NFPA 253

Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

1995 Edition

NFPA®

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
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This edition of NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, was prepared by the Technical Committee on Fire Tests and acted on by the National Fire Protection Association, Inc., at its Annual Meeting held May 22-25, 1995, in Denver, CO. It was issued by the Standards Council on July 21, 1995, with an effective date of August 11, 1995, and supersedes all previous editions.

The 1995 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 253

Experience suggests that during the early stages of a fire, floor covering systems seldom have acted as a fire spread medium. However, in a few fires involving multiple occupancy buildings, the floor covering materials in corridors were primarily responsible for fire spread over a considerable distance. This caused grave concern and pointed to the need for a realistic test to evaluate the flame spread of floor covering systems.

The flooring radiant panel test had its inception with the Armstrong Cork Company in 1966. In 1972, conceptualization of critical radiant flux (W/cm^2 at extinguishment) as a measure of flame spread hazard was underway at the National Bureau of Standards. It was determined in the course of NBS work on model corridor fire tests that the radiant energy levels incident on the floor covering had a considerable influence on whether or not flaming combustion would propagate. Accordingly, it was natural to apply the critical radiant flux concept, and, in 1973, the National Bureau of Standards prepared a draft of the flooring radiant panel test.

In 1975, the Technical Committee on Fire Tests began its evaluation of the proposed test methods, which culminated in the adoption of this test as an official NFPA standard in May 1978. The standard was revised in 1984 and 1990.

The 1995 edition includes significant improvements based on work conducted by NIST and the carpet industry. These findings improve the overall application of the standard and provide measured improvement in test precision. Other changes include a new pilot burner and reduction of the variation in the airflow through the chamber, which reduces the variability of data. Revisions also were made to eliminate “permissive” language. These revisions create closer harmony with ASTM E648, *Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.*

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A.

Information on referenced publications can be found in Chapter 9 and Appendix E.

Chapter 1 General

1-1 Scope.

1-1.1 This fire test response standard describes a procedure for measuring critical radiant flux behavior of horizontally mounted floor covering systems exposed to a flaming ignition source in a graded, radiant heat energy environment within a test chamber. The specimen can be mounted over underlayment or over a simulated concrete structural floor, bonded to a simulated structural floor, or otherwise mounted in a typical and representative way.

1-1.2 This fire test response standard measures the critical radiant flux at flameout. It provides a basis for estimating one aspect of fire exposure behavior for floor covering systems.

The imposed radiant flux simulates the thermal radiation levels likely to impinge on the floors of a building whose upper surfaces are heated by flames or hot gases, or both, from a fully developed fire in an adjacent room or compartment. The standard was developed to simulate an important fire exposure component in fires that develop in corridors or exitways of buildings and is not intended for routine use in estimating flame spread behavior of floor covering in building areas other than corridors or exitways. Appendix F provides information on the proper application and interpretation of the results of this test.

1-1.3 The values stated in SI units are to be regarded as the standard.

1-1.4 This standard shall be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and shall not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, the results of the test shall be permitted to be used as elements of a fire hazard assessment or a fire risk assessment that takes into account all factors that are pertinent to an assessment of the fire hazard or fire risk of a particular end use.

1-1.5 This standard does not purport to address all safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use. Specific safety precautions are provided in Chapter 4.

1-2 Significance and Use.

1-2.1 This fire test response standard is designed to provide a basis for estimating one aspect of the fire exposure behavior of a floor covering system installed in a building corridor. The test environment simulates conditions that have been observed and defined in full-scale corridor experiments.

1-2.2 The test is suitable for regulatory statutes, specification acceptance, design purposes, or development and research.

1-2.3 The fundamental assumption inherent in the test is that "critical radiant flux" is one measure of the sensitivity to flame spread of floor covering systems located in a building corridor.

1-2.4 The test is applicable to floor covering system specimens that follow or simulate accepted installation practice. Tests on the individual elements of a floor system are not valid for evaluation of the flooring system.

1-3 Summary of Test Method. The basic elements of the test chamber include an air-gas-fueled radiant heat energy panel inclined at 30 degrees to and directed at a horizontally mounted floor covering system specimen. The radiant panel generates a radiant energy flux distribution along the 100-cm length of the test specimen from a nominal maximum of 1.0 W/cm^2 to a minimum of 0.1 W/cm^2. The test is initiated by open-flame ignition from a pilot burner. The distance burned to flameout is converted to W/cm^2 from the flux profile graph shown in Figure 1-3 and is reported as critical radiant flux W/cm^2.

1-4 Definitions.

Blackbody Temperature. The temperature of a perfect radiator; a surface with an emissivity of unity and, therefore, a reflectivity of zero (0).

Corridor. An enclosed space connecting a room or compartment with an exit. The corridor includes normal extensions, such as lobbies and other enlarged spaces.

Critical Radiant Flux. The level of incident radiant heat energy on the floor covering system at the most distant flameout point. It is reported as W/cm^2.

Flameout. The time at which the last vestige of flame or glow disappears from the surface of the test specimen, frequently accompanied by a final puff of smoke; time zero (0) is the time at which the specimen is moved into the chamber and the door is closed. (*See Section 6-3.*)

Floor Covering. A separate or secondary surface applied over a flooring and including underlayment materials, carpeting, resilients, and coating systems.

