UL 1479

STANDARD FOR SAFETY

Fire Tests of Penetration Firestops

UL Standard for Safety for Fire Tests of Penetration Firestops, UL 1479

Fourth Edition, Dated June 10, 2015

Summary of Topics

This revision of ANSI/UL 1479 dated April 30, 2025 includes the following changes in requirements:

– Environmental Exposure Temperature and Duration; 9.2.1

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated March 28, 2025.

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ANSI/UL 1479-2025

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UL 1479

Standard for Fire Tests of Penetration Firestops

Prior to the first edition, the requirements for the products covered by this standard were included in the Standard for Fire Tests of Building Construction and Materials, UL 263, and in the Standard for Fire Tests of Door Assemblies, UL 10B.

Prior to the 4th edition, the title of the Standard was Standard for Fire Tests of Through-Penetration Firestops.

First Edition – January, 1983
Second Edition – June, 1994
Third Edition – May, 2003

Fourth Edition

June 10, 2015

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through April 30, 2025.

The most recent designation of ANSI/UL 1479 as an American National Standard (ANSI) occurred on April 30, 2025. 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 ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover through penetration firestops of various materials and construction that are intended for use in openings in fire resistive wall, floor or floor-ceiling assemblies, and membrane type penetration firestops of various materials and construction that are intended for use in openings in fire resistive wall assemblies.

1.2 The method of testing penetration firestops as specified by these requirements consists of exposure of test samples to a fire of standard time and temperature and to an application of a hose stream. Ratings are then established on the basis of:

a) The length of time the firestop resists fire before the first development of through openings or flaming on the unexposed surface;

b) Acceptable limitation of thermal transmission; and

c) Acceptable performance under the application of the hose stream.

1.3 The method of testing also includes optional air leakage tests to determine the rate of air leakage through penetration firestop systems resulting from a specified air pressure difference applied across the surface of the systems.

1.4 The method of testing also includes optional water leakage tests to determine the ability of penetration firestop systems to resist the passage of water under a three foot pressure head. This method does not evaluate the ability of uncured firestop systems to resist such exposure.

1.5 Two ratings are established for each penetration firestop system: an F rating based upon flame occurrence on the unexposed side of the test sample and acceptable hose stream performance; and a T rating based on temperature rise and flame occurrence on the unexposed side of the test sample and acceptable hose stream performance.

1.6 An L rating may also be established for a penetration firestop system. The L rating is based on the amount of air leakage through the test sample.

1.7 A W rating may also be established for a penetration firestop system. The W rating is based on the water resistance of the test sample.

1.8 The method of testing penetration firestop systems containing piping systems for vented (drain, waste or vent) systems and closed (process or supply) systems is differentiated by the capping or non-capping of the piping systems on the unexposed side of the test assembly as described in 5.1.1.2.

1.9 Tests conducted in accordance with these requirements are intended to demonstrate the performance of penetration firestops during exposure to fire, but are not intended to determine acceptability of firestops for use after exposure to fire. These requirements do not cover the ampacity of conductors encased in penetration firestop materials.

1.10 The results obtained from the air leakage tests are expressed in ft^3/min (m^3/s) per ft^2 (m^2) of opening. The results are intended to develop data to assist authorities having jurisdiction, and others, in determining the acceptability of penetration firestops with reference to the control of air movement through the assembly.

1.11 These requirements do not cover outlet boxes and fittings for use in and evaluated for fire resistance as part of a fire-resistance-rated floor, floor-ceiling or wall assembly.

2 Units of Measurement

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

3 References

3.1 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.

4 Glossary

4.1 For the purpose of this standard the following definitions apply.

4.2 AIR-FLOW METERING SYSTEM – A device used to measure the air flow.

4.3 AIR LEAKAGE (Q) – The volume of air flowing, per unit of time, through the openings around the test sample under a test pressure difference, expressed as ft^3/min (m^3/s). This air leakage volume is to be reported standardized to an ambient air temperature of 75°F (24°C).

4.4 AIR LEAKAGE TEST CHAMBER – A sealed chamber or box with an opening, a removable mounting panel, or one open side in which or against which the test sample is installed and sealed.

4.5 AIR SYSTEM – A controllable blower, compressed air supply, exhaust system, or reversible blower designed to provide an essentially constant required air flow at the specified fixed test pressure difference for the period required to obtain readings of air leakage.

4.6 AMBIENT TEMPERATURE EXPOSURE – The temperature at the exposed face of the test sample is to be 75 ±20°F (24 ±11°C).

4.7 ELEVATED TEMPERATURE EXPOSURE – The temperature at the exposed face of the test sample is to be 400 ±10°F (204 ±5°C).

4.8 EXTRANEOUS LEAKAGE (Q_L) – The difference between the metered air flow (Q_m) and the air leakage (Q).

4.9 MEMBRANE-PENETRATION FIRESTOP – A specific construction that:

a) Consists of material(s) that fills or covers the opening and that is intended to prevent the passage of flame;

b) Consists of penetrating items, such as outlet boxes, cabinets, pipes, ducts, along with their means of support through the wall opening; and

c) Only penetrates one side of a fire resistive assembly.

4.10 METERED AIR FLOW (Q_m) – The volume of air flowing per unit of time through the air flow metering system, expressed as ft^3/min (m^3/s).

4.11 RATE OF AIR LEAKAGE – The total air leakage per sample, expressed as ft^3/min (m^3/s) per ft^2 (m^2) of opening.

4.12 REPLACEMENT AIR – The volume of air, at ambient temperature, added to the test chamber, to replace the air leakage (Q) volume of air in either the ambient or elevated temperature exposure tests.

4.13 TEST ASSEMBLY – The wall or floor into which the test sample is mounted or installed.

4.14 TEST PRESSURE DIFFERENCE – The specified difference in static air pressure across the fixed test sample, expressed as inch of water column (Pa).

4.15 TEST SAMPLE – The through-penetration or membrane-penetration firestop being tested.

4.16 THROUGH-PENETRATION FIRESTOP – A specific construction that:

a) Consists of material(s) that fills or covers the opening and that is intended to prevent the passage of flame;

b) Consists of penetrating items, such as cables, cable trays, conduits, ducts, and pipes, along with their means of support through the wall, floor or floor-ceiling opening; and

c) Penetrates through a fire resistive assembly.

PERFORMANCE

5 Fire Exposure Test

5.1 Test sample

5.1.1 Through-penetration firestop

5.1.1.1 For through-penetration firestop systems, the penetrations and supporting construction to be tested shall be representative of the construction for which ratings are desired with respect to materials, workmanship, and details such as dimensions of parts. The through-penetration firestop system is to be installed in accordance with the manufacturer's specified installation instruction procedure. When a through-penetration firestop is intended for use in both floor and walls, each orientation is to be tested unless it is demonstrated that testing in a single orientation does not affect the test results.

5.1.1.2 Penetrating items are to be installed in the test sample so that they extend a minimum of 11 in (279 mm) from the exposed side, and a maximum of 37 in (940 mm) from the unexposed side unless either or both of these extensions are not characteristic of actual field installations. For conditions where a penetrant is required to be longer for the Water Leakage Test, Section 8, the unexposed side penetrant is permitted to extend a maximum of 4 in (100 mm) beyond the water level utilized per Section 8 to accommodate the additional length needed for water leakage testing and securement of the penetrant. For partially insulated penetrations, a minimum of 11 in (279 mm) of the bare penetration shall extend beyond the termination of the insulation on the exposed side of the assembly. The extended portions of the penetrating items on the unexposed side are to be mechanically supported by a metal rack and secured at no more than two points. The individual ends of the penetrating items are to be covered on the exposed side to prevent excessive transfer of gases through the test sample. When the penetrating item is intended to be representative of a closed system that is not normally vented or open to the atmosphere, the penetrating item can also be capped or sealed on the unexposed side. Otherwise, penetrating items shall not be capped or sealed on the unexposed side.

5.1.1.3 Penetrating items of horizontal assemblies are to be exposed to the furnace temperatures for the minimum specified distance of 11 in (279 mm) from the plane representing the bottom surface of a floor assembly or floor-ceiling assembly and shall not be contained within the cavity of a wall under test

conditions regardless of whether the intended application involves a completely exposed penetrant or one which may be fully or partially contained within the cavity of a wall.

5.1.1.4 The periphery of the test sample is to be not closer than 1-1/2 times the thickness of the test assembly, or a minimum of 12 in (300 mm), to the furnace edge, whichever is greater. The distance between the test sample periphery and furnace edge can be reduced if it is demonstrated that the edge effects do not affect the test results.

5.1.2 Membrane-penetration firestop systems for other than outlet boxes

5.1.2.1 For membrane-penetration firestop systems for other than outlet boxes, the penetrations and supporting construction to be tested shall be representative of the construction for which ratings are desired with respect to materials, workmanship, and details such as dimensions of parts. The membrane-penetration firestop system is to be installed in accordance with the manufacturer's specified installation instruction procedure.

5.1.2.2 Each representative construction type of membrane-penetration firestop system for which rating is desired is to be tested. The membrane-penetration system, other than metallic outlet boxes, shall be evaluated with the firestop system exposed to the furnace condition and also a second configuration with the firestop system facing away from the furnace. If it is determined by the testing laboratory that one exposure is representative of both exposures, the testing laboratory shall test that one exposure.

5.1.3 Membrane-penetration firestop systems for outlet boxes

5.1.3.1 For membrane-penetration firestop systems for outlet boxes, the penetrations and supporting construction to be tested shall be representative of the type construction for which ratings are desired with respect to materials, workmanship, and details such as dimensions of parts. The membrane-penetration firestop system for outlet boxes is to be installed in accordance with the manufacturer's specified installation instruction procedure.

5.1.3.2 Unless a different rating is desired for a different construction scheme, the outlet boxes are to be installed in the test sample which is minimum 48 in (1219 mm) in width as indicated in Figure 5.2. The exposed surface shall contain one receptacle outlet box with faceplate positioned at the height of 12 in (305 mm) from the bottom of the test assembly. The unexposed surface shall contain one outlet box with faceplate and one switch outlet box with faceplate. The exposed surface outlet box and the unexposed surface outlet box shall be located at the same level in the assembly with the maximum 24 in (610 mm) space and interconnected with the appropriate conduit. The switch outlet box shall be located at a maximum of 32 in (813 mm) above the exposed outlet box and interconnected with the appropriate wiring, conduit and associated hardware. Unless otherwise specified, all boxes shall be secured to framing members.

5.2 Conditioning

5.2.1 Prior to fire testing, each test sample and test assembly is to be conditioned, if necessary, to provide a moisture condition representative of that likely to exist in similarly-constructed buildings. The test assembly can be conditioned independent of the conditioning of the test samples. The moisture condition is to be established by storage in air having 50% relative humidity at 73°F (23°C) until an equilibrium moisture condition is achieved. If it is impractical to achieve this equilibrium moisture condition, the test can be conducted when the dampest portion of the test assembly and test sample have achieved an equilibrium moisture content resulting from storage in air having 50 to 75% relative humidity at 73 ±5°F (23 ±3°C).

Exception: These requirements can be waived if:

a) An equilibrium moisture condition is not achieved within a 12-month conditioning period; or

b) The construction is such that hermetic sealing resulting from the conditioning has prevented drying of the interior of the test sample or assembly, in which case the conditioning need then be continued only until the test assembly has developed sufficient strength to retain the test sample securely in position.

5.2.2 The method for determining the relative humidity within hardened concrete by use of electric sensing elements is described in Appendix I of a paper by Carl A. Menzel, "A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity," Proceedings, ASTM, Volume 55, Page 1085 (1955). A similar procedure with electric sensing elements can be used to determine the relative humidity within a test assembly and test sample made of materials other than concrete.

5.2.3 For wood construction, the moisture content of the wood shall not be greater than 13 % as determined by an electrical resistance method.

5.3 Protection of assembly and sample

5.3.1 The testing equipment and test sample and assembly are to be protected from any condition of wind or weather that might influence the test results. The ambient air temperature at the beginning of the test is to lie within the range of 50 to 90°F (10 to 32°C). The velocity of air across the unexposed surface of the test sample, measured immediately before the test begins, is not to exceed 4.4 ft/s (1.3 m/s) as determined by an anemometer placed at right angles to the unexposed surface. If mechanical ventilation is employed during the test, an air stream is not to be directed across the surface of the sample.

5.4 Furnace temperature control and measurement

5.4.1 The temperature of the furnace is to be controlled so that the area under the measured temperature-time curve of furnace temperature, obtained by averaging the results from thermocouple (see 5.4.5 – 5.6.1.1.2) or pyrometer readings, is within 10% of the corresponding area under the standard temperature-time curve illustrated in Figure 5.1 for fire tests for 1 h or less duration, within 7.5% for tests longer than 1 h but not longer than 2 h, and within 5% for tests exceeding 2 h in duration. The points on the curve that determine its character are as follows in (a) – (h) below. For a more precise definition of the temperature-time curve, see Table 5.1.

a) 50 – 90°F (10 to 32°C) at 0 min

b) 1000°F (538°C) at 5 min

c) 1300°F (704°C) at 10 min

d) 1550°F (843°C) at 30 min

e) 1700°F (927°C) at 1 h

f) 1850°F (1010°C) at 2 h

g) 2000°F (1093°C) at 4 h

h) 2300°F (1260°C) at 8 h

Figure 5.1

Time-temperature curve

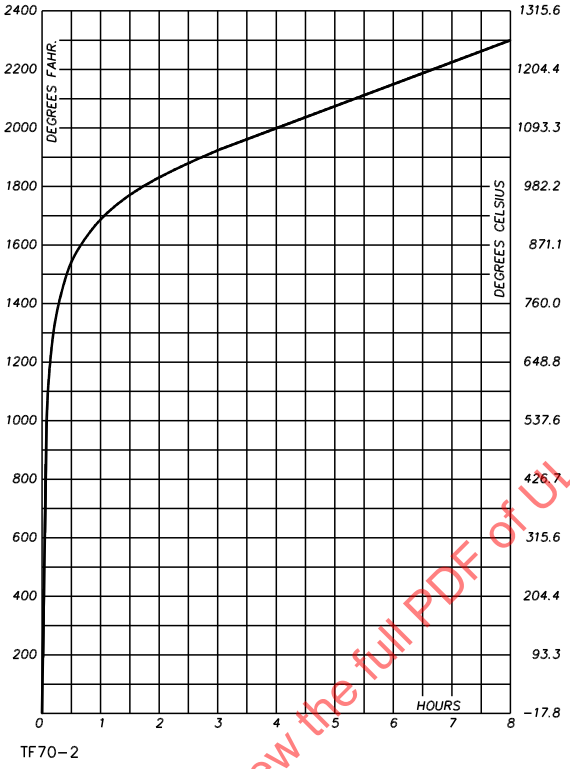

Table 5.1
Standard time-temperature curve for control of fire tests

Time	Temperature	Area above 68°F base		Temperature	Area above 20°C base	
h:min	°F	°F, min	°F, h	°C	°C, min	°C, h
0:00	68	00	0	20	00	0
0:05	1 000	2 330	39	538	1 290	22
0:10	1 300	7 740	129	704	4 300	72
0:15	1 399	14 150	236	760	7 860	131
0:20	1 462	20 970	350	795	11 650	194
0:25	1 510	28 050	468	821	15 590	260
0:30	1 550	35 360	589	843	19 650	328
0:35	1 584	42 860	714	862	23 810	397
0:40	1 613	50 510	842	878	28 060	468
0:45	1 638	58 300	971	892	32 390	540
0:50	1 661	66 200	1 103	905	36 780	613
0:55	1 681	74 220	1 237	916	41 230	687
1:00	1 700	82 330	1 372	927	45 740	762
1:05	1 718	90 540	1 509	937	50 300	838
1:10	1 735	98 830	1 647	946	54 910	915

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Table 5.1 Continued

Time	Temperature	Area above 68°F base		Temperature	Area above 20°C base	
h:min	°F	°F, min	°F, h	°C	°C, min	°C, h
1:15	1 750	107 200	1 787	955	59 560	993
1:20	1 765	115 650	1 928	963	64 250	1 071
1:25	1 779	124 180	2 070	971	68 990	1 150
1:30	1 792	132 760	2 213	978	73 760	1 229
1:35	1 804	141 420	2 357	985	78 560	1 309
1:40	1 815	150 120	2 502	991	83 400	1 390
1:45	1 826	158 890	2 648	996	88 280	1 471
1:50	1 835	167 700	2 795	1 001	93 170	1 553
1:55	1 843	176 550	2 942	1 006	98 080	1 635
2:00	1 850	185 440	3 091	1 010	103 020	1 717
2:10	1 862	203 330	3 389	1 017	112 960	1 882
2:20	1 875	221 330	3 689	1 024	122 960	2 049
2:30	1 888	239 470	3 991	1 031	133 040	2 217
2:40	1 900	257 720	4 295	1 038	143 180	2 386
2:50	1 912	276 110	4 602	1 045	153 390	2 556
3:00	1 925	294 610	4 910	1 052	163 670	2 728
3:10	1 938	313 250	5 221	1 059	174 030	2 900
3:20	1 950	332 000	5 533	1 066	184 450	3 074
3:30	1 962	350 890	5 848	1 072	194 940	3 249
3:40	1 975	369 890	6 165	1 079	205 500	3 425
3:50	1 988	389 030	6 484	1 086	216 130	3 602
4:00	2 000	408 280	6 805	1 093	226 820	3 780
4:10	2 012	427 670	7 128	1 100	237 590	3 960
4:20	2 025	447 180	7 453	1 107	248 430	4 140
4:30	2 038	466 810	7 780	1 114	259 340	4 322
4:40	2 050	486 560	8 110	1 121	270 310	4 505
4:50	2 062	506 450	8 441	1 128	281 360	4 689
5:00	2 075	526 450	8 774	1 135	292 470	4 874
5:10	2 088	546 580	9 110	1 142	303 660	5 061
5:20	2 100	566 840	9 447	1 149	314 910	5 248
5:30	2 112	587 220	9 787	1 156	326 240	5 437
5:40	2 125	607 730	10 129	1 163	337 630	5 627
5:50	2 138	628 360	10 473	1 170	349 090	5 818
6:00	2 150	649 120	10 819	1 177	360 620	6 010
6:10	2 162	670 000	11 167	1 184	372 230	6 204
6:20	2 175	691 010	11 517	1 191	383 900	6 398
6:30	2 188	712 140	11 869	1 198	395 640	6 594
6:40	2 200	733 400	12 223	1 204	407 450	6 791
6:50	2 212	754 780	12 580	1 211	419 330	6 989

Table 5.1 Continued on Next Page

Table 5.1 Continued

Time	Temperature	Area above 68°F base		Temperature	Area above 20°C base	
h:min	°F	°F, min	°F, h	°C	°C, min	°C, h
7:00	2 225	776 290	12 938	1 218	431 270	7 188
7:10	2 238	797 920	13 299	1 225	443 290	7 388
7:20	2 250	819 680	13 661	1 232	455 380	7 590
7:30	2 262	841 560	14 026	1 239	467 540	7 792
7:40	2 275	863 570	14 393	1 246	479 760	7 996
7:50	2 288	885 700	14 762	1 253	492 060	8 201
8:00	2 300	907 960	15 133	1 260	504 420	8 407

5.4.2 The measured temperature to be compared with the standard temperature-time curve is to be the average temperature obtained from the readings of thermocouples symmetrically disposed and distributed within the test furnace to indicate the temperature near all parts of the test assembly.

5.4.3 A minimum of three thermocouples are to be used, and there are to be no fewer than five thermocouples per 100 ft^2 (9.3 m^2) of floor surface, and no fewer then nine thermocouples per 100 ft^2 of wall surface. The floor surface or wall surface area is to be the gross area of test-assembly and -sample areas.

5.4.4 The junctions of the thermocouples are to be placed 12 in (305 mm) from the exposed face of a floor test assembly and 6 in (152 mm) from the exposed face of a wall test assembly.

5.4.5 The temperatures are to be read at intervals of 5 min or less during the first 2 h and at intervals of 10 min or less thereafter.

5.5 Furnace thermocouple preparation

5.5.1 Each furnace thermocouple is to be enclosed in a sealed protection tube. The exposed combined length of protection tube and thermocouple in the furnace chamber is to be not less than 12 in (0.3 m). Other types of protection tubes can be used provided that the temperature measurements are within the limits of accuracy specified in 5.5.2.

5.5.2 The time constant of the protected thermocouple assembly is to lie within the range of 5.0 to 7.2 min. A typical thermocouple assembly complying with this time constant requirement can be fabricated by fusion-welding the twisted ends of 18 AWG (0.82 mm^2) chromel-alumel wires, mounting the leads in porcelain insulators and inserting the assembly into a standard weight nominal 1/2-in iron, steel, or inconel pipe, and sealing the end of the pipe that is inside the furnace. The thermocouple junction is to be inside the pipe, 1/2 in (13 mm) from the sealed end.

5.6 Unexposed side temperature measurement

5.6.1 Sample thermocouple location

5.6.1.1 Through-penetration firestop

5.6.1.1.1 Temperature measurements are to be made by thermocouples placed at each of the following locations on the unexposed side of the test sample and test assembly, as illustrated in Figure 5.2.

a) At a point on the surface of the test sample, 1 in (25 mm) from one of each type of penetrating item employed in the field of the penetration firestop material. Thermocouples are to be covered by

a pad (see 5.6.1.1.3 and 5.6.2.1.1); however, if the grouping of items through the test sample does not permit use of a pad, the thermocouple need not be used.

b) At a minimum of one point on the penetration firestop material surface at the periphery of the test sample.

c) At least three points on the penetration firestop material surfaces approximately equidistant from a penetrating item or group of penetrating items in the field of the firestop and the periphery.

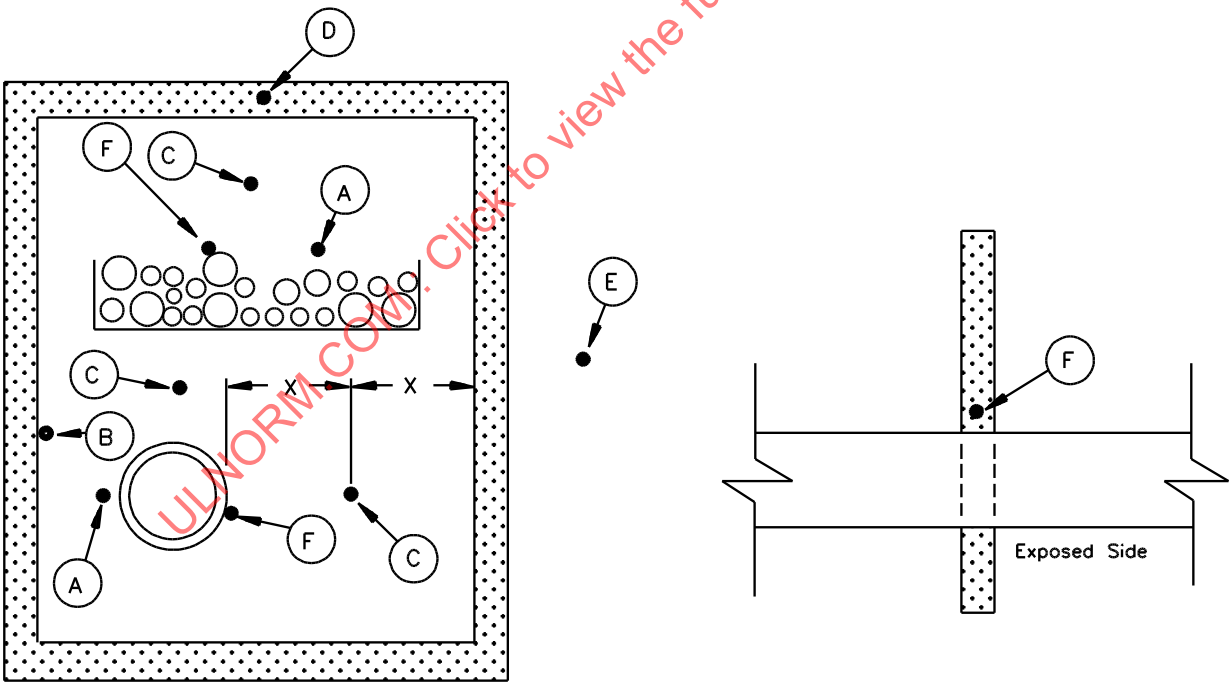
d) At a point on any frame installed around the perimeter of the opening.

e) At a point on the unexposed surface of the wall or floor assembly at least 12 in (0.3 m) from any opening.

f) At one point on each type of penetrating item. On each type of penetrating item at a point 1 in (25 mm) from the unexposed surface of the test assembly. When the penetrating item is insulated or coated on the unexposed side, the thermocouple shall be located on the exterior surface of the insulation or coating. When the insulation or coating does not extend the full length of the penetrating item on the unexposed side, an additional thermocouple shall be installed on the penetrating item 1 in (25 mm) beyond the termination of the insulation or coating.

Figure 5.2

Temperature measurements locations[a]



[a] See 5.6.1.1.1 for description of letter symbols.

5.6.1.1.2 Temperature measurements can be made at locations in addition to those described in 5.6.1.1.1 for the purpose of evaluating the performance of the firestop.

5.6.1.1.3 Temperatures on the surface of the penetration firestop and test assembly are to be measured with thermocouples placed under flexible pads (see 5.6.2.1.1). The pads are to be held firmly against the surface and are to fit closely about the thermocouples. Each thermocouple junction is to be located under the center of each pad. The thermocouple leads under the pads are to be not larger than 18 AWG (0.82 mm^2) and are to be electrically insulated with heat- and moisture-resistant coverings.

5.6.1.1.4 Where temperature measurements are being made on the penetrating item, the thermocouple bead is to be held firmly against the penetrating item. The thermocouple leads are not to be larger than 22 AWG (0.32 mm^2) and are to be electrically insulated with heat and moisture-resistant coverings. The pads, as described in 5.6.2.1.1, are to be held firmly against the penetrating item and are to fit closely about the thermocouples.

5.6.1.1.5 Temperatures are to be measured at intervals of 15 min or less until a reading exceeding 212°F (100°C) has been obtained at any one point. Thereafter, the readings can be taken more frequently at the discretion of testing personnel, but the intervals need not be less than 5 min.

5.6.1.2 Membrane-penetration firestop systems

5.6.1.2.1 Membrane-penetration firestop systems for other than outlet boxes

5.6.1.2.1.1 For items penetrating the exposed surface, temperature measurements are to be made by thermocouples placed at each of the following locations on the unexposed side of the test sample and test assembly, as illustrated in Figure 5.3.

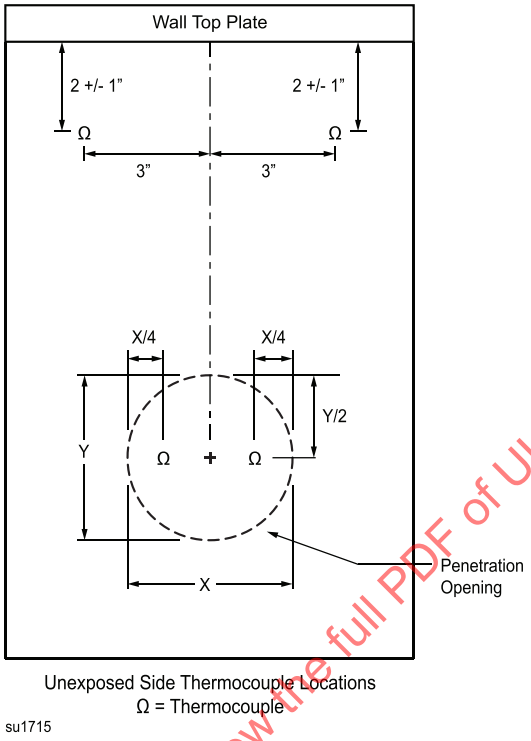
a) A minimum of two points directly opposite to the opening of the exposed side. If the area opposite to the opening of the exposed surface is not sufficient to locate two thermocouples, one thermocouple at the center of the projected area shall be used. If the penetrating item is less than 6 in (152 mm) in diameter, a minimum of one thermocouple shall be used. At the discretion of the test laboratory, more thermocouples may be used.

b) A minimum of two points on the unexposed surface at least 2 ±1 in (51 ±25 mm) below the top of the wall. The two points shall be located a maximum of 3 in (76 mm) laterally at each side from the center of the opening.

c) Temperature measurements are to be made in accordance with 5.6.1.1.1 when the penetrating item exits the unexposed surface.

Figure 5.3

Temperature Measurement Locations for membrane-penetration firestop systems for other than outlet boxes



5.6.1.2.1.2 For items penetrating the unexposed surface only, temperature measurements are to be made in accordance with 5.6.1.1.1.

5.6.1.3 Membrane penetration firestop systems for Outlet boxes

5.6.1.3.1 Temperature measurements are to be made by thermocouples placed at each of the following locations on the unexposed surface of the test sample and test assembly, as illustrated in Figure 5.4.

a) At two points on the near top of the faceplate of the snap switch outlet box. Thermocouples are to be covered by a pad (2”x2” thermocouple pad).

b) At two points on the near top of the faceplate of the snap switch outlet box. Thermocouples are to be covered by a pad (2”x2” thermocouple pad).

c) At a point on the unexposed surface of the wall centered over outlet box. Thermocouples are to be covered by a pad (6”x6” thermocouple pad).

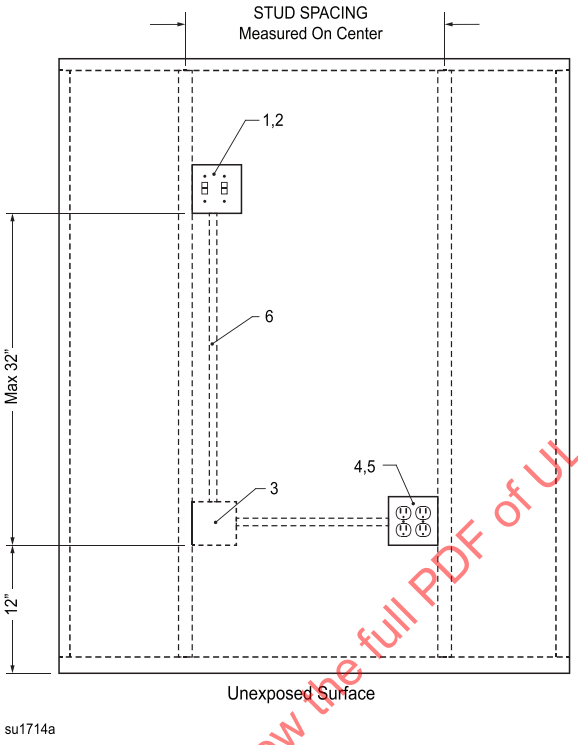
d) At two points on the near top of the faceplate of the receptacle. Thermocouples are to be covered by a pad (2”x2” thermocouple pad).

e) At two points on the near top of the faceplate of the receptacle. Thermocouples are to be covered by a pad (2”x2” thermocouple pad).

f) At a point on the unexposed surface of the wall 12 in above outlet box. Thermocouples are to be covered by a pad (6”x6” thermocouple pad).

Figure 5.4

Temperature measurements locations for membrane-penetration firestop systems for outlet boxes[a]



[a] *See 5.6.1.3.1 for description of letter symbols. Example of outlet box test assembly.*

5.6.1.3.2 The test assembly shall include the following:

a) Duplex electrical receptacles complying with Standard for Attachment Plugs and Receptacles, UL 498, and switches complying with Standard for General Use Snap Switches, UL 20, which is each of minimum amperage and voltage.

b) Gang boxes complying with Standard for Metallic Outlet Boxes, UL 514A, sized to accommodate the electrical receptacles and switches referenced above. The maximum height, width and depth of box of the intended construction shall be installed.

c) Unless otherwise specified, maximum diameter and minimum wall thickness steel conduits sized for use with the box system.

d) Zinc conduit connectors where applicable.

e) Wiring intended for use with the specific receptacles and switches.

f) Faceplate for each outlet box.

g) Other components representative of the electrical assembly.

5.6.1.3.3 Temperature measurements can be made at locations in addition to those described in 5.6.1.3.1 for the purpose of evaluating the performance of the firestop.

5.6.1.3.4 Temperatures on the surface of the membrane-penetration firestop and test assembly are to be measured with thermocouples placed under flexible pads (see 5.6.2.1.1). The pads are to be held firmly against the surface and are to fit closely about the thermocouples. Each thermocouple junction is to be located under the center of each pad. The thermocouple leads under the pads are to be not larger than 18 AWG (0.82 mm^2) and are to be electrically insulated with heat- and moisture-resistant coverings.

5.6.2 Thermocouple pads

5.6.2.1 Through-penetration firestop systems

5.6.2.1.1 Each thermocouple used to measure temperatures on the unexposed surface of the sample and assembly is to be covered with a flexible pad that:

a) Is of inorganic material that can be bent without breaking;

b) Has a length and a width of 2 ±0.04 in (50 ±1 mm);

c) Is 0.375 ±0.063 in (9.5 ±1.6 mm) thick;

d) Has a density of 18.7 ±0.2 lb/ft^3 (300 ±3 kg/m^3); and

e) Has a thermal conductivity at 150°F (65.6°C) of 0.37 ±0.03 Btu·in/(h·ft^2·°F) [0.053 ±0.004 W/(m·K)].

5.6.2.2 Membrane-penetration firestop systems (both outlet and non-outlet box)

5.6.2.2.1 Each thermocouple used to measure temperatures on the unexposed surface of the sample and assembly is to be covered with a flexible pad that:

a) Is of inorganic material that can be bent without breaking,

b) Has a length and a width of 2 ±0.04 in (50 ±1 mm) for thermocouples on penetrating items,

c) Has a length and a width of 6 ±0.04 in (152 ±1 mm) for thermocouples on the unexposed wall surface,

d) Is 0.375 ±0.063 in (9.5 ±1.6 mm) thick,

e) Has a density 18.7 ±0.2 lb/ft^3 (300 ±3 kg/m^3), and

f) Has a thermal conductivity at 150°F (65.6°C) of 0.37 ±0.03 Btu·in/(h·ft^2·°F) [0.053 ±0.004 W/(m·K)].

5.7 Differential pressure measurements

5.7.1 General

5.7.1.1 The appropriate differential pressure between the exposed and unexposed surfaces of the test assembly (see 5.7.3.1) is to be measured no less frequently than once every minute.

5.7.1.2 The differential pressure between the exposed and unexposed surfaces of the test assembly is to be measured at sufficient locations to determine the specified pressure differential at elevations specified in 5.7.3.1.

NOTE: See Section A3 for information regarding differential pressure measurement.

5.7.1.3 The pressure sensors shall be located where they will not be subjected to direct impingement of convection currents from the flames or in the path of the exhaust gases.

5.7.1.4 Tubing connected to each pressure sensor shall be horizontal both in the furnace and at its egress through the furnace wall, such that the pressure is relative to the same elevation from the inside to the outside of the furnace.

5.7.2 Pressure measurement apparatus

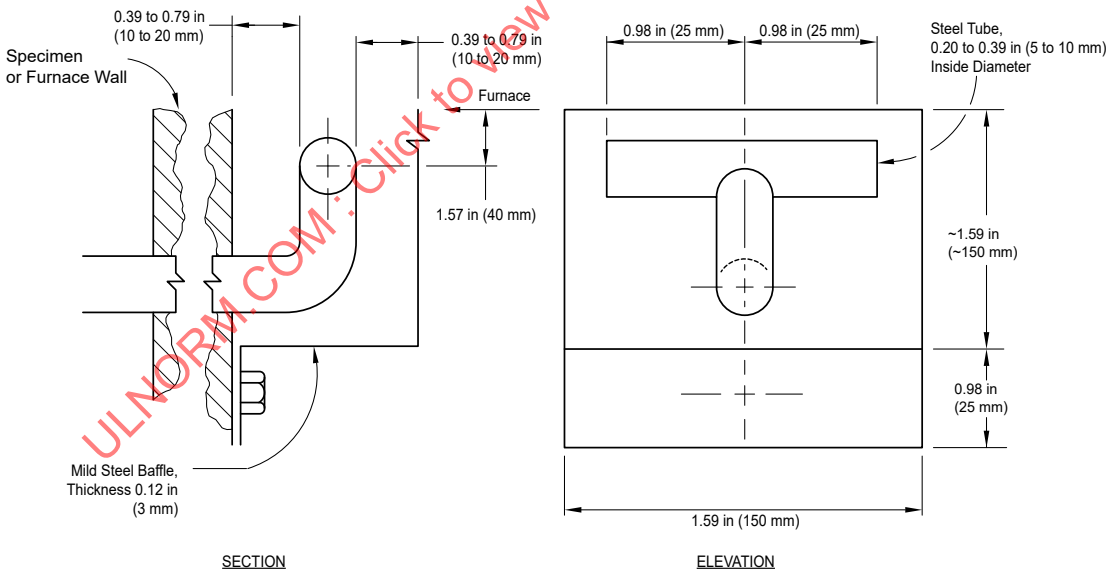
5.7.2.1 The differential pressure between the exposed and the unexposed surface of the test assembly is to be measured by means of a manometer or equivalent transducer capable of reading pressure within an accuracy of 0.01 in of water (2.5 Pa) increments.

5.7.2.2 The pressure sensors are to be either of the “T” type or the “tube” type as illustrated in Figure 5.5 or Figure 5.6, respectively, and manufactured from stainless steel or equivalent material. The steel baffle shown in Figure 5.5 is optional.

NOTE: The characteristics of air flow are different from furnace to furnace. The steel baffle is intended to provide additional shielding, at the discretion of the test laboratory, to the T-shaped probe from air flow currents within the furnace that may affect pressure readings.

Figure 5.5

Pressure measurement probe – T-shaped probe



The “T” branches shall be horizontally oriented.

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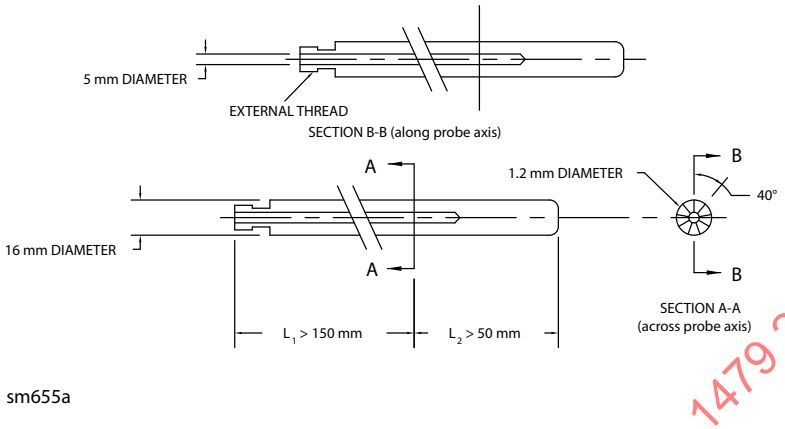
Figure 5.6

Pressure measurement probe – Tube probe



5.7.3 Differential pressure selection

5.7.3.1 Excluding the first 5 min of the test, the furnace pressure differential shall be a minimum of 0.01 in of water (2.5 Pa) at a distance of 12 in (305 mm) from the surface of horizontal test assemblies and a minimum of 0.01 in of water (2.5 Pa) at a level 0.78 in (20 mm) below the lowest level of materials that fill openings surrounding penetrating items passing through vertical test assemblies.

Exception: Atmospheric changes (or other causes which result in the test chamber dropping below the specified 0.01 in of water pressure) shall not be considered unacceptable provided such drops do not exceed 1 min in duration and collectively do not exceed 5% of the test time.

5.8 Duration of test

5.8.1 The test sample and assembly are to be subjected to the fire exposure for a period equal to the desired F rating (see Section 10) for the firestop or until a through opening develops in, or flaming occurs on the unexposed side of, the test sample; whichever is less.

6 Hose Stream Test

6.1 A duplicate test sample and test assembly is to be subjected to a fire exposure test for a period equal to one-half of the desired F rating (see Section 10) but not more than 60 min. Immediately after the fire exposure, the test sample is to be subjected to the impact, erosion, and cooling effects of a hose stream, as described in the Standard Practice for Application of Hose Stream, ASTM E2226, using the water pressure and duration specified in Table 6.1.

Table 6.1
Pressure and duration – hose stream test

Desired F rating (F), min	Water pressure at base of nozzle, psi (kPa)	Duration of application, s/ft^2 (s/m^2) of exposed area[a]
240 ≤ F < 480	45 (310)	3.0 (32)
120 ≤ F < 240	30 (210)	1.5 (16)

Table 6.1 Continued on Next Page

Table 6.1 Continued

Desired F rating (F), min	Water pressure at base of nozzle, psi (kPa)	Duration of application, s/ft^2 (s/m^2) of exposed area[a]
90 ≤ F < 120	30 (210)	0.90 (9.7)
F < 90	30 (210)	0.60 (6.5)

[a] The rectangular area of the wall or floor assembly into which the test assembly is mounted is to be considered as the exposed area, as the hose stream must traverse this calculated area during its application.

6.2 The test sponsor can elect, with the advice and consent of the testing body, to conduct the hose stream test on the sample constructed for the fire exposure test. The hose stream test is to be conducted within 10 min of completion of the fire exposure test.

7 Air Leakage Test

7.1 Test sample

7.1.1 Each representative construction type of penetration firestop for which rating is desired is to be tested.

7.2 Conditioning

7.2.1 A test sample containing hygroscopic materials or other materials that can be affected by moisture is to be conditioned in an environment having a dry bulb temperature of 77 ±5°F (25 ±3°C) and a relative humidity of 40 to 65% until reaching equilibrium.

7.3 Test chamber

7.3.1 The air leakage test chamber is to consist of a sealed chamber or box having an opening, a removable mounting panel, or one open side in or against which the test sample is installed and sealed. A means of access into the chamber can be provided to facilitate adjustments and observations of the installed test sample.

7.3.2 At least one static pressure tap is to be provided to measure the test chamber pressure and is to be located so that the reading is unaffected by the velocity of the air supplied to or exiting from the chamber.

7.3.3 The temperature of the chamber shall be determined by averaging the temperatures obtained from the readings of not less than three thermocouples symmetrically distributed 6 in (152 mm) from the exposed face of the side of the test sample or from the side of the test chamber in which the test sample is installed. The temperatures are to be measured and recorded at intervals not exceeding 5 min and at the time each pressure differential is recorded.

7.3.4 The pressure shall be measured by means of a manometer or equivalent transducer. The manometer or transducer shall be capable of reading 0.02 in of water column (5 Pa) increments with a measurement precision of 0.01 in of water (2 Pa).

7.3.5 The air supply opening into the test chamber is to be arranged so that supplied air does not impinge directly on the test sample.

7.4 Test setup

7.4.1 The test sample is to be installed in or against the test chamber. The same test sample to be used for the Fire Exposure Test, Section 5, can be used for the Air Leakage Test, prior to the Fire Exposure Test.

7.4.2 The outer perimeter of the test sample is to be sealed to the chamber wall. Nonhardening mastic compounds or pressure-sensitive tape can be used to seal the test sample at the chamber opening, to seal the access door to the chamber, and to achieve air tightness in the construction of the chamber. Rubber gaskets with clamping devices can also be used for this purpose.

7.4.3 Each penetrating item containing hollow spaces, voids or passageways through which air can leave the chamber shall be sealed on the ends of each penetrating item to prevent the passage of air through the penetrating item.

7.5 Extraneous chamber leakage requirements

7.5.1 Prior to the ambient temperature air leakage test, the extraneous chamber air leakage rate (Q_{La}) is to be measured using an air-impermeable sheet to cover the test sample mounted on the test chamber at the air pressure differential to be applied during the air leakage test. The extraneous chamber air leakage rate (Q_{La}) is to be measured prior to the ambient temperature exposure tests specified in 7.6.2 and after the elevated temperature exposure tests specified in 7.7.1. The extraneous chamber air leakage rate measured after the elevated temperature exposure tests (Q_{Le}) is to be measured after the temperatures at the faces of the test sample have returned to 75 ±20°F (24 ±11°C) at the air pressure differential applied during the air leakage test.

7.5.2 The extraneous chamber leakage shall be measured by means of a rotameter or equivalent air flow meter. The device shall have a measurement resolution better than 3% of the measured value.

7.5.3 For the air leakage tests to be acceptable, the value of Q_{Le} shall be within ±10% of Q_{La}.

7.5.4 Should the air leakage test be conducted only at ambient temperature, the value of Q_{Le} shall be determined after the air leakage test at ambient temperature.

7.6 Ambient temperature exposure tests

7.6.1 Prior to the conduct of the ambient temperature exposure test, the air-impermeable sheet used for extraneous leakage measurement shall be removed from the test sample without disturbing the seal between the test sample and the test chamber.

7.6.2 The chamber temperature is to be 75 ±20°F (24 ±11°C). The air flow into the test chamber is to be adjusted to provide a positive test pressure differential of 0.30 ±0.01 in water (75 ±2 Pa) between the test chamber and the space immediately outside the test chamber. After the test conditions are stabilized, the airflow rate through the air flow metering system and the test pressure differential are to be measured and recorded. This airflow rate is designated the total metered air flow (Q_{Ma}) at ambient temperature. When required by codes, other test pressure differentials shall be permitted to be used.

7.7 Elevated temperature exposure tests

7.7.1 The test chamber temperature is to be 75 ±20°F (24 ±11°C) prior to the conduct of the test. The test chamber temperature shall be uniformly increased so that it reaches 350°F (177°C) within 15 min and 400°F (204°C) within 30 min. The chamber temperature shall be stabilized at 400 ±10°F (204 ±5.6°C). Then, the airflow into the test chamber shall be adjusted to provide a positive differential of 0.30 ±0.01 in of water column (75 ±2 Pa) between the test chamber and the space immediately outside the test chamber.

After the temperature and pressure differential are stabilized within the above tolerances for a period of at least 5 min, the airflow rate through the airflow metering system and the pressure differential shall be measured and recorded. This airflow rate shall be designated as the total metered rate (Q_{Me}) at elevated temperature. When required by codes, other test pressure differentials shall be permitted to be used.

7.8 Recorded test data

7.8.1 The barometric pressure, temperature, and relative humidity of the supply air are to be measured at the test sample and recorded. The supply air flow values are to be corrected to standard temperature, humidity and pressