UL 10C

STANDARD FOR SAFETY

Positive Pressure Fire Tests of Door Assemblies

UL Standard for Safety for Positive Pressure Fire Tests of Door Assemblies, UL 10C

Third Edition, Dated June 9, 2016

Summary of Topics

This revision of ANSI/UL 10C dated May 27, 2021 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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

The requirements are substantially in accordance with Proposal(s) on this subject dated February 12, 2021 and May 3, 2021.

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UL 10C

Standard for Positive Pressure Fire Tests of Door Assemblies

Prior to the first edition, the requirements for the products covered by this standard were included in the Standard for Fire Tests of Door Assemblies, UL 10B.

First Edition – February, 1998
Second Edition – January, 2009

Third Edition

June 9, 2016

This ANSI/UL Standard for Safety consists of the Third Edition including revisions through May 27, 2021.

The most recent designation of ANSI/UL 10C as a Reaffirmed American National Standard (ANS) occurred on May 27, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These methods of fire tests are applicable to swinging door assemblies, including door frames with lights and panels, of various materials and types of construction for use in wall openings to retard the passage of fire. The method does not provide an evaluation of a swinging door assembly when that assembly is part of a larger assembly (e.g. sliding fire door assembly), or when it is intended to be used as an elevator entrance.

1.2 Tests made in conformity with these test methods are intended to register performance during the test exposure; but such tests shall not be construed as determining suitability for use after exposure to fire.

1.3 It is the intent that tests made in conformity with these test methods allow for the development of data to enable regulatory bodies to determine the suitability of door assemblies for use in locations where fire resistance of a specified duration is required.

1.4 These methods are intended to evaluate the ability of a door assembly to remain in an opening during a predetermined test exposure.

1.5 The tests expose a specimen to a standard fire exposure controlled to achieve specified temperatures throughout a specified time period, followed by the application of a specified standard fire hose stream. The exposure, however, is not representative of all fire conditions, which vary with changes in the amount, nature, and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. It does, however, provide a relative measure of fire performance of door assemblies under these specified fire exposure conditions.

1.6 Any variation from the construction or conditions that are tested is capable of substantially changing the performance characteristics of the assembly.

1.7 The methods do not provide the following:

a) Full information as to performance of all door assemblies in walls constructed of materials other than those tested.

b) Evaluation of the degree by which the door assembly contributes to the risk of fire by generation of smoke, toxic gases, or other products of combustion.

c) A temperature limit on the unexposed side of the door assembly.

d) A limit on the number of openings allowed in glazed areas or of the number and size of lateral openings between the door and frame.

e) Measurement of the degree of control or limitation of the passage of smoke or products of combustion through the door assembly. Note: See limitations for the passage of smoke detailed in the Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives, NFPA 105

2 General

2.1 Units of measurement

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

2.2 Undated references

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

CONTROL OF FIRE TESTS

3 Furnace Construction

3.1 Furnace size

3.1.1 The furnace shall be able to accommodate the full-sized sample. Small-scale size furnaces are capable of being used for testing small but full-sized samples or representative features of full-sized samples. The furnace face shall be greater in area than the exposed face of the sample by at least 20 percent. The additional area between the sample and the furnace shall be filled by wall or partition construction.

3.1.2 The furnace shall have a chamber depth, i. e. the distance between the exposed face of the specimen and the face of the furnace lining immediately opposite the specimen, of not less than 23 in (584 mm) and not more than 51 in (1296 mm).

3.2 Furnace construction materials

3.2.1 The furnace shall be constructed of materials which have a greater resistance to heat flow through the other three sides than through the sample.

3.3 Furnace burners

3.3.1 The furnace shall be heated with burners that are fired using either natural gas or liquefied petroleum gases.

3.3.2 The heat output of the burners shall be controllable and shall expose the specimen to a uniform heating as specified in 4.1.1.

3.3.3 The burners shall function so that the fuel gas is introduced into the furnace where the gas mixes with air present in the furnace and then burns; or, as an alternate, the fuel gas is mixed with air prior to its ignition in the furnace.