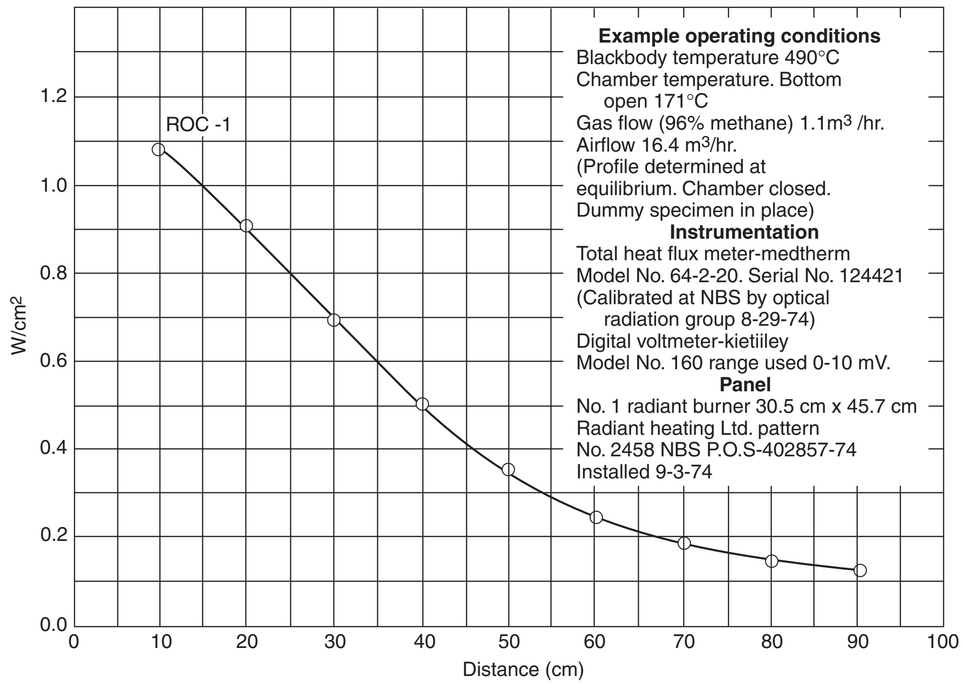
Floor Covering System. A flooring or a combination of flooring and floor covering.

Flooring. A primary floor surface or a final floor surface.

Flux Profile. The curve of incident radiant heat energy on the specimen plane relative to the distance from the point of initiation of flaming ignition (i.e., 0 cm).

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.



Note: in. = cm x 0.3937; Btu/ft^2 • sec = W/cm^2 x 1.135.

Figure 1-3 Standard radiant heat energy flux profile.

Standard Cushion. *Type II — Rubber Coated Jute and Animal Hair or Fiber,* Federal Specification DDD-C-001023 (GSA-FSS), Amendment 1, March 10, 1972 (minimum 9.53 mm thick, 1.47 kg/0.836 m^2).

Standard Simulated Concrete Subfloor. Uncoated fiber-reinforced cement board with a nominal thickness of 6.3 mm and a density of 1762 kg/m^3 ± 80 kg/m^3.

Total Flux Meter. The instrument used to measure the level of radiant heat energy incident on the specimen plane at any point.

Chapter 2 Test Apparatus

2-1 Radiant Panel Test Apparatus. The apparatus shall be essentially as shown in Figures 2-1(a) and (b).

2-2 Test Chamber. The flooring radiant panel test chamber employed for this test shall be located in a draft-protected laboratory.

2-2.1 The flooring radiant panel test chamber [*see Figures 2-2.1(a) and (b)*] shall consist of an enclosure 1400 mm long × 500 mm wide × 710 mm high above the test specimen. The sides, ends, and top shall be of 13-mm calcium silicate board, of 0.74 g/cm^3 nominal density insulating material, and shall have a thermal conductivity at 177°C of 0.128 W/(m•K). One side shall be provided with an approximately 100-mm × 1100-mm, draft-tight, fire-resistant glass window so that the entire length of the test specimen can be observed from outside the fire test chamber. On the same side and below the observation window, there shall be a door that, when open, allows the specimen platform to be moved out for mounting or removal of test specimens. Where necessary for observation, a draft-tight, fire-resistant observation window shall be installed at the low flux end of the chamber.

2-2.2 The bottom of the test chamber shall consist of a sliding steel platform that has provisions for rigidly securing the test specimen holder in a fixed and level position.

2-2.2.1 The test specimen holder shall be level when in place and shall be secured to the specimen mounting platform.

Figure 2-1(a) Flooring radiant panel test apparatus.

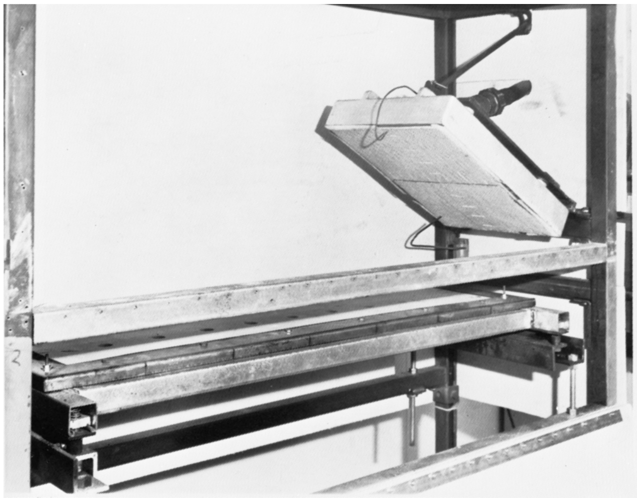


Figure 2-1(b) Flooring radiant panel test showing carpet specimen and gas-fueled panel.

