NFPA® 288

Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance–Rated Assemblies

2012 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance–Rated Assemblies

2012 Edition

This edition of NFPA 288, *Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance–Rated Assemblies*, was prepared by the Technical Committee on Fire Tests. It was issued by the Standards Council on December 13, 2011, with an effective date of January 2, 2012, and supersedes all previous editions.

This edition of NFPA 288 was approved as an American National Standard on January 2, 2012.

Origin and Development of NFPA 288

This test procedure was developed in response to inquiries from outside sources to investigate and establish a testing procedure for floor fire doors. NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, had a reference for horizontal access doors. It required 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described in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials* (now withdrawn).

NFPA 251 noted that the test standard did not provide for the effect on fire endurance of conventional openings in the assembly unless specifically provided for in the construction tested. This provision limited the testing of the floor fire door to the particular floor/ceiling or roof assembly used. Prior to this test method being developed, some testing laboratories provided testing and labeling of these products. There were many test protocols that had to be assumed, which created inconsistency in the testing procedures and listing requirements.

This test procedure provides for consistency in the testing and listing of floor fire doors. The test procedure has incorporated provisions from NFPA 251, *Standard Methods of Tests of fire Resistance of Building Construction and Materials* (now withdrawn), NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, where appropriate.

The 2007 edition of NFPA 288 was a reconfirmation of the 2001 edition.

The 2012 edition's scope has been expanded to include horizontal assemblies, such as roofs. Requirements for thermocouple locations have been revised.

Technical Committee on Fire Tests

Committee Scope: This Committee shall have primary responsibility for documents on fire testing procedures, for reviewing existing fire test standards and recommending appropriate action to NFPA, for recommending the application of and advising on the interpretation of acceptable test standards for fire problems of concern to NFPA technical committees and members, and for acting in a liaison capacity between NFPA and the committees of other organizations writing fire test standards. This Committee does not cover fire tests that are used to evaluate extinguishing agents, devices, or systems.

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NFPA 288

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2012 Edition

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

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 horizontal fire door assemblies of various materials and types of construction that are installed in openings of fire resistance–rated floor systems or roofs to retard the passage of fire.

1.1.2 Tests made in conformity with this test method demonstrate the performance of horizontal fire door assemblies during the test exposure; however, such tests shall not be construed as determining the suitability of horizontal 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 horizontal fire door assembly to protect openings in fire resistance–rated floors or roofs.

1.3 Application.

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

(1) By measuring the ability of the horizontal 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. The exposure, however, is not representative of all fire conditions, since 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, roof, and floors. The exposure shall provide a relative measure of the fire performance of horizontal 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 horizontal fire door assemblies in floors or roofs that are constructed of materials other than those tested
(2) An evaluation of the degree to which a horizontal 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 horizontal fire door assembly
(4) Measurement of flame spread over the surface of the horizontal fire door assembly

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. (Reserved)

2.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition. Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections. (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 defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

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 or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Horizontal 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 or roof.

Chapter 4 Control of Fire Test

4.1 Time-Temperature Curve.

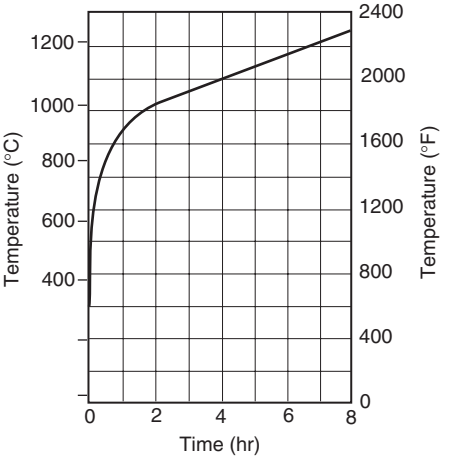
4.1.1 The fire exposure of horizontal fire door assemblies shall be controlled to conform to the applicable portion of the standard time-temperature curve shown in Figure 4.1.1.

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 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 (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.



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.

