NFPA 288

Standard Methods of Fire Tests of Floor Fire Door Assemblies Installed Horizontally in Fire Resistance–Rated Floor Systems

2001 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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This edition of NFPA 288, *Standard Methods of Fire Tests of Floor Fire Door Assemblies Installed Horizontally in Fire Resistance–Rated Floor Systems,* was prepared by the Technical Committee on Fire Tests and acted on by NFPA at its May Association Technical Meeting held May 13–17, 2001, in Anaheim, CA. It was issued by the Standards Council on July 13, 2001, with an effective date of August 2, 2001.

This edition of NFPA 288 was approved as an American National Standard on August 2, 2001.

Origin and Development of NFPA 288

The development of this edition is in recognition that there are currently no specific test procedures that can be appropriately used for the testing of floor fire doors. This test procedure was developed in response to inquiries from outside sources to investigate and establish a testing procedure for these particular products. NFPA 80, *Standard for Fire Doors and Fire Windows,* has a reference for horizontal access doors in 11.2.1. It requires these assemblies to be tested in a horizontal position in accordance with the procedure described in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials.*

NFPA 251 notes in 1.3.4(f) that the test standard does not provide for the effect on fire endurance of conventional openings in the assembly unless specifically provided for in the construction tested. This provision would limit the testing of the floor fire door to the particular floor/ceiling or roof assembly used. Prior to this test method being developed there were a couple of testing laboratories providing testing and labeling of these products. There were many test protocols that had to be assumed, which would create inconsistency in the testing procedures and listing requirements.

This test procedure will provide for consistency in the testing and listing of these particular products. The test procedure has incorporated existing provisions as found in NFPA 251 and NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* when appropriate.

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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 Annex A.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard shall apply to floor fire door assemblies of various materials and types of construction that are installed horizontally in openings of fire resistance–rated floor systems to retard the passage of fire.

1.1.2 Tests made in conformity with this test method demonstrate the performance of floor fire door assemblies during the test exposure. However, such tests shall not be construed as determining the suitability of floor fire door assemblies for use after their exposure to fire.

1.2 Purpose. This test method develops data used to determine the ability of a floor fire door assembly to protect openings in fire resistance–rated floors.

1.3 Application.

1.3.1 This test method evaluates the performance of a floor fire door assembly as follows:

(1) By measuring the ability of the floor fire door to remain in an opening and resist the passage of flame and heat during a predetermined test exposure
(2) By measuring the load-carrying ability of the test specimen during the fire test

1.3.2 This test method shall expose a specimen to a standard fire that is controlled to achieve specified temperatures throughout a specified time period. However, the exposure is not representative of all fire conditions, as fire conditions can vary with changes in the amount, nature, and distribution of fire loading; ventilation; compartment size and configuration; and the thermal-physical properties of the compartment wall, ceiling, and floors. The exposure shall provide a relative measure of the fire performance of floor fire door assemblies under the specified fire exposure conditions.

1.3.3 This test method does not provide the following:

(1) Information on the performance of floor fire door assemblies in floors that are constructed of materials other than those tested
(2) An evaluation of the degree to which a floor fire door assembly contributes to the fire hazard through the generation of smoke, toxic gases, or other products of combustion
(3) A measurement of the degree of control or limitation of the passage of smoke or products of combustion through the floor fire door assembly
(4) Measurement of flame spread over the surface of the floor fire door assembly

Chapter 2 Referenced Publications (Reserved)

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not included, common usage of the terms shall apply.

3.2 NFPA Official Definitions.

3.2.1 Shall. Indicates a mandatory requirement.

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

3.2.3 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definition.

3.3.1 Floor Fire Door Assembly. A combination of a fire door, a frame, hardware, and other accessories installed in a horizontal plane, which together provide a specific degree of fire protection to a through-opening in a fire resistance–rated floor.

Chapter 4 Control of Fire Test

4.1 Time–Temperature Curve.

4.1.1 The fire exposure of floor fire door assemblies shall be controlled to conform to the applicable portion of the standard time–temperature curve shown in Figure 4.1.1.