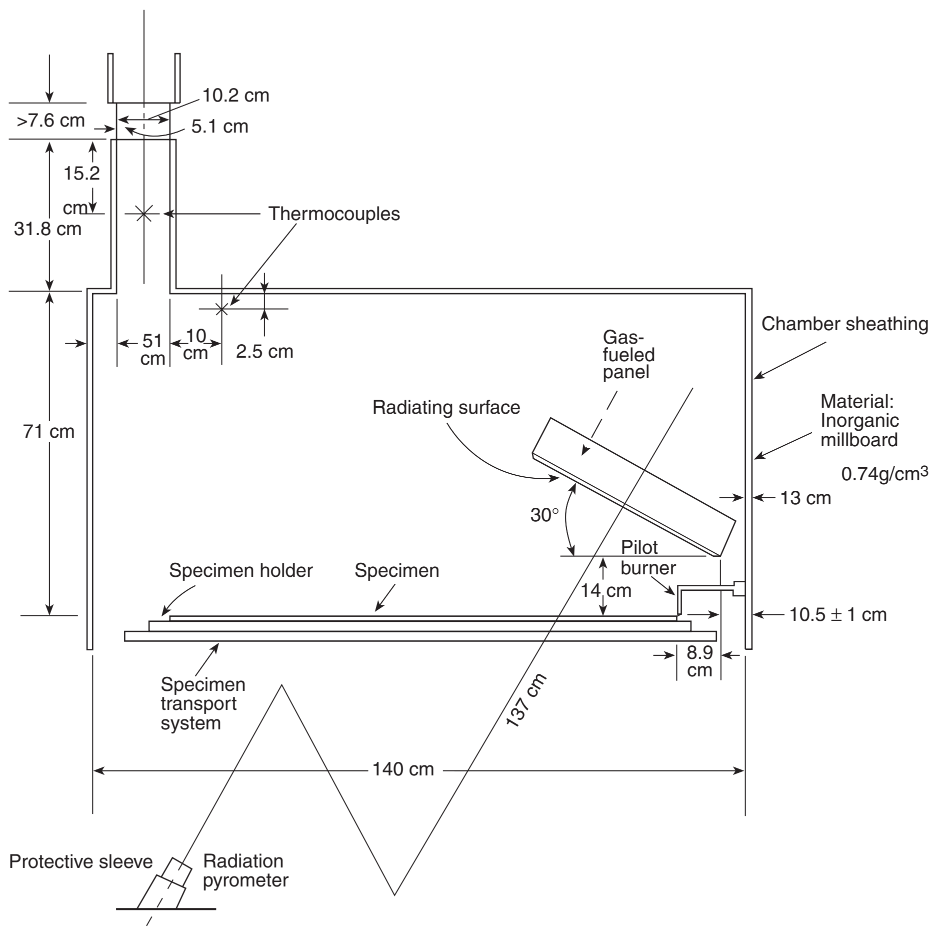
2-2.2.2 The free, or air access, area around the platform shall be 2580 cm^2 to 3225 cm^2.

2-2.3 The top of the chamber shall have an exhaust stack with interior dimensions of 102 mm ± 3 mm wide × 380 mm ± 3 mm deep × 318 mm ± 3 mm high at the opposite end of the chamber from the radiant panel.

2-3 Radiant Heat Energy Source.

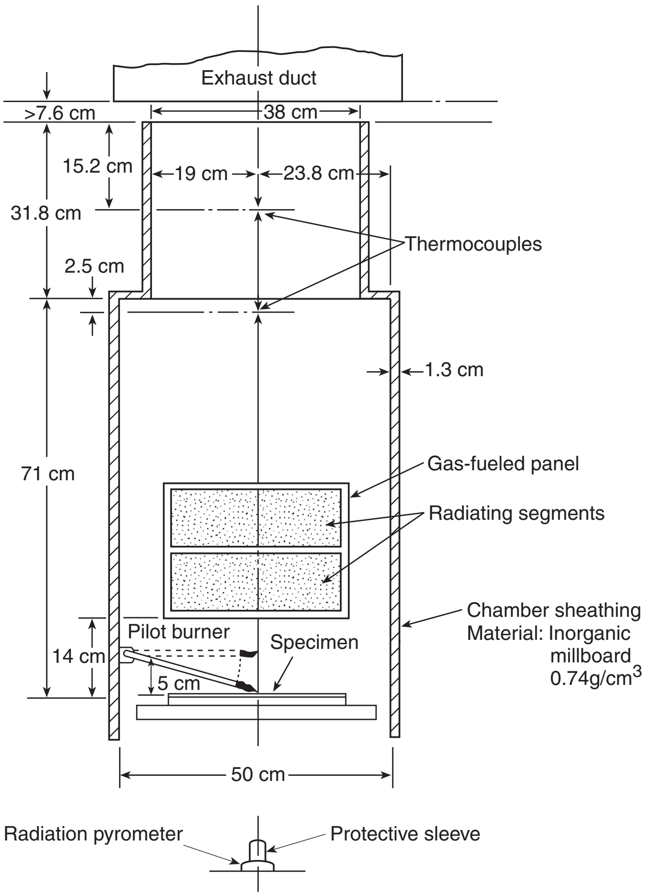
(a) The radiant heat energy source shall be a panel consisting of a porous refractory material mounted in a cast-iron frame or steel frame and having a radiation surface of 305 mm × 457 mm. It shall be capable of operating at temperatures up to 816°C.

(b) The panel fuel system shall consist of a venturi-type aspirator for mixing gas and air at approximately atmospheric pressure, a clean, dry air supply capable of providing 28.3 NTP m^3/hr at 76 mm of water column, and suitable instrumentation for monitoring and controlling the flow of fuel to the panel. The radiant heat energy panel shall be fired by propane, methane, or natural gas.



Note: in. = cm x 0.3937.

Figure 2-2.1(a) Flooring radiant panel tester schematic (side elevation).



Note: in. = cm × 0.3937.

