flame.

6.3 The burner gas is to be ignited. The time for sample ignition as well as time of occurrence and distance of flame front advancement are to be observed and recorded with the room darkened. Where required to determine flame spread due to burning material on the floor of the tunnel (see 7.3), time of occurrence and distance of flame front advancement on the floor is also to be observed and recorded. The test is to be continued for a 10-min period, except that test termination before 10 min have elapsed is not prohibited if the sample is completely consumed in the fire area, no further progressive burning is evident, and the photoelectric-cell reading has returned to the base line.

6.4 The photoelectric-cell output is to be recorded immediately prior to the test and at least every 2 s during the test.

6.5 The gas pressure, the pressure differential across the orifice plate, and the volume of gas used in each test are to be recorded.

6.6 When the test is ended, the gas supply is to be shut off, smoldering and other conditions within the test duct are to be observed, and the specimen removed for further examination.

6.7 The flame-spread distance and change in photoelectric-cell readings are to be plotted as specified in 5.11 for use in determining the flame spread and smoke-developed indices as described in Classification, Section 7. The flame spread observations are to be recorded at the time of occurrence or at time intervals not in excess of 30 s if no flame advancement is noted. In addition, the peak is to be noted, together with the time of occurrence. Flame spread distance is to be the observed distance minus 4-1/2 ft (1.37 m).

7 Classification

7.1 General

7.1.1 The flame spread index (FSI) is the calculated flame spread (CFS) as determined in accordance with 7.1.2 – 7.1.4 rounded to the nearest multiple of 5 points. The FSI for repetitive testing is to be determined in accordance with 7.2.

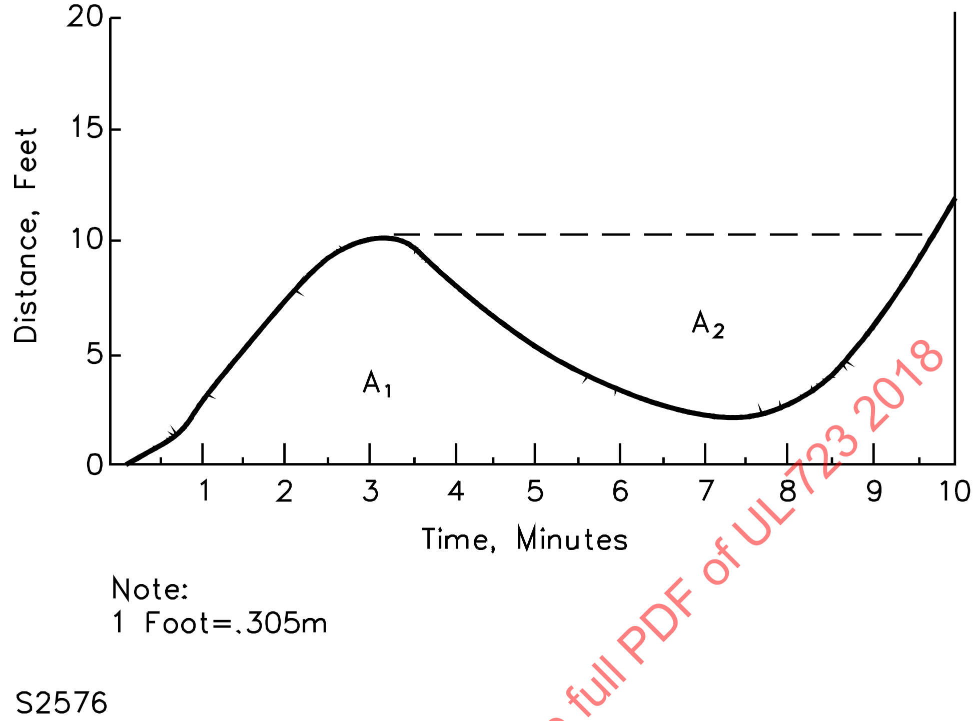
7.1.2 The total area (A_T) under the flame spread time-distance curve is to be determined by disregarding any flame front recession. For example, in Figure 7.1 the flame has spread to 10 ft (3.05 m) in 3 min and then receded. The area is calculated as though the flame had spread to 10 ft in 3 min and then remained at 10 ft for the remainder of the test or until the flame front again passed 10 ft, as shown by the dashed line in Figure 7.1. The area (A_T) used for calculating the flame spread index is to be the sum of areas A_1 and A_2 in Figure 7.1.

7.1.3 If this total area (A_T) is less than or equal to 97.5 min-ft (1783 s-m), the CFS is to be 0.515 times the total area (CFS = 0.515 A_T).

7.1.4 If the total area (A_T) is greater than 97.5 min-ft (1783 s-m), the CFS is to be 4900 divided by the distance of 195 minus the total area (A_T) [CFS = 4900/(195 – A_T)].

7.1.5 The smoke developed index (SDI) is the calculated smoke developed (CSD) as determined in accordance with 7.1.6 rounded to the nearest multiple of 5 points, except for values of 200 or over. For values of 200 or over, the SDI is the CSD rounded to the nearest 50 points. The SDI for repetitive testing is to be determined in accordance with 7.2.