4.1.2 The standard time–temperature curve shall be defined by the points specified in Table 4.1.2.

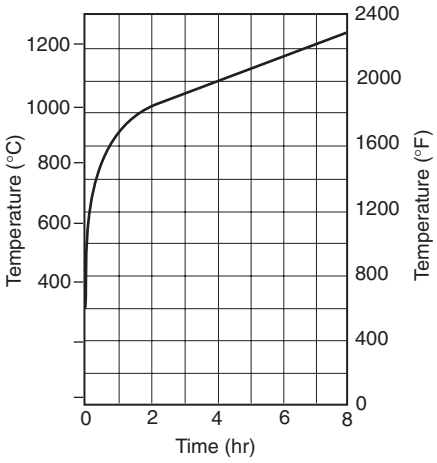
4.1.3 The temperature inside the furnace at the start of the test shall be ambient.

4.2 Furnace Temperature Measurements.

4.2.1 The temperature fixed as specified in Section 4.1 shall be the average temperature that is obtained from the readings of not less than nine thermocouples, which are symmetrically disposed and distributed to show the temperature near all parts of the sample. The thermocouples shall be enclosed in protection tubes of such materials and dimensions that the time constant of the protected thermocouple assembly lies within the range of 5.0 minutes to 7.2 minutes. The exposed length of the pyrometer tube and thermocouple in the furnace chamber shall be not less than 305 mm (12 in.). Other types of protecting tubes or pyrometers shall be permitted to be used that, under test conditions, provide the same time range specified above within the accuracy requirement that applies for the measurement of furnace temperature. The junction of the thermocouples shall be placed 305 mm

Table 4.1.2 Standard Time–Temperature Curve for Control of Fire Tests

Time (hr:min)	Temperature (°C)	Area Above 20°C Base		Temperature (°F)	Area Above 68°F Base	
		°C-min	°C-hr		°F-min	°F-hr
0:00	20	0	0	68	0	0
0:05	538	1,290	22	1000	2,330	39
0:10	704	4,300	72	1300	7,740	129
0:15	760	7,860	131	1399	14,150	236
0:20	795	11,650	194	1462	20,970	350
0:25	821	15,590	260	1510	28,050	468
0:30	843	19,650	328	1550	35,360	589
0:35	862	23,810	397	1584	42,860	714
0:40	878	28,060	468	1613	50,510	842
0:45	892	32,390	540	1638	58,300	971
0:50	905	36,780	613	1661	66,200	1,103
0:55	916	41,230	687	1681	74,220	1,237
1:00	927	45,740	762	1700	82,330	1,372
1:05	937	50,300	838	1718	90,540	1,509
1:10	946	54,910	915	1735	98,830	1,647
1:15	955	59,560	993	1750	107,200	1,787
1:20	963	64,250	1,071	1765	115,650	1,928
1:25	971	68,990	1,150	1779	124,180	2,070
1:30	978	73,760	1,229	1792	132,760	2,213
1:35	985	78,560	1,309	1804	141,420	2,357
1:40	991	83,400	1,390	1815	150,120	2,502
1:45	996	88,280	1,471	1826	158,890	2,648
1:50	1,001	93,170	1,553	1835	167,700	2,795
1:55	1,006	98,080	1,635	1843	176,550	2,942
2:00	1,010	103,020	1,717	1850	185,440	3,091
2:10	1,017	112,960	1,882	1862	203,330	3,389
2:20	1,024	122,960	2,049	1875	221,330	3,689
2:30	1,031	133,040	2,217	1888	239,470	3,991
2:40	1,038	143,180	2,386	1900	257,720	4,295
2:50	1,045	153,390	2,556	1912	276,110	4,602
3:00	1,052	163,670	2,728	1925	294,610	4,910
3:10	1,059	174,030	2,900	1938	313,250	5,221
3:20	1,066	184,450	3,074	1950	332,000	5,533
3:30	1,072	194,940	3,249	1962	350,890	5,848
3:40	1,079	205,500	3,425	1975	369,890	6,165
3:50	1,086	216,130	3,602	1988	389,030	6,484
4:00	1,093	226,820	3,780	2000	408,280	6,805
4:10	1,100	237,590	3,960	2012	427,670	7,128
4:20	1,107	248,430	4,140	2025	447,180	7,453
4:30	1,114	259,340	4,322	2038	466,810	7,780
4:40	1,121	270,310	4,505	2050	486,560	8,110
4:50	1,128	281,360	4,689	2062	506,450	8,441
5:00	1,135	292,470	4,874	2075	526,450	8,774
5:10	1,142	303,660	5,061	2088	546,580	9,110
5:20	1,149	314,910	5,248	2100	566,840	9,447
5:30	1,156	326,240	5,437	2112	587,220	9,787
5:40	1,163	337,630	5,627	2125	607,730	10,129
5:50	1,170	349,090	5,818	2138	628,360	10,473
6:00	1,177	360,620	6,010	2150	649,120	10,819
6:10	1,184	372,230	6,204	2162	670,000	11,167
6:20	1,191	383,900	6,398	2175	691,010	11,517
6:30	1,198	395,640	6,594	2188	712,140	11,869
6:40	1,204	407,450	6,791	2200	733,400	12,223
6:50	1,211	419,330	6,989	2212	754,780	12,580
7:00	1,218	431,270	7,188	2225	776,290	12,938
7:10	1,225	443,290	7,388	2238	797,920	13,299
7:20	1,232	455,380	7,590	2250	819,680	13,661
7:30	1,239	467,540	7,792	2262	841,560	14,026
7:40	1,246	479,760	7,996	2275	863,570	14,393
7:50	1,253	492,060	8,201	2288	885,700	14,762
8:00	1,260	504,420	8,407	2300	907,960	15,133