Figure 2-2.1(b) Flooring radiant panel tester schematic (low flux elevation).

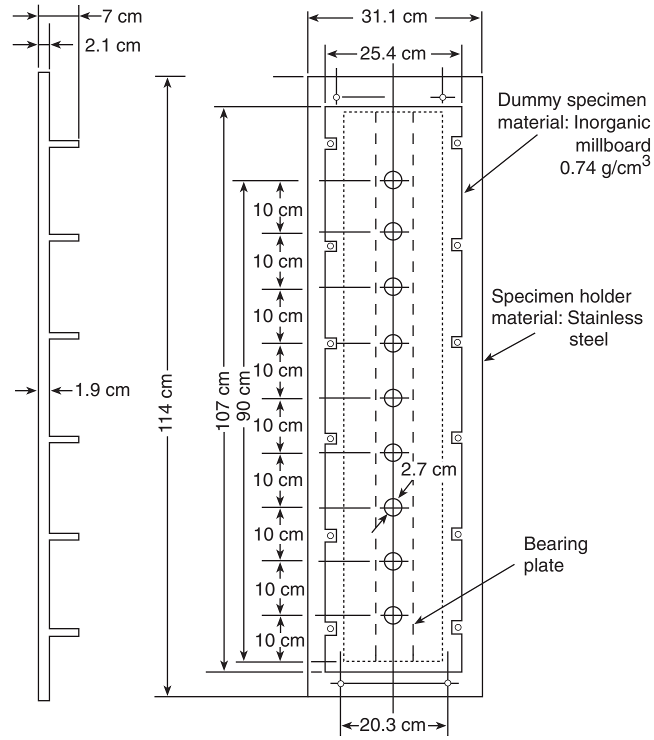
2-3.1 The radiant heat energy panel shall be mounted at 30 degrees to the horizontal specimen plane. The horizontal distance from the zero (0) mark on the specimen fixture to the bottom edge (projected) of the radiating surface of the panel shall be 89 mm.

The panel-to-specimen vertical distance shall be 140 mm [*see Figures 2-2.1(a) and (b)*]. The angle and dimension given above shall be followed to obtain the required radiant flux profile.

2-3.2 The radiation pyrometer for standardizing the thermal output of the panel shall be suitable for viewing a circular area 254 mm in diameter at a distance of about 1.37 m. It shall be calibrated over an operating blackbody temperature range of 490°C to 510°C in accordance with the procedure described in Appendix B.

2-3.3 A high impedance voltmeter or potentiometric voltmeter with a suitable millivolt range shall be used to monitor the output of the radiation pyrometer described in 2-3.2.

2-4* Specimen Holder. The specimen holder (*see Figure 2-4*) shall be constructed from heat-resistant stainless steel having a thickness of 1.98 mm, and an overall dimension of 1140 mm × 320 mm, with a specimen opening of 200 mm × 1000 mm. Six slots shall be cut in the flange on either side of the holder to reduce warping. The holder shall be fastened to the platform with two stud bolts at each end.



Note: in. = cm × 0.3937

Figure 2-4 Dummy specimen in specimen holder.

2-5 Pilot Burner.

2-5.1 The pilot burner used to ignite the specimen shall be a nominal 6-mm inside diameter, 10-mm outside diameter stainless steel tube line burner having nineteen evenly spaced 0.7-mm diameter (no. 70 drill) holes drilled radially along the centerline and sixteen evenly spaced 0.7-mm diameter (no. 70 drill) holes drilled radially 60 degrees below the centerline (*see Figure 2-5.1*). In operation, the gas flow is adjusted to a flow rate of 0.085 m^3/hr to 0.100 m^3/hr (air scale). With the gas flow properly adjusted and the pilot burner in the test position, the pilot flame shall extend from approximately 63.5 mm at either end to approximately 127 mm at the center.

2-5.1.1 The pilot burner shall be positioned no more than 5 degrees from the horizontal, so that the flame generated impinges on the specimen at the zero (0) distance burned point [*see Figures 2-2.1(a) and (b)*]. When not being applied to the specimen, the burner shall be capable of being moved at least 50 mm away from the specimen.

2-5.1.2 The holes in the pilot burner shall be kept clean. A soft wire brush shall be used to remove surface contaminants. Nickel-chromium or stainless steel wire or its equivalent with an outside diameter of 0.5 mm shall be used for opening the holes.

2-6 Thermocouples.

2-6.1 A 3.2-mm stainless steel-sheathed, grounded junction, Chromel-Alumel thermocouple shall be located in the flooring radiant panel test chamber. [*See Figures 2-2.1(a) and (b).*]