Figure 7.1
Example of time-distance curve with flame front recession



7.1.6 The test results for smoke density are to be plotted and the area under the curve determined. The area is to be divided by the area under the curve determined for red oak or heptane, as described in Section 5 and multiplied by 100 to establish a numerical index by which the performance of the material is to be compared with that of fiber-cement board and select-grade red-oak flooring or heptane. Fiber-cement board has been arbitrarily established as zero SDI and red oak flooring and heptane, arbitrarily established as 100 SDI. In the unlikely event of particulate blockage of the photocell, the test shall be deemed invalid and re-conducted, or a qualifying notation shall be included in the test report.

7.2 Multiple test data

7.2.1 General

7.2.1.1 When multiple test data are provided, the flame-spread index and smoke-developed index are to be determined as specified in 7.2.2 – 7.2.5.

7.2.2 Flame-spread index (FSI)

7.2.2.1 Each individual CFS value is to be rounded to the nearest multiple of 5 points. If the rounded values do not exceed a 10-point range, the CFS values are to be averaged and the resultant average rounded to the nearest multiple of 5 points and will be the FSI. See 7.2.2.2 for when values exceed a 10-point range.

7.2.2.2 When the individual rounded values exceed a 10-point range, the highest individual rounded value will be the FSI or the highest and lowest individual rounded values are to be reported as a range.

7.2.3 Smoke-developed index (SDI) – all rounded smoke values 200 or under

7.2.3.1 Each individual CSD value is to be rounded to the nearest multiple of 5 points. If the rounded values do not exceed a 20-point range, the CSD values are to be averaged and the resultant average rounded to the nearest multiple of 5 points will be the SDI. See 7.2.3.2 for when values exceed a 20-point range.

7.2.3.2 When the individual rounded values exceed a 20-point range, the highest individual rounded value will be the SDI or the highest and lowest individual rounded values are to be reported as a range.

7.2.4 Smoke-developed index (SDI) – all rounded smoke values 200 or over

7.2.4.1 Each individual CSD value is to be rounded to the nearest multiple of 5 points. If the rounded values do not exceed a 50-point range, the CSD values are to be averaged and the resultant average rounded to the nearest multiple of 50 points and will be the SDI. See 7.2.4.2 for when values exceed a 50-point range.

7.2.4.2 When the individual rounded values exceed a 50-point range, report the SDI in one of two ways:

a) The highest individual value is to be rounded to the nearest multiple of 50 points and reported as the SDI, or

b) The highest and lowest individual values are to be rounded to the nearest multiple of 50 points and the SDI reported as a range.

7.2.5 Rounded smoke values both under and over 200

7.2.5.1 Each individual CSD value is to be rounded to the nearest multiple of 5 points. If the rounded values do not exceed a 20-point range, the SDI value is to be 200. See 7.2.5.2 for when rounded values exceed a 20-point range.

7.2.5.2 When the individual rounded values exceed a 20-point range, the highest individual value is to be rounded to the nearest multiple of 50 points and will be the SDI or the highest individual value is to be rounded to the nearest multiple of 50 points and together with the lowest individual rounded value is to be reported as a range.

7.3 Test data for ceiling and floor values

7.3.1 When testing thermoplastics materials that melt and drip to the floor of the test chamber and continue burning, flame spread values associated with burning on the floor of the tunnel, shall be calculated, in addition to the flame spread values associated with burning in the ceiling position. Furthermore, smoke developed values shall also be distinguished, as described below.

7.3.2 Ceiling flame spread values shall be calculated as shown in Section 7. Calculations shall be based upon flame front advancement observed at the ceiling position until the time of maximum flame front advancement at the ceiling position and such time that material on the tunnel floor ignites and advances. In some cases, following ignition on the floor, burning on the floor may be responsible for further ignition and flame propagation in the ceiling position and it may be difficult to distinguish between floor flame spread and ceiling flame spread during the test. In those instances, the ceiling flame spread value shall be calculated based on the initial, maximum flame front advancement in the ceiling position prior to flame propagation on the floor of the tunnel.

7.3.3 Throughout the remainder of the test duration, floor flame spread values shall be calculated as shown in Section 7 and based upon flame front advancement observed on the floor. In instances where it is difficult to distinguish between floor flame spread and ceiling flame spread, as described in 7.3.2, the propagation observed shall be used to determine floor flame spread values.

7.3.4 Ceiling smoke developed values shall be calculated as shown in Section 7 and based on smoke obscuration under the time vs. percent obscuration curve recorded until such time that the material on the tunnel floor ignites and advances.

7.3.5 Total smoke developed values shall be calculated as shown in Section 7 and based on the total smoke obscuration under the time vs. percent obscuration curve recorded for the duration of the test.

8 Analysis of Products of Combustion

8.1 Although not required as a part of this method, drawing products of combustion from the test duct during the progress of the test for chemical analysis is not prohibited.

REPORT

9 General

9.1 The report shall include the following:

a) Description of the material being tested;

b) Test results as calculated in Classification, Section 7. When both ceiling and floor flame spread and ceiling and total smoke developed values are determined, these values shall be reported as shown in the example in item (1) below:

1) ***Flame Spread X***, ***Smoke Developed Y***. (Flame spread and smoke developed recorded while material remained in the original test position. Ignition of molten residue on the furnace floor resulted in flame travel equivalent to calculated flame spread index of X and smoke developed index of Y.)

c) Details of the method used in placing the specimen in the test chamber;

d) Observations of the burning characteristics of the specimen during test exposure, such as delamination, sagging, shrinkage, and fallout; and

e) Graphical plots of flame spread and smoke developed data.