4 Time-Temperature Curve

4.1 General

4.1.1 The fire exposure of door assemblies shall be controlled to conform to the applicable portion of the standard time-temperature curve shown in Appendix A. The points on the curve that determine its character are:

1000°F (538°C) at 5 minutes

1300°F (704°C) at 10 minutes

1462°F (795°C) at 20 minutes

1550°F (843°C) at 30 minutes

1638°F (892°C) at 45 minutes

1700°F (927°C) at 1 hour

1792°F (978°C) at 1-1/2 hours

1850°F (1010°C) at 2 hours

1925°F (1052°C) at 3 hours

2000°F (1093°C) at 4 hours

4.2 Uniformity of temperature distribution

4.2.1 At any time after the first 10 minutes of fire exposure, the temperature rise indicated by any of the thermocouples used to determine the furnace temperature shall not differ from each other by more than 270° F (150° C). With test constructions where either the sample or any associated construction incorporates combustible materials that produce flaming within the furnace or where excess air drawn into the furnace is identified as causing localized heating or cooling of one or more of the furnace thermocouple hot junctions, the deviation of temperature rise from each other recorded by the thermocouples so affected shall not exceed 450°F (250°C).

5 Furnace Temperatures

5.1 The temperatures of the test exposure shall be the average temperature obtained by a minimum of three thermocouples and no fewer than one thermocouple per 15 square feet of test assembly exposed to the furnace symmetrically disposed and distributed to show the temperature near all parts of the test assembly, Figure 5.1. The thermocouples shall be protected by: (1) sealed 1/2 in (12.7 mm) wrought-steel or wrought-iron pipe of standard weight or (2) Inconel 600 series schedule 40 pipe (0.8 inch OD / 0.6 inch ID, 20 mm OD / 15 mm ID).

5.2 The junction of the thermocouples shall be initially located 6 in (152 mm) from the exposed face of the test assembly or from the construction in which the assembly is installed. During the fire exposure, if the movement of the test sample causes the sample's distance to the thermocouple junction to vary, the location of the junction shall be reset to 6 in (152 mm) at intervals not exceeding 10 minutes during the first 30 minutes of the test. Thereafter, the intervals are to be increased to not more than 30 minutes.

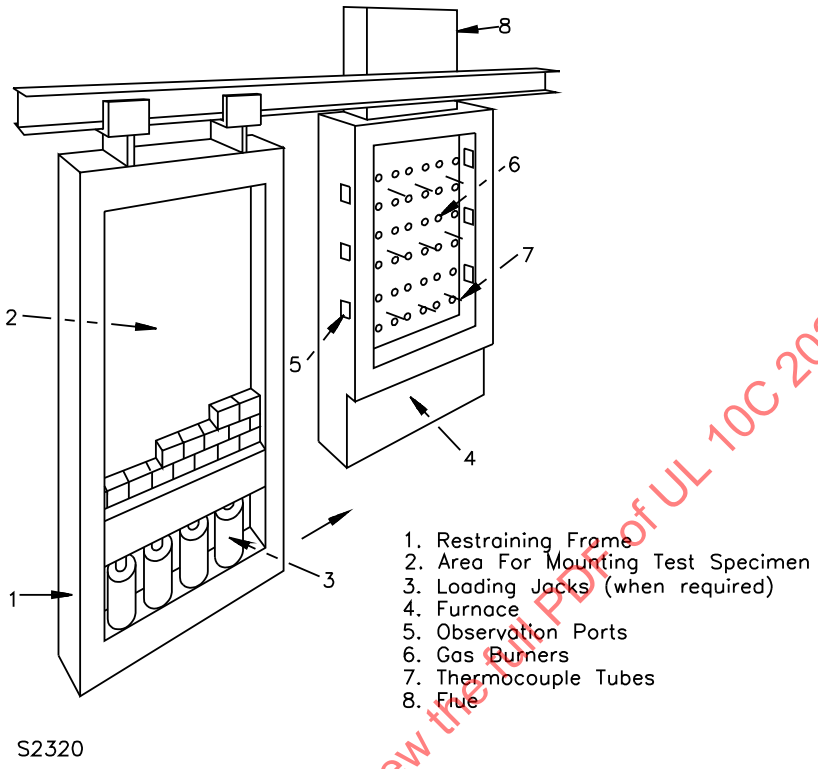
5.3 The temperatures shall be read at intervals not exceeding 1 minute.