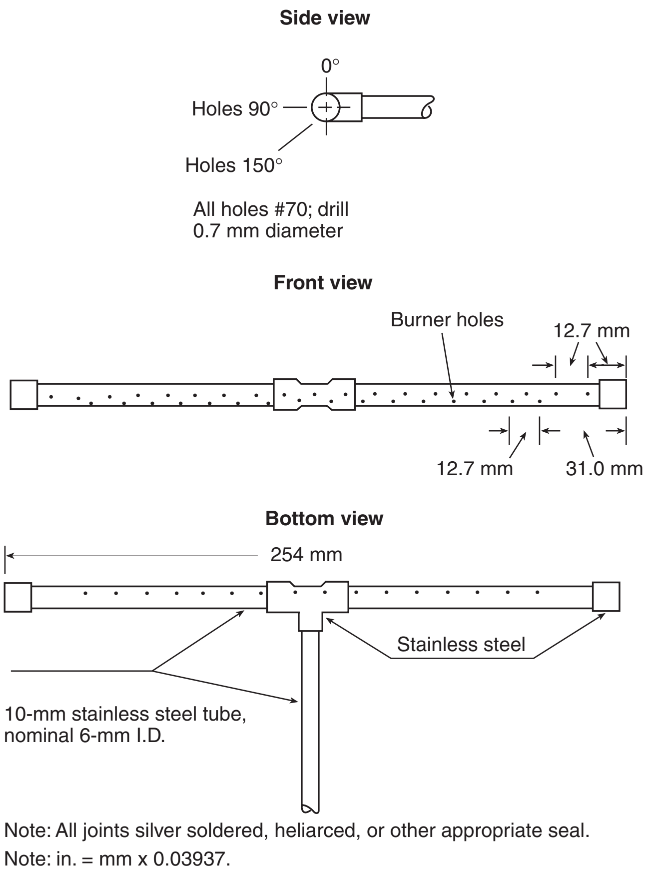


Figure 2-5.1 Pilot burner.

2-6.1.1 The thermocouple shall be kept clean to ensure the accuracy of the readout.

2-6.1.2 The chamber thermocouple shall be located in the longitudinal central vertical plane of the chamber, 25 mm down from the top and 102 mm back from the inside of the exhaust stack.

2-6.2 An indicating potentiometer with a range of 100°C to 500°C shall be used to determine the chamber temperature prior to the test.

2-7* Exhaust Hood. An exhaust duct with a capacity of 28.3 NTP m^3/min to 85 NTP m^3/min, decoupled from the chamber stack by at least 76 mm on all sides, and with an effective canopy area larger than the plane area of the chamber with the specimen platform in the out position, shall be used to remove combustion products from the chamber. With the panel turned on and the dummy specimen in place, the airflow rate through the stack shall be 76.2 m/min ± 15.2 m/min when measured with a hot wire anemometer 30 seconds after insertion of the probe into the center of the stack opening at a distance of 152 mm down from the top of the stack opening.

2-8 Dummy Specimen.

2-8.1 The dummy specimen, which is used in the flux profile determination, shall be made of 19-mm inorganic calcium silicate board, with a nominal density of 0.74 g/cm^3 (*see Figure 2-4*). It shall measure 250 mm × 1070 mm with 27-mm diameter holes located on the centerline at points ranging from 100 mm to 900 mm, spaced in 100-mm increments, starting at the maximum flux end of the specimen.

To provide proper and consistent seating of the flux meter in the hole openings, a stainless steel or galvanized steel bearing plate shall be mounted and secured firmly to the underside of the calcium silicate board with holes corresponding to those specified above. The bearing plate shall run the length of the dummy specimen and shall have a minimum width of 76 mm. The thickness of the bearing plate shall vary to maintain the flux meter height specified in 5-1.6 up to the maximum of 3.2 mm.

2-8.1.1* The total heat flux transducer used to determine the flux profile of the chamber in conjunction with the dummy specimen (*see 2-3.3*) shall have a range of 0 W/cm^2 to 1.5 W/cm^2 and shall be calibrated over the operating flux level range of 0.10 W/cm^2 to 1.5 W/cm^2 in accordance with the procedure outlined in Appendix B. A source of cooling water at 15°C to 25°C shall be provided for this instrument.

2-8.1.2 A high impedance voltmeter or potentiometric voltmeter with a range of 0 mv to 10 mv and reading to 0.01 mv shall be used to measure the output of the total heat flux transducer during the flux profile determination.

2-9 Timer. A timer reading to the nearest 0.1 minute shall be used to measure preheating, pilot contact, and flameout times.

Chapter 3 Test Specimens

3-1 Sampling Procedure.

3-1.1 The sample selected for testing shall be representative of the product.

3-1.2 ASTM sampling practice shall be followed.

3-2 Specimen Size and Mounting.

3-2.1 The test specimen shall be a floor covering system sized to provide for adequate clamping in the mounting frame. Its minimum dimensions shall exceed the frame width (200 mm nominal) and length (1000 mm nominal) by about 50 mm. Holes shall be made in the specimen to accommodate the mounting frame bolts. (*See Figure 2-4.*)

3-2.2 The floor covering system specimen shall simulate actual installation practice insofar as possible. Typical examples of floor covering systems are as follows:

(a) A hardwood floor nailed to a plywood subfloor, sanded and finished according to standard practice;

(b) A carpet with or without integral cushion pad bonded to a high density inorganic sheet simulating a concrete subfloor;

(c) A carpet mounted over the standard cushion or the standard simulated concrete subfloor;

(d) A carpet mounted over the actual cushion pad or a carpet mounted over the actual subfloor to be used in the installation;

(e) A resilient floor bonded to a high density inorganic sheet simulating a concrete subfloor.

3-2.3 A minimum of three specimens per sample shall be tested.

3-3 Specimen Conditioning. Test specimens shall be conditioned at 21°C ± 3°C and a relative humidity of 50 percent ± 5 percent horizontally or vertically in open racks for optimum air circulation for a minimum of 48 hours; carpet specimens that have been glued down shall be conditioned for a minimum of 96 hours. Conditioning shall be conducted in accordance with ASTM E171, *Standard Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials.*

Chapter 4 Safety Precautions

4-1 Gas-Air Fuel Explosions. The possibility of a gas-air fuel explosion in the test chamber shall be recognized. Suitable safeguards consistent with sound engineering practice shall be installed in the panel fuel supply system. Safeguards shall include one or more of the following:

(a) A gas feed cutoff activated when the air supply fails;

(b) A fire sensor directed at the panel surface that stops fuel flow when the panel flame goes out;

(c) A commercial gas water heater or gas-fired furnace pilot burner control thermostatic shutoff that is activated when the gas supply fails, or other suitable approved device.