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	1,000	2,330	39
0:10	704	4,300	72	1,300	7,740	129
0:15	760	7,860	131	1,399	14,150	236
0:20	795	11,650	194	1,462	20,970	350
0:25	821	15,590	260	1,510	28,050	468
0:30	843	19,650	328	1,550	35,360	589
0:35	862	23,810	397	1,584	42,860	714
0:40	878	28,060	468	1,613	50,510	842
0:45	892	32,390	540	1,638	58,300	971
0:50	905	36,780	613	1,661	66,200	1,103
0:55	916	41,230	687	1,681	74,220	1,237
1:00	927	45,740	762	1,700	82,330	1,372
1:05	937	50,300	838	1,718	90,540	1,509
1:10	946	54,910	915	1,735	98,830	1,647
1:15	955	59,560	993	1,750	107,200	1,787
1:20	963	64,250	1,071	1,765	115,650	1,928
1:25	971	68,990	1,150	1,779	124,180	2,070
1:30	978	73,760	1,229	1,792	132,760	2,213
1:35	985	78,560	1,309	1,804	141,420	2,357
1:40	991	83,400	1,390	1,815	150,120	2,502
1:45	996	88,280	1,471	1,826	158,890	2,648
1:50	1,001	93,170	1,553	1,835	167,700	2,795
1:55	1,006	98,080	1,635	1,843	176,550	2,942
2:00	1,010	103,020	1,717	1,850	185,440	3,091
2:10	1,017	112,960	1,882	1,862	203,330	3,389

Table 4.1.2 *Continued*

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
2:20	1,024	122,960	2,049	1,875	221,330	3,689
2:30	1,031	133,040	2,217	1,888	239,470	3,991
2:40	1,038	143,180	2,386	1,900	257,720	4,295
2:50	1,045	153,390	2,556	1,912	276,110	4,602
3:00	1,052	163,670	2,728	1,925	294,610	4,910
3:10	1,059	174,030	2,900	1,938	313,250	5,221
3:20	1,066	184,450	3,074	1,950	332,000	5,533
3:30	1,072	194,940	3,249	1,962	350,890	5,848
3:40	1,079	205,500	3,425	1,975	369,890	6,165
3:50	1,086	216,130	3,602	1,988	389,030	6,484
4:00	1,093	226,820	3,780	2,000	408,280	6,805
4:10	1,100	237,590	3,960	2,012	427,670	7,128
4:20	1,107	248,430	4,140	2,025	447,180	7,453
4:30	1,114	259,340	4,322	2,038	466,810	7,780
4:40	1,121	270,310	4,505	2,050	486,560	8,110
4:50	1,128	281,360	4,689	2,062	506,450	8,441
5:00	1,135	292,470	4,874	2,075	526,450	8,774
5:10	1,142	303,660	5,061	2,088	546,580	9,110
5:20	1,149	314,910	5,248	2,100	566,840	9,447
5:30	1,156	326,240	5,437	2,112	587,220	9,787
5:40	1,163	337,630	5,627	2,125	607,730	10,129
5:50	1,170	349,090	5,818	2,138	628,360	10,473
6:00	1,177	360,620	6,010	2,150	649,120	10,819
6:10	1,184	372,230	6,204	2,162	670,000	11,167
6:20	1,191	383,900	6,398	2,175	691,010	11,517
6:30	1,198	395,640	6,594	2,188	712,140	11,869
6:40	1,204	407,450	6,791	2,200	733,400	12,223
6:50	1,211	419,330	6,989	2,212	754,780	12,580
7:00	1,218	431,270	7,188	2,225	776,290	12,938
7:10	1,225	443,290	7,388	2,238	797,920	13,299
7:20	1,232	455,380	7,590	2,250	819,680	13,661
7:30	1,239	467,540	7,792	2,262	841,560	14,026
7:40	1,246	479,760	7,996	2,275	863,570	14,393
7:50	1,253	492,060	8,201	2,288	885,700	14,762
8:00	1,260	504,420	8,407	2,300	907,960	15,133

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 — 152 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 horizontal 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 Thermocouples shall not be located opposite or on top of structural members if temperatures at such points will be lower than temperatures at more representative locations.

4.3.2.4* Thermocouples shall not be located over fasteners such as screws, nails, or staples unless one of the following applies:

(1) The aggregate area of any part of such fasteners on the unexposed surface is greater than 1 percent of the area within any 152 mm (6 in.) diameter circle.
(2) 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).