Note: The following are the points that determine the curve:

538°C (1000°F) .....at 5 minutes
704°C (1300°F) .....at 10 minutes
843°C (1550°F) .....at 30 minutes
927°C (1700°F) ..... at 1 hour
1010°C (1850°F) ..... at 2 hours
1093°C (2000°F) ..... at 4 hours
1260°C (2300°F) ..... at 8 hours or over

FIGURE 4.1.1 Standard time–temperature curve.

(12 in.) away from the exposed face of the specimen at the beginning of the test and, during the test, shall not touch the sample as a result of the sample's deflection.

4.2.2 The temperatures shall be measured at intervals not exceeding 1 minute during the test period.

4.2.3 The accuracy of the furnace control shall be such that the area under the time–temperature curve, obtained by averaging the results from the thermocouple readings, is within 10 percent of the corresponding area as specified in Table 4.1.2 for fire tests of 1 hour or less duration, within 7.5 percent for those tests lasting more than 1 hour and not more than 2 hours, and within 5 percent for tests exceeding 2 hours' duration.

4.3 Temperatures of Unexposed Surfaces.

4.3.1* Measurements. Temperatures of unexposed surfaces shall be measured with thermocouples or with thermometers placed under thermocouple pads.

4.3.1.1 Thermocouple pads shall meet the following requirements or shall be otherwise demonstrated to be equivalent by comparative tests:

(1) Length and width — 1.52 mm ± 3.2 mm (6 in. ± ⅛ in.)
(2) Thickness — 10.2 mm ± 1.3 mm (0.40 in. ± 0.05 in.)
(3) Thermal conductivity [at 65°C (150°F)] — 0.55 ± 0.039 W/m·K (0.38 ± 0.027 Btu·in./hr·ft^2·°F)

4.3.1.2 The wire leads of the thermocouple or the stem of the thermometer shall have an immersion under the pad and shall be in contact with the unexposed surface for not less than 90 mm (3½ in.). The hot junction of the thermocouple, or the bulb of the thermometer, shall be placed under the approximate center of the pad. The outside diameter of protecting or insulating tubes and of thermometer stems shall not exceed 8 mm (5⁄16 in.). The pad shall be held firmly against the surface and shall fit closely about the thermocouples or thermometer stems. Thermometers shall be of the partial-immersion type, with a length of stem, between the end of the bulb and the immersion mark, of 76 mm (3 in.). The wires for the thermocouple in the length covered by the pad shall be not heavier than No. 18 B & S gauge [1.02 mm (0.04 in.)] and shall be electrically insulated with heat-resistant and moisture-resistant coatings.

4.3.2 Location. Temperature measurements shall be obtained from at least nine points on the surface, as detailed in 4.3.2.1 through 4.3.2.4.