Safeguards shall be arranged for a manual reset.

4-2 Exhaust System. The exhaust system shall be designed and operated so that the laboratory environment is protected from smoke and gas. Operator exposure to combustion products shall be minimized by following sound safety practice. The operator shall ensure that the exhaust system is working properly and shall wear appropriate clothing, including gloves.

Chapter 5 Radiant Heat Energy Flux Profile Standardization

5-1 Procedure.

5-1.1 In a continuing program of tests, the flux profile shall be determined at least weekly. Where the time interval between tests is greater than one week, the flux profile shall be determined at the start of the test series.

5-1.2 The dummy specimen shall be mounted in the mounting frame, and the assembly shall be attached to the sliding platform.

5-1.3 With the sliding platform outside the chamber, the radiant panel shall be ignited. The unit shall heat for $1^1/_2$ hours. The pilot burner shall be off during this determination. The fuel mixture shall be adjusted to provide an air-rich flame. Fuel flow shall be set to bring the panel blackbody temperature to about 500°C, and the chamber temperature shall be recorded.

5-1.4 When equilibrium has been established, the specimen platform shall be moved into the chamber and the door shall be closed.

5-1.5 The closed chamber shall be allowed to equilibrate for 30 minutes.

5-1.6 The radiant heat energy flux level shall be measured at the 400-mm point with the total flux meter instrumentation. This shall be accomplished by inserting the flux meter into the opening so that its detecting plane is 1.6 mm to 3.2 mm above and parallel to the plane of the dummy specimen and then reading its output after 30 sec ± 10 sec. If the level is within the limits specified in 5-1.7, the flux profile determination shall be started. Otherwise, the necessary adjustments in panel fuel flow shall be made. Data shall be recorded using the flux profile data log format shown in Appendix D, or equivalent.

5-1.7 The test shall be run under chamber operating conditions that provide a flux profile as shown in Figure 1-3. The radiant heat energy incident on the dummy specimen shall be as follows:

(a) Between 0.87 W/cm^2 and 0.95 W/cm^2 at the 200-mm point;

(b) Between 0.48 W/cm^2 and 0.52 W/cm^2 at the 400-mm point; and

(c) Between 0.22 W/cm^2 and 0.26 W/cm^2 at the 600-mm point.

5-1.8 The flux meter shall be inserted into the 100-mm opening following the procedure outlined in 5-1.6. The mv output shall be read at 30 sec ± 10 sec. The same procedure shall be repeated at the 200-mm point. The 300-mm to 900-mm flux levels shall be determined in the same manner. Following the 900-mm measurement, a reading check shall be made at 400 mm. The test chamber is in calibration when it is within the limits set forth in 5-1.7 and the profile determination is completed. Otherwise, the fuel flow shall be adjusted carefully, allowing 30 minutes for equilibrium, and the procedure shall be repeated.

5-1.9 The radiant heat energy flux data shall be plotted as a function of distance along the specimen plane on rectangular coordinate graph paper. The best smooth curve shall be drawn carefully through the data points. This curve is hereafter referred to as the flux profile curve.

5-1.10 The open chamber temperature and radiant panel blackbody temperature identified with the standard flux profile shall be determined by opening the door and moving the specimen platform outside the chamber. The chamber shall be allowed to equilibrate for 30 minutes. The chamber temperature and optical pyrometer output that indicate the panel blackbody temperature shall be read and recorded in degrees Celsius. These temperature settings shall be used in subsequent test work instead of measuring the dummy specimen radiant flux at 200 mm, 400 mm, and 600 mm.

Chapter 6 Test Procedure

6-1 Pretest Heating. With the sliding platform outside the chamber, the radiant panel shall be ignited. The unit shall be allowed to heat for $1^1/_2$ hours. A sheet of inorganic millboard, such as calcium silicate, or equivalent, shall be used to cover the opening when the hinged portion of the front panel is open and the specimen platform is moved out of the chamber. The millboard shall be used to prevent heating of the specimen and to protect the operator. The panel blackbody temperature and the chamber temperature shall be read. If these temperatures are in agreement to within ±5°C of those determined in accordance with 5-1.10, the chamber is ready for use.

6-2 Sample Mounting. The sample holder shall be inverted on a workbench and the flooring system shall be inserted. The steel bar clamps shall be placed across the back of the assembly and the nuts shall be tightened firmly. The sample holder shall be returned to its upright position, the test surface shall be cleaned with a vacuum, and the sample holder shall be mounted on the specimen platform. Carpet specimens shall be brushed to raise the pile to its normal position.

6-3 Ignition of Pilot Burner. The pilot burner shall be ignited, keeping it at least 50 mm away from the specimen, the specimen shall be moved into the chamber, and the door shall be closed. The timer shall be started. After 5 minutes, the chamber shall be preheated. With the pilot burner on and at least 50 mm away from the specimen, the pilot burner flame shall be brought into contact with the specimen at the zero (0) mm mark. The pilot burner flame shall remain in contact with the specimen for 5 minutes. It then shall be removed to a position at least 50 mm away from the specimen and the pilot burner flame shall be extinguished.

6-4 Flame Propagation of Specimen. If the specimen does not propagate flame within 5 minutes following pilot burner flame application, the test shall be terminated. For specimens that do propagate flame, the test shall be continued until the flame goes out. Significant phenomena such as melting, blistering, and penetration of flame to the substrate shall be observed and recorded.

6-5 Completion of Test. When the test is completed, the door shall be opened and the specimen platform shall be pulled out. The protective inorganic millboard sheet shall be put in place.