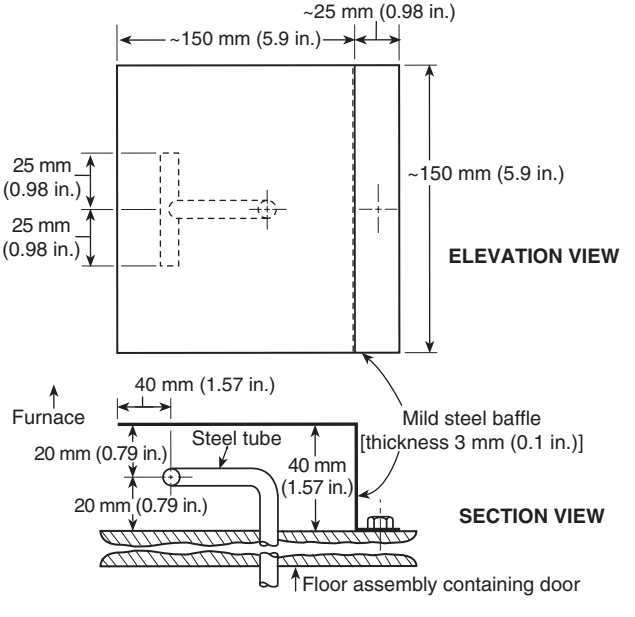


FIGURE 4.4.1(a) Static Pressure-Measuring Device Dimensions.

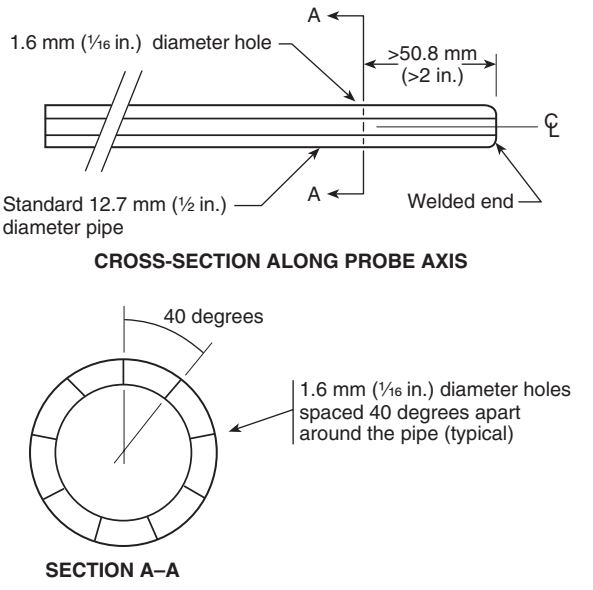


FIGURE 4.4.1(b) Pressure-Sensing Probe.

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 5 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 305 mm (12 in.) away from the specimen. The pressure — the average of the two readings during the test — shall be reported.

Chapter 5 Test Specimen

5.1 Construction and Size.

5.1.1 The construction and size of a test horizontal 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 horizontal 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 or roof 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 or roof in which the horizontal 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 or roof construction.

5.2 Mounting.

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

5.2.2 Horizontal 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 horizontal fire door assembly being tested.

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

5.3 Clearances.

5.3.1 Horizontal fire door assemblies 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 horizontal fire door assembly when viewed perpendicular to the face of the door.

5.4 Protection and Conditioning.

5.4.1 The horizontal 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 or roof 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 in the first 5 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 measured at two locations along the centerline of the specimen and at 305 mm (12 in.) below the specimen. The pressure — the average of the two readings during the test — shall be reported.

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 or roof 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 information specified in 7.1.1 through 7.1.11.

7.1.1 The performance of the horizontal 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 horizontal fire door, frame, and floor or roof 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 horizontal 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 conditions in 8.1.1 through 8.1.7.

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

8.1.4 Hardware shall secure the horizontal 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 horizontal 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 horizontal fire door assembly 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 horizontal 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 or roof on all sides and shall not permit through-openings between the frame and the doors or between the frame and the adjacent floor or roof.

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 Annex B.

A.4.3.2.4 Fasteners can be higher or lower in temperature than those at more representative locations.

A.5.4.2.1 If, during the conditioning of the specimen, it is desirable or necessary to use accelerated drying techniques, the laboratory conducting the test is responsible for avoiding procedures that significantly alter the structural or fire resistance characteristics of the floor or roof 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:

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

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 Preformed 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

(6) The pads are shaped by wetting, forming, and then drying to constant weight to provide complete contact on sharply contoured surfaces.

Supporting data are available from ASTM International.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. (Reserved)

C.1.2 Other Publications.

C.1.2.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM C 569, *Test for Indentation Hardness of Preformed Thermal Insulations*, 1989 (discontinued).

Menzel, C. A., *A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity*, Proceedings, American Society for Testing and Materials, Vol. 55, Appendix I, 1955.

C.1.2.2 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Wood Handbook of the Forest Products Laboratory, U.S. Department of Agriculture, pp. 320–321, 1955 edition.

C.2 Informational References. (Reserved)

C.3 References for Extracts in Informational Sections. (Reserved)

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