5.4 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 under the standard time-temperature curve for fire tests of 1 hour or less duration, within 7.5 percent for those over 1 hour and not more than 2 hours, and within 5 percent for tests exceeding 2 hours in duration.

5.5 For a summary of the accuracies for the various rating periods, see Appendix A.

Figure 5.1

Test furnace



6 Unexposed Surface Temperatures and Cotton Pad Test

6.1 Unexposed surface temperatures are to be recorded, and are to be determined in accordance with 6.2 – 6.9.

Exception: Single-layer metal doors need not comply with the requirements of 6.2 – 6.9.

6.2 Unexposed surface temperatures shall be taken at not less than three points, with a minimum of one thermocouple in each 16-ft^2 (1.5 m^2) area of the door. Thermocouples shall not be located over reinforcements extending through the door, over glass panels, or nearer than 12 in (305 mm) from the edge of the door.

6.3 Surface temperatures of test specimens are to be measured by means of thermocouples with a wire diameter of not more than 0.03 in (0.7 mm). Each thermocouple is to be brazed to the center of the face of a copper disk 1/2 in (12 mm) in diameter and 0.01 in (0.2 mm) thick, which is secured to the surface of the specimen at the required position.

6.4 Unexposed surface temperatures are to be measured with thermocouples placed under flexible, oven-dry, felted pads. The properties of these felted pads are to comply with the requirements specified in Table 6.1. The felted pads are not to break when shaped to contact the surface against which they are placed.

Table 6.1
Felted Pad

Characteristic	Requirement
Length and width	1.2 ± 0.02 in (30 ± 0.5 mm)
Thickness[a]	0.08 ± 0.02 in (2 ± 0.5 mm)
Density	56.2 ± 6.2 lb/ft^3 (900 ± 100 kg/m^3
Thermal conductivity at 150 °F (66 °C)	0.37 ± 0.03 Btu-inch per hour per square foot per °F (0.053 ± 0.004 W/m·K)
Hardness[b] (on the soft face)	2.25 to 4.5 (modified Brinnell)

[a] The thickness measurement is to be made under the light load of a 1/2 in (12.7-mm) diameter pad of a dial micrometer gage.

[b] The hardness measurement is to be made by pressing a 1 in (25.4 mm) diameter steel ball against the specimen and measuring the indentation obtained between a minor load of 2 pounds-mass (0.91 kg) and an additional major load of 10 pounds-mass (4.5 kg) [12 pounds-mass (5.4 kg) total load]. The hardness is obtained by the relationship:

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

In which:
y is the difference in indentation in inches.

6.5 The disk and the felted pad are to be fixed to the surface of the specimen by mechanical fastening, tape, or adhesive, based on the nature of the material forming the specimen. When a mechanical fastening method is used to secure the thermocouple and pad, the testing laboratory shall ensure the fastener is not greater than 3/8 inch in length. The pads shall be fixed so as to maintain contact between the thermocouple and the surface of the test specimen.

6.6 Unexposed surface temperatures are to be read at intervals not exceeding 1 minute.

6.7 The thermocouples and felted pads are to be removed after 30 minutes of fire exposure.

Exception: The thermocouples and felted pads are to remain on the assembly when unexposed surface temperature data beyond the first 30 minutes of fire exposure is being evaluated.

6.8 The passage of flames and gases that may be hot enough to ignite combustibles through cracks, holes, or other openings in or around a door shall be determined by applying a cotton pad to such openings at regular intervals during the test. The cotton pad shall not be in contact with the element but shall be held for not less than 10 seconds and not more than 30 seconds between 1 ±1/4 in (25 ±5 mm) away from and centrally opposite any cracks, holes, or other openings in or around the door. The cotton pad shall not be re-used if it has absorbed any moisture or become charred during a previous application.

Exception No. 1: The cotton pad shall not be applied to door assemblies where the average temperature of the assembly has risen greater than 450°F (250°C) above the ambient temperature.

Exception No. 2: The cotton pad shall not be applied to door assemblies where there is flaming within the limits described in Exception Nos. 1, 2 and 3 to 15.1.