6-6 Data Collection and Recording. The distance burned shall be measured (i.e., the point of farthest advance of the flame front to the nearest 1 mm). The distance to W/cm^2 critical radiant heat flux at flameout shall be converted from the flux profile curve. Data shall be recorded using the data log format shown in Appendix D, or equivalent.

6-7 Removal of Specimen. The specimen and its mounting frame shall be removed from the movable platform.

6-8 Subsequent Testing. The succeeding test shall be started as soon as the panel blackbody and chamber temperatures are verified (*see 5-1.10*). The test assembly shall be at room temperature prior to start-up.

Chapter 7 Calculations

7-1 General. The mean, standard deviation, and coefficient of variation of the critical radiant flux test data on the three specimens shall be calculated in accordance with ASTM Manual 7, *Manual on Quality Control of Materials.*

$$S = \sqrt{\frac{(\Sigma X^2 - n\bar{X}^2)}{n-1}} \text{ and } V = \frac{S}{X} \times 100$$

where:

S = Estimated standard deviation

X = Value of single observation

n = Number of observations

X = Arithmetic mean of the set of observations

V = Coefficient of variation.

Chapter 8 Report

8-1 Required Information. The report shall include the following:

(a) Description of the floor covering system tested, including its elements;

(b) Description of the procedure used to assemble the floor covering system specimen;

(c) Number of specimens tested;

(d) Individual values of critical radiant flux;

(e) Average critical radiant flux, standard deviation, and coefficient of variation;

(f) Observations of the burning characteristics of the specimen during the testing exposure, such as delamination, melting, sagging, and shrinking.

Chapter 9 Referenced Publications

9-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

9-1.1 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM, Manual 7, *Manual on Quality Control of Materials.*
ASTM E171, *Standard Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials*, 1994.

9-1.2 U.S. Government Publication. General Services Administration, 18th and F Streets NW, Washington, DC 20405.

Type II—Rubber Coated Jute and Animal Hair or Fiber, Federal Specification DDD-C-001023 (GSA-FSS), Amendment 1, March 10, 1972.

Appendix A Explanatory Material

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

A-2-4 An acceptable heat-resistant stainless steel is AISI Type 300 (UNA-NO8 330) or equivalent.

A-2-7 An acceptable anemometer is an Omega HH-615 HT hot-wired anemometer manufactured by Omega Engineering Inc., Stamford, CT.

A-2-8.1.1 An acceptable heat flux transducer is a Schmidt-Boelter-type Medtherm 64-2-20, manufactured by Medtherm Corporation, Huntsville, AL.

Appendix B Procedure for Calibration of Apparatus

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

B-1 Radiation Pyrometer.

B-1.1 The radiation pyrometer should be calibrated by means of a conventional blackbody enclosure placed within a furnace and maintained at uniform temperatures of 490°C, 500°C, and 510°C. The blackbody enclosure can consist of a closed

Chromel metal cylinder with a small sight hole in one end. The radiation pyrometer is sighted on the opposite end of the cylinder where a thermocouple indicates the blackbody temperature. The thermocouple is placed within a drilled hole and in good thermal contact with the blackbody. When the blackbody enclosure has reached the appropriate temperature equilibrium, the output of the radiation pyrometer should be read. This procedure is repeated for each temperature.

B-1.2 As an alternative to the procedure described in B-1.1, a laboratory may be permitted to utilize the services of an outside agency to provide calibration traceable to the National Institute of Standards and Technology (NIST).

B-2 Total Heat Flux Meter.

B-2.1 The total flux meter should be developed by transfer calibration methods with a NIST-calibrated flux meter. This calibration should make use of the flooring radiant panel tester as the heat source. Measurements should be made at each of the nine dummy specimen positions, and the mean value of these results should be used to constitute the final calibration.

B-2.2 Each laboratory should maintain a dedicated, calibrated reference flux meter against which one or more working flux meters can be compared as needed. The working flux meters should be calibrated at least annually.

Appendix C Mounting Methods

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

C-1 Introduction. This appendix has been compiled as an aid in selecting a method for mounting various flooring materials in the fire test chamber. These mountings are recommended for test method uniformity and convenience.

C-2 Mounting Procedures.

C-2.1 Carpet and Cushion Pad over Concrete, Simulated. Carpet specimens should be cut in the machine direction. To mount a specimen, the holder should be inverted on a clean, flat surface. The test specimen should be inserted into the holder. The cushion pad then is inserted with the pattern side facing the carpet, followed by nominal 6.3-mm thick, fiber-reinforced, high density (762 kg/m^3 ± 80 kg/m^3) cement board and a 13-mm inorganic millboard with a density of 0.74 g/cm^3.[1] Finally, the steel bar clamps should be placed across the assembly and tightened firmly. The test assembly should be mounted on the specimen transport frame so that the pile lay faces the panel.

C-2.2 Carpet with or without Integral Cushion Pad Bonded to Concrete, Simulated. Carpet specimens should be cut in the machine direction. The adhesive used should be that which is recommended by the carpet manufacturer.[2] The adhesive needs to be applied to the smooth side of the fiber-reinforced cement board in accordance with the directions provided by the adhesive manufacturer.[3] A nominal 9.1-kg roller with a diameter of 76 mm and a width approximately that of the specimen should be used to apply the adhesive across the top of the specimen to ensure good contact with the substrate. Specimens may be permitted to be stacked under a dead load after bonding specimens to the fiber-reinforced cement board for no more than 24 hours prior to conditioning (*see Section 3-3 for storage and conditioning requirements*). The specimen should be mounted in the testing frame as described in C-2.1 and should be tested in accordance with standard procedure.

C-2.3 Carpet, Other. The actual subfloor may be permitted to be substituted for the standard fiber-reinforced cement board substrate.