4.3.2.1 Five thermocouples shall be symmetrically disposed, of which one shall be located approximately at the center of the floor fire door assembly and four shall be located approximately at the center of each quadrant. The other four of the nine thermocouples shall be located at the discretion of the testing agency to obtain representative information on the performance of the assembly under test.

4.3.2.2 All of the thermocouples shall be located at a minimum distance of 1½ times the thickness of the construction or 305 mm (12 in.) from the edges of the test specimen.

4.3.2.3 The thermocouples shall be located opposite or on top of structural members if temperatures at such points will be lower than at more representative locations.

4.3.2.4 The thermocouples shall be located over fasteners such as screws, nails, or staples that will be higher or lower in temperature than at a more representative location, where if the aggregate area of any part of such fasteners on the unexposed surface is less than 1 percent of the area within any 152-mm (6-in.) diameter circle, unless the fasteners extend through the assembly.

4.3.3 The temperature shall be measured at intervals not exceeding 1 minute during the test period.

4.3.4 The temperature end point of the fire exposure period shall be determined by the average of the measurements taken at individual points.

4.3.5 Where a temperature rise of 181°C (325°F) occurs at any one of these points, the fire exposure period shall be judged as determined in accordance with 7.1.1.

4.4 Furnace Pressure.

4.4.1 The furnace pressure-sensing probes shall be as shown in Figure 4.4.1(a) or Figure 4.4.1(b).

4.4.2 The pressure shall be measured using a differential pressure instrument capable of reading in increments no coarser than 2.5 Pa (0.01 in. wg) with a precision of ±1.25 Pa (±0.005 in. wg). The differential pressure measurement instrument(s) shall be located to minimize "stack" effects caused by vertical runs of pressure tubing between the furnace probe(s) and instrument locations.

4.4.3 The furnace pressure(s) shall be measured and recorded at intervals not exceeding 1 minute during the test period.

4.4.4 Control of the furnace pressure shall be established no later than 10 minutes after the start of the test and shall be maintained throughout the remainder of the test. The pressure shall be measured at two locations along the centerline of the specimen and 300 mm (12 in.) below the specimen. The pressure — the average of the two readings during the test — shall be reported.

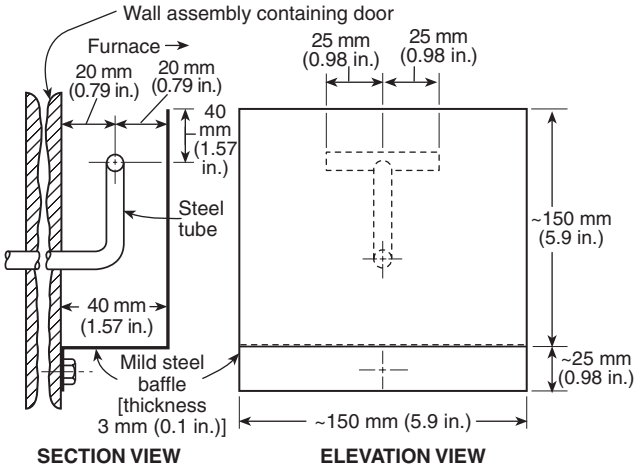


FIGURE 4.4.1(a) Static pressure-measuring device dimensions.

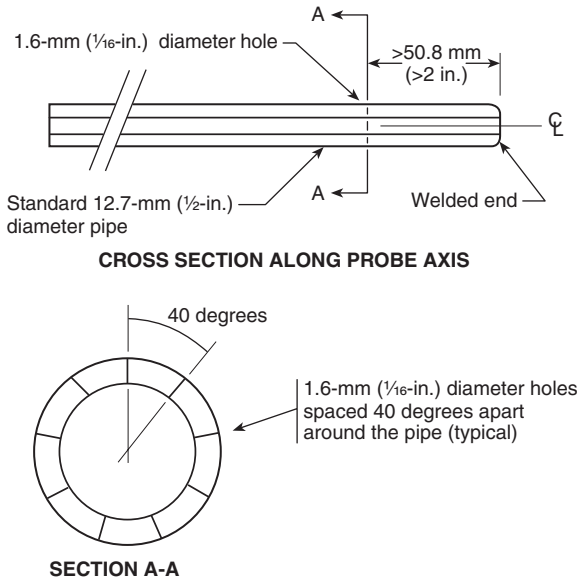


FIGURE 4.4.1(b) Pressure-sensing probe.

Chapter 5 Test Specimen

5.1 Construction and Size.

5.1.1 The construction and size of a test floor fire door assembly, which can include single doors or doors in pairs, shall be representative of the type of assembly for which the classification or rating is desired. A floor fire door assembly shall be tested in the largest size for which a classification is desired.

5.1.2 This test procedure shall apply to floor assemblies with or without attached, furred, or suspended ceilings and requires application of fire exposure to the underside of the specimen being tested.

5.1.3 The floor in which the floor fire door assembly is tested shall be adequate to retain the assembly throughout the fire test.

5.1.4 Door frame anchors, where used, shall be suitable for the floor construction.

5.2 Mounting.

5.2.1 Floor fire doors shall be mounted either to open downward into the furnace chamber or upward away from the furnace, according to the individual design. However, floor fire doors shall be mounted on the furnace chamber in the same manner as they are to be installed in buildings.

5.2.2 Floor fire door frames shall be evaluated when mounted to verify that the doors open either away from or into the furnace to obtain representative information on the performance of the floor fire door assembly being tested.

5.2.3 The mountings of all floor fire doors shall not prevent free and easy operation of the test door.

5.3 Clearances.

5.3.1 Floor fire doors shall be installed with the maximum clearance between the door and the frame as specified by the manufacturer.

5.3.2 There shall be no openings through the floor fire door assembly when viewed perpendicular to the face of the door.

5.4 Protection and Conditioning.

5.4.1 The floor fire door assembly and test specimen shall be protected during and after fabrication to ensure their quality and condition when tested.

5.4.2 For test assemblies employing concrete, the test shall not be conducted until the floor system is close to its full strength, and, if it contains moisture, until the test assembly achieves an air-dry condition in accordance with the requirements of 5.4.2.1 and 5.4.2.2.

5.4.2.1* Prior to the fire test, the test specimen construction shall be conditioned to provide a moisture condition that is representative of that which is likely to exist in similar construction in buildings. For purposes of standardization, the moisture condition shall be considered to be that which would exist at equilibrium as a result of drying the specimen in an ambient atmosphere of 50 percent relative humidity at 23°C (73°F). Specimens shall be permitted to be tested when a portion of the structure that is 152 mm (6 in.) below the surface has achieved a moisture content that corresponds to drying to equilibrium with air that is in the range of 50 percent to 75 percent relative humidity at 23°C ± 3°C (73°F ± 5°F).

5.4.2.1.1 When the laboratory finds that specimens dried in a heated building fail to meet the requirements of 5.4.2.1 after a 12-month conditioning period these requirements shall be permitted to be waived.

5.4.2.1.2 In the event that the nature of the construction is such that drying of the specimen interior is prevented by hermetic sealing, the requirements of 5.4.2.1 shall be permitted to be waived.

5.4.2.2* Within 72 hours prior to the fire test, information on the actual moisture content and distribution within the floor system and test specimen shall be obtained. The information shall be included in the test report.

5.4.3 The testing equipment and test specimen undergoing the fire test shall be protected from any condition of wind or weather that might lead to abnormal results.

5.4.3.1 The ambient air temperature at the beginning of the test shall be 10°C to 32°C (50°F to 90°F).

5.4.3.2 The velocity of air across the unexposed surface of the test specimen, measured immediately before the test begins, shall not exceed 1.3 m/sec (4.4 ft/sec) as determined by an anemometer placed at a right angle to the unexposed surface.

5.4.3.3 If mechanical ventilation is used during the test, an airstream shall not be directed across the surface of the specimen.

Chapter 6 Implementation of Fire Test

6.1 Fire Test. The fire test shall be continued until the exposure period of the desired classification or rating is reached, unless the conditions of acceptance that are required in Chapter 8 are exceeded in a shorter period.

6.2 Furnace Pressure. Except for the first 10 minutes of the fire test, the furnace pressure shall be at least 2.5 Pa (0.01 in. wg) greater than the pressure on the unexposed side of the assembly.

6.3 Loading. Throughout the fire test, a superimposed load shall be applied to the specimen to simulate the maximum load condition.

6.3.1 The maximum load condition shall be, as nearly as practicable, the maximum load allowed by the limiting condition of the design under nationally recognized structural design criteria for the floor in which the door is installed.

6.3.2 A fire test shall be permitted to be conducted by applying a restricted load condition to the specimen that shall be identified for a specific load condition other than the maximum permitted load condition.

Chapter 7 Reporting Results

7.1 Results. Results shall be reported based on performance in the tests specified in this standard. The report shall include the following information.

7.1.1 The performance of the floor fire door assembly shall be reported for one of the following desired exposure periods:

(1) 30 minutes
(2) ¾ hour
(3) 1 hour
(4) 1½ hours
(5) 2 hours
(6) 3 hours and over (in hourly increments)

7.1.2 The temperature measurements of the furnace shall be reported.

7.1.3 The temperature measurements of the unexposed surface shall be reported.

7.1.4 The pressure measurements made inside the furnace shall be reported.

7.1.5 All observations that have a bearing on the performance of the test assembly shall be reported.

7.1.6 Flaming, if any, on the unexposed surface of the door leaf shall be reported.

7.1.7 The amount of movement of any portion of the edges of the door adjacent to the door frame from the original position shall be reported as referenced in Chapter 8.

7.1.8 The materials and the construction of the floor fire door, frame, and floor assembly in which it was installed and the details of the installation, hardware, door frame, and anchors, hangers, guides, trim, finish, and clearance or lap shall be recorded or appropriately referenced to ensure positive identification or duplication in all respects.

7.1.9 Reports of tests in which loading is used shall describe the following:

(1) How the applied load was calculated
(2) The design standard used
(3) The details of the system used to apply the load
(4) The time of load application relative to the start and finish of the test

7.1.10 Reports for tests in which other than maximum load conditions as referenced in Section 6.3 are imposed shall define the conditions of loading used in the test and shall designate "restricted load condition" in the title of the test report.

7.1.11* Where the indicated resistance period is ½ hour or more, as determined by the average or maximum temperature rise on the unexposed surface or within the test specimen, or by failure under load as referenced in Section 6.3, an adjustment shall be made for variation of the furnace exposure from that prescribed, in those cases where the fire test exposure affects the classification, by multiplying the indicated resistance period by two-thirds of the difference in the area between the curve of the average furnace temperature and the standard curve for the first three-fourths of the period and then dividing the product by the area between the standard curve and a baseline of 20°C (68°F) for the same portion of the indicated period. The latter area shall be increased by 30°C-hr or 54°F-hr (1800°C-min or 3240°F-min) to compensate for the thermal lag of the furnace thermocouples during the first part of the test. For fire exposure that occurs during the test that is higher or lower than standard, the indicated resistance period shall be increased or decreased by the amount of the correction above or below, respectively, for fire exposure that differs from the standard.

Chapter 8 Conditions of Acceptance

8.1 General. A floor fire door assembly shall be considered as meeting the requirements for acceptable performance when it remains in the opening during the fire tests and complies with the following conditions.

8.1.1 The test assembly shall withstand the fire test without developing any openings through the assembly that can be seen from the unexposed side when observing the location of the suspected opening when viewed perpendicular to the plane of the assembly.

8.1.2 The specimen shall sustain the applied load during the classification period without developing unexposed surface conditions that ignite cotton waste.

8.1.3 The transmission of heat through the specimen during the classification period shall not raise the average temperature on its unexposed surface more than 139°C (250°F) above

its initial temperature. Additionally, a temperature rise of 181°C (325°F) shall not be exceeded at any one point.

8.1.4 Hardware shall secure the floor fire door in the closed position in accordance with the conditions of acceptance. In addition, the latch bolt shall remain projected and shall be intact after the test. The hardware shall not be required to be operable following the test.

8.1.5 The movement of floor fire doors shall not result in any portion of the edges that are adjacent to the door frame moving in a direction that is perpendicular to the plane of the floor fire door for a distance from its original position that is greater than the thickness of the door during the fire tests.

8.1.6 The movement of floor fire doors mounted in pairs shall not result in any portion of the meeting edges moving from its original position a distance that is greater than the thickness of the door away from the adjacent door edge in a direction that is perpendicular to the plane of the doors during the fire tests.

8.1.7 Door frames to be evaluated with doors shall remain securely fastened to the floor on all sides and shall not permit through-openings between the frame and the doors or between the frame and the adjacent floor.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.4.3.1 Under certain conditions, it is unsafe or impracticable to use thermometers.

The unexposed surface is the surface that is exposed to ambient air.

Additional information on refractory pads can be found in Section B.1.

A.5.4.2.1 If, during the conditioning of the specimen, it appears desirable or is necessary to use accelerated drying techniques, the laboratory conducting the test is responsible for avoiding procedures that significantly alter the structural or fire endurance characteristics of the floor system, test specimen, or both, from those produced as the result of drying in accordance with the procedures required in 5.4.2.1.

See Appendix I of *A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity* for a recommended method for determining the relative humidity within a hardened concrete specimen with electric sensing elements. A similar procedure with electric sensing elements can be used to determine the relative humidity within fire test specimens made with other materials.

With wood constructions, the moisture meter based on the electrical resistance method can be used, where appropriate, as an alternative to the relative humidity method to indicate when wood has attained the proper moisture control. Electrical methods are described on pages 320 and 321 of the 1955 edition of the *Wood Handbook of the Forest Products Laboratory*, U.S. Department of Agriculture. The relationships between relative humidity and moisture content are illustrated by the graphs in Figure 23 on page 327 of this publication. They indicate that wood has a moisture content of 13 percent at a relative humidity of 70 percent for a temperature of 21°C to 27°C (70°F to 80°F).

A.5.4.2.2 If the moisture condition of the fire test assembly is likely to change drastically from the sample taken 72 hours prior to the test, the sample should be taken not later than 24 hours prior to the test.

A.7.1.11 The following formula illustrates how to correct for the variation of furnace exposure:

$$C = \frac{2I(A - A_1)}{3(A_3 + L)}$$

where:
C = correction in the same units as I
I = indicated fire resistance period
A = area under the curve of the indicated average furnace temperature for the first three-fourths of the indicated period
A_s = area under the standard furnace curve for the same part of the indicated period
L = lag correction in the same units as A and A_s [30°C-hr or 54°F-hr (1800°C-min or 3240°F-min)]

Annex B Recommendations for Thermocouple Pads

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

B.1 Refractory Fiber Pads. Specific product information is being provided for informational purposes only. This product information has not been independently verified, certified, or endorsed by NFPA or any of its Technical Committees.

B.2 Ceraform 126®. Ceraform 126® is a registered trade name of Manville Specialty Products Group, P.O. Box 5108, Denver, CO 80217.

Comparative fire tests have demonstrated that a refractory fiber material, designated Ceraform 126®, placed with the softer surfaces in contact with the thermocouple, can be substituted for the previously specified asbestos pad where the distortion of the unexposed face of the specimen is minimal. The pads are relatively rigid and should not be used on surfaces that are subject to sharp distortions or discontinuities during the test.

The properties of Ceraform 126® material are as follows:

(1) Length and width — 152 mm ± 3 mm (6 in. ± ⅛ in.).
(2) Thickness — 9.5 mm ± 1.6 mm (0.375 in. ± 0.063 in.). The thickness measurement is made under the light load of a 13-mm (½-in.) diameter pad of a dial micrometer gauge.
(3) Dry weight — 67 g ± 24 g (0.147 lb ± 0.053 lb).
(4) Thermal conductivity [at 65°C (150°F)] — 0.053 W/m·K ± 0.004 W/m·K (0.37 Btu·in./hr·ft^2·°F ± 0.03 Btu·in./hr·ft^2·°F).
(5) Hardness indentation on soft face should be 1.9 mm ± 0.6 mm (0.075 in. ± 0.025 in.). Indentation is determined in accordance with ASTM C 569, *Test for Indentation Hardness of Performed Thermal Insulations*. Modified Brinell values of hardness are obtained from the following equation:

$$\text{Hardness} = \frac{2.24}{y}$$

where:
y = measured indentation in inches