6.9 The cotton pad, measuring 4 in (100 mm) square by 3/4 in (20 mm) thick, shall consist of new undyed and soft cotton fibers without any admixture of artificial fibers, and shall have a mass between 3 and 4 grams. The cotton pad shall be conditioned by drying in an oven at 212°F (100°C) for at least 30 minutes. The cotton pad shall be attached by wire clips to a 4 in by 4 in (100 mm by 100 mm) frame of 0.04 in (1 mm) diameter wire.

7 Furnace Pressure

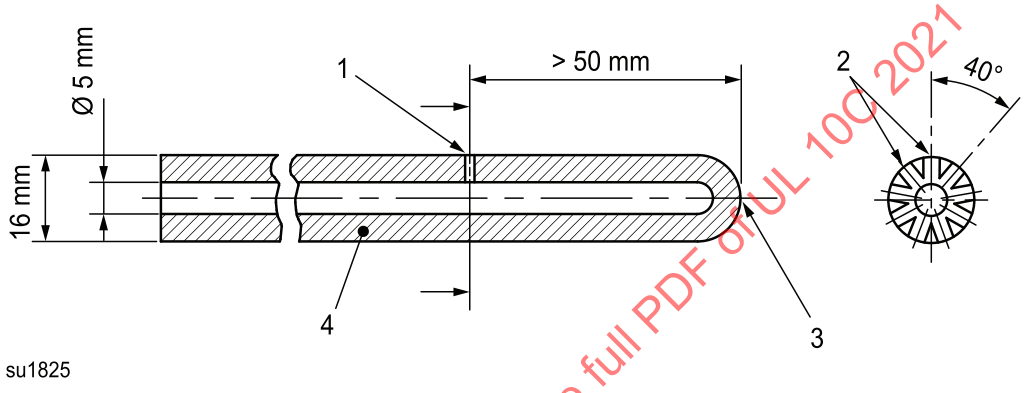
7.1 The neutral plane within the test furnace shall be established prior to the initiation of the fire test. Such pressure shall remain constant or increase to maintain the neutral plane upon initiation of the fire test. Control of the furnace pressure is to be established beginning no later than 5 minutes after the start of the test and is to be maintained throughout the remainder of the fire test.

7.2 The pressure in the furnace, relative to atmosphere, is to be measured at the top of the assembly and at a location 40 in above the sill.

7.3 The pressure probe is to be constructed from 1/2 in (12.7 mm) diameter stainless steel tube with a welded, closed end, and incorporating nine radial, 1/16-in (1.6-mm) diameter holes spaced equidistance around the tube's perimeter as shown in Figure 7.1. The probe is to be located so that the center line of the sensing holes are positioned 6 ±1 in (152 ±2.5 mm) from the surface of the exposed face of the test assembly and a minimum of 18 in (457 mm) from the edges of the furnace. The probes are to be positioned horizontally in the furnace without a change in vertical elevation of the probes or tubing within the furnace. Alternatively "T" shaped pressure-sensing probes may be used as shown in Figure 7.2.

Figure 7.1

Tube shaped pressure-sensing probe

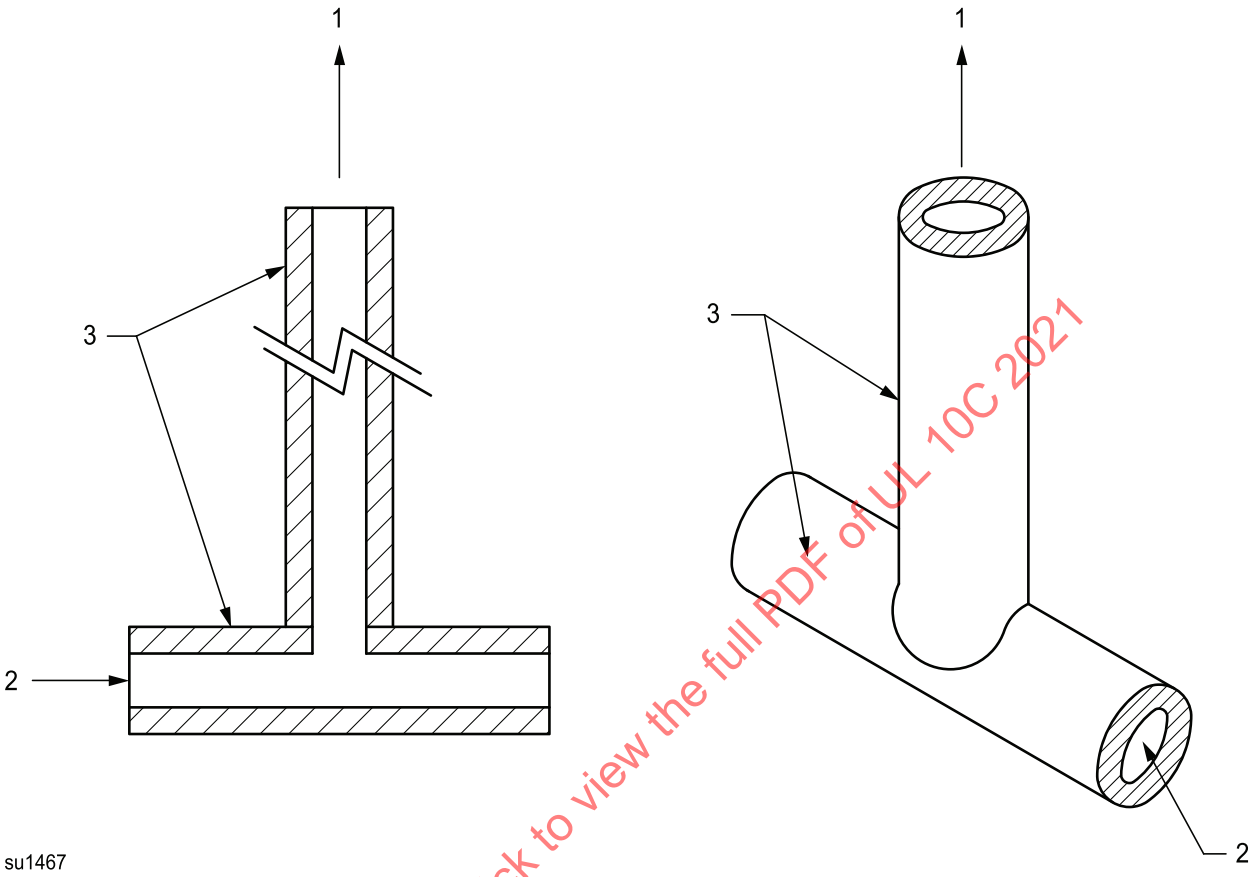


Key

1) Holes, 3.0 mm diameter
2) Holes, 3.0 mm diameter, spaced 40° apart around the pipe
3) Welded end
4) Tube shaped pressure-sensing probe

Figure 7.2

"T" shaped pressure-sensing probe



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Key

1) Open to transducer

2) Open

3) "T" shaped pressure-sensing probe. Inside diameter 0.2 in to 0.4 in (5 mm to 10 mm)

Note: 1 inch = 25.4 mm

7.4 Data recording is to provide monitoring of the output of an electric pressure transducer in the range of ±0.25 in H_2O (66 Pa) with an accuracy of ±1 percent. The pressure transducers are to be located within 3 ft (914 mm) vertically, and 10 ft (3048 mm) horizontally from the static probes outside the furnace.

7.5 Pressures are to be read at intervals not exceeding 1 minute.

7.6 The oxygen percentage is to be determined by centering a minimum of one 1/4-in (6.4-mm) inside diameter stainless steel tube containing eight 1/16-inch (1.6-mm) diameter holes in the damper plenum, approximately half way between the furnace and the exhaust damper. The tube is then to be connected to an oxygen analyzer which has an accuracy of ±2.0 percent in the range of 0 to 10 percent. Locating more than one probe in the plenum and averaging the readings is permitted.

7.7 The oxygen percentages are to be read at intervals not exceeding 1 minute and recorded.

TEST ASSEMBLIES

8 Construction and Size

8.1 The construction and size of the test door assembly, consisting of single doors, doors in pairs, or specialty doors (such as Dutch doors, double-egress doors, and the like), frame and hardware, shall be representative of that for which the classification or rating is being evaluated.

8.2 A floor structure shall be provided as part of the opening to be protected, except where such floor interferes with the operation of the door. The floor segment shall be of noncombustible material and shall project into the furnace approximately twice the thickness of the test door or to the limit of the frame, whichever is greater.

9 Mounting for Test Purposes

9.1 Swinging doors, except as specified in 9.4 and 9.5, shall be mounted so as to open into the furnace chamber.

9.2 The mounting of all doors shall be such that they fit within the frame. Such mounting shall not prevent free and easy operation of the test door.

9.3 Clearances for swinging doors shall be as follows:

a) One-eighth (+0, minus 1/16) in (3.1 ±1 mm) along the top;

b) One-eighth (+0, minus 1/16) in (3.1 ±1 mm) along the hinge and latch jambs;

c) One-eighth (+0, minus 1/16) in (3.1 ±1 mm) along the meeting edge of doors in pairs;

d) Three-eighths (+0, minus 1/16) in (9.5 +0, minus 1.6 mm) at the bottom edge of a single swing door; and

e) One-fourth (+0, minus 1/16) in (6.4 +0, minus 1.6 mm) at the bottom of a pair of doors.

9.4 Door frames shall be evaluated when mounted so as to have the doors open either away from or into the furnace chamber, at the discretion of the testing authority, to obtain representative information on the performance of the construction under test.

9.5 Surface-mounted hardware (for example, fire-exit devices and door closers) for use on fire doors shall be evaluated by being installed on one door assembly swinging into the furnace chamber and another door assembly swinging away from the furnace chamber.

CONDUCT OF TESTS

10 Supporting Construction

10.1 Wall construction materials shall have the strength to retain the assembly securely in position throughout the Fire Endurance Test, Section 11, and the Hose Stream Test, Section 12.

11 Fire Endurance Test

11.1 Prior to the start of the endurance test the pressure in the furnace chamber is to comply with Clause 7.2.

11.2 Within 5 minutes of elapsed time into the fire exposure, the neutral plane of the furnace is to be established at a maximum of 40 in (1016 mm) up from the bottom of the test assembly.

11.3 The pressure that is maintained over the top one-third of the door assembly is not to exceed 0.08 in H_2O (20 Pa) over any portion of the test sample.

11.4 The test is to be continued until the exposure period of the classification or rating being evaluated is reached.

11.5 The fire endurance test shall follow the fire exposure as referenced in Section 4.

12 Hose Stream Test

12.1 Immediately after and within 3 minutes of the end of the Fire Endurance Test, Section 11, the test assembly is to be subjected to the impact, erosion, and cooling effects of a hose stream directed first at the bottom center and then at all parts of the exposed surface. The hose stream is to be applied with a smooth steady movement of the hose at a rate to ensure all parts of the test assembly are impacted by the hose stream. When all parts of the test assembly have been impacted by the hose stream, the application pattern is to be reversed. See Appendix B for a description of the pattern.

12.2 The hose stream is to be delivered through a 2-1/2 in (63.5 mm) hose discharging through a play pipe as described in the Standard for Play Pipes for Water Supply Testing in Fire Protection Service, UL 385. The minimum water pressure at the base of the play pipe and the minimum duration of application in seconds per ft^2 (s/m^2) of exposed area are to be as prescribed in Table 12.1.

Table 12.1
Water pressure at base of play pipe and duration of application

Desired rating	Water pressure at base of play pipe,		Duration of application of exposed area,	
	psi	(kPa)	seconds per square foot	(s/m^2)
3-hour or 4-hour	45	310	3.0	32
1-1/2-hour and over if less than 3-hour	30	207	1.5	16
1-hour and over if less than 1-1/2-hour	30	207	0.9	10
Less than 1 hour	30	207	0.6	6

Note – The exposed area shall be calculated using the outside dimensions of the test specimen, including a frame or other parts of the assembly when provided, but normally not including the wall into which the specimen is mounted. Where multiple test specimens are mounted in the same wall, the hose stream is to be calculated and applied to each sample individually, or the rectangular wall area encompassing all of the specimens is to be considered as the exposed area since the hose stream must traverse this area during its application.

12.3 The tip of the play pipe shall be located a maximum of 20 ft (6 m) from and on a line normal to the center of the test door. When impossible to be so located, the play pipe shall be on a line deviating not more than 30 degrees from the line normal to the center of the test door. When so located, the distance from the center shall be less than 20 ft by an amount equal to 1 ft (0.3 m) for each 10 degrees of deviation from the normal.

REPORT

13 General

13.1 Results shall be reported in accordance with the performance in the tests prescribed in these test methods. The report shall show the performance under the desired exposure period chosen from the following: 20-minute, 30-minute, 3/4-hour, 1-hour, 1-1/2-hour, 3-hour, or 4-hour.

13.2 The report shall include the temperature measurements of the furnace, including their deviation from the specified time-temperature curve and, if determined, of the unexposed side of the test assembly. See 6.1.

13.3 The report shall also contain a record of all observations having a bearing on the performance of the test assembly. Oxygen percentage readings as recorded in 7.7 shall be included in the test report in either tabular or graphic format.

13.4 Any flaming on the unexposed surface of the assembly shall be recorded.

13.5 The amount of movement of any portion of the edges of the door adjacent to the door frame from the original position shall be recorded. See Conditions of Acceptance, General, Section 14, and Specific, Section 15.

13.6 The materials and construction of the door, frame, and wall or partition, and the details of the installation, hardware, door frame and wall anchors, trim, finish, and clearance shall be recorded or appropriately referenced to provide positive identification or duplication in all respects.

13.7 Pressure measurements made in the furnace and the location of such measurements relative to the neutral plane of the door assembly and the plane at the top of the door assembly are to be recorded.

CONDITIONS OF ACCEPTANCE

14 General

14.1 A door assembly shall be determined to comply with the requirements for performance when it remains in the opening during the Fire Endurance Test, Section 11, and the Hose-Stream Test, Section 12, within the limitations specified in 14.2.

14.2 The test assembly shall withstand the Fire Endurance Test, Section 11, and the Hose-Stream Test, Section 12, without developing openings anywhere through the assembly.

Exception No. 1: For assemblies with a fire exposure period of 1-1/2 hours or less, dislodging of small portions of glass, as specified in 15.14 and 15.15, by the hose stream is permitted.

Exception No. 2: Separation between meeting edges of pairs of doors within the limits specified in 15.5 and 15.6 is permitted.

Exception No. 3: An opening between the bottom edge of a door and sill within the limits specified in 9.3 is permitted.

14.3 An opening for the purpose of the requirement in 14.2, is defined as a through-hole in the assembly that is capable of being seen from the unexposed side when viewed from the direction perpendicular to the plane of the assembly at the location of the suspected opening.

15 Specific

15.1 No flaming shall occur on the unexposed surface of a door assembly nor shall the sample permit the passage of hot gases sufficient to ignite the cotton pad.

Exception No. 1: Sustained flaming of less than 10 seconds duration is permitted.

Exception No. 2: After 30 minutes, intermittent light flaming [not greater than 6 in (152 mm) long, nor burning for periods exceeding 5-minute intervals, along the edges of doors] is permitted.

Exception No. 3: Light flaming during the last 15 minutes of the classification period of 45 minutes or greater, is permitted on the unexposed surface area of the door, when it is contained within a distance of 1-1/2 in (38.1 mm) from a vertical door edge, and within 3 in (76.2 mm) from the top edge of the door and within 3 inches from the top edge of the frame of a vision panel.

15.2 When hardware is to be evaluated for use on fire doors, it shall hold the door closed in accordance with the conditions of acceptance for the intended door assembly classification period and, in addition, the latch bolt shall remain projected and shall be intact after the test. The hardware is not required to be operable after test.

15.3 The movement of swinging doors shall not result in any portion of the edges adjacent to the door frame moving from the original position in a direction perpendicular to the plane of the door more than the thickness of the door during the entire classification period, nor more than 1-1/2 times the door thickness as a result of the Hose Stream Test, Section 12.

15.4 The movement of swinging doors mounted in pairs shall not result in any portion of the meeting edges moving more than the thickness of the door away from the adjacent door edge in a direction perpendicular to the plane of the doors during the entire classification period nor more than 1-1/2 times the door thickness as a result of the Hose Stream Test, Section 12.