C-3 Resilient Flooring. Commercial installation practice should be followed or simulated, or both. In most instances, this necessitates bonding to the standard fiber-reinforced cement substrate.

C-4 Hardwood Flooring. Commercial installation practice should be followed or simulated, or both. In a typical system, the substrate is a 16-mm plywood sheet covered with building paper. The oak flooring strips are nailed to the plywood and then sanded, sealed, and waxed. The assembly should be tested with the moisture content of the oak at 7 percent to 8 percent.

Appendix D Sample Data Log

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

D-1 Radiant Flux Profile Data Log.

Date____

Blackbody temperature __________ mv ____________ °C

Gas flow_________________________ NTP m^3/hr

Airflow___________________________ NTP m^3/hr

Room temperature__________________________°C

Pressure: Air _______ cm of H_2O; Gas ___________ cm of H_2O

Flux meter radiometer no.______________ Conversion factor from calibration on ____________

Distance (cm)	mv	W/cm^2
10	__________	__________
20	__________	__________
30	__________	__________
40	__________	__________
50	__________	__________
60	__________	__________
70	__________	__________
80	__________	__________
90	__________	__________

Signed _____________________________________

[1] The fiber-reinforced cement board might spall during a test. This can be avoided by heating for 12 hours at 163°C.

[2] In the absence of a manufacturer's recommendation, a multipurpose adhesive typical of commercial installation shall be selected by the laboratory.

[3] In the absence of a manufacturer's recommendation, the adhesive should be applied with a 3.2-mm V-notched trowel.

D-2 Flooring Radiant Panel Test Data Log.

Test no. ____________ Date ___________ Time _______________
Laboratory ____
Specimen identification/code no. _________________________
Test Assembly
Panel: Angle _______degrees; Temperature ________ °C
Flow: Gas __________ NTP m^3/hr; Air ____________ NTP m^3/hr
Pressure, initial:
Air _________cm of H_2O; Gas ____________ cm of H_2O
Chamber temperature:
Initial ________ °C; Maximum _______________ °C
Room temperature ______________________________ °C
Hood draft _________________________________ cm of H_2O

Flame Front Advance

Distance (cm)	Time (min)				
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________
________	________	________	________	________	________

Total burn length ____________________________________ cm
Critical radiant flux ____________________________ W/cm^2
Flame front out_____ min; Flux profile reference ___________
All flame out___________________________ min
Observations
Signed ____

Appendix E Commentary on Critical Radiant Flux Test

This Appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

E-1 Introduction.

E-1.1 The development and behavior of fires in buildings and rooms or compartments are complex phenomena and are not well understood. As a result, efforts to establish safety requirements must, for the present, be based on the selection and use of those components of the fire system that might become involved and that can be regulated. These efforts, together with experienced engineering rationale, must serve until a more valid technical basis for fire engineering design has been determined.

E-1.2 When fire develops in a building, experience suggests that the traditional floor covering systems have seldom served as a medium for fire spread during the early stages of a fire. During several fires in the early 1970s, floor covering materials in corridors became involved for considerable distances. The test method that is described in this standard has been recommended as a means to control potential fire spread in floor covering systems.

E-1.3 Since the quantity and nature of room furnishing items cannot at present be controlled with regard to fire involvement of the full room, it is necessary to assume that floor involvement can and will, on occasion, occur. It is appropriate to recommend the application of only those floor covering systems meeting high levels of resistance to fire involvement based on critical radiant flux for use in corridors. Building codes cover interior finish in general, and it appears that only in corridors do the requirements for floor covering systems need to be more restrictive.

E-1.4 This appendix is intended to provide information on the technical relevance of the test method to the problem of fires. It is intended to provide both the technical and lay public with a basis for interpreting the significance and limitations of the data resulting from the test.

E-2 Nature of the Test.

E-2.1 Convective heat flow cannot serve as a major feedback mechanism in most cases of fires involving floor covering systems because of the buoyancy of the flames and hot gases. Therefore, these horizontal surfaces of building finishes seldom have been recognized as primary hazards in the spread of flames. However, corridor fire tests conducted at NIST together with building fire incidents have indicated that fire spread can occur in corridors exposed to burnout conditions in adjacent rooms.[1, 2] Fires were observed to propagate the full length of the corridor where little, if any, combustible other than the floor covering system was involved in the corridor finish. Analysis of the measurements made during such tests has made clear the importance of radiant heat transfer from upper corridor surfaces, flame, smoke, and gases in serving a fire-support role. Therefore, the sensitivity of a floor covering system to the radiant support of combustion is recommended as a basis for ranking floor covering systems with respect to fire behavior.[3,4] Critical radiant flux, the heat flux level below which surface flame spread will not occur, was selected as the floor covering system fire property of controlling importance. If a room fire does not impose a radiant flux that exceeds this critical level on a corridor floor covering system, flame spread will not occur.

E-2.2 Critical radiant flux does not provide information on the irradiance level to which the flooring is exposed when fire occurs. This is influenced largely by other variables that include:

(a) The nature, quantity, and arrangement of the fire load in the compartment where ignition occurs.

(b) The ventilation conditions in the portion of the building that becomes exposed to fire.

(c) The geometry of the compartment and ventilation passages.

(d) The heat release rate of the fire load and the floor covering system.

(e) The heat capacity of the enclosing walls, ceiling, and floors.

E-3 Experimental Studies of Relevance.

E-3.1 One important fire property of floor covering systems has been identified that, if the effective irradiance level can be predicted when fire occurs, can provide information on the extent of fire spread possibility. The use of this property alone, at least in some cases, is inadequate for the prediction of fire spread under severe exposure conditions. For instance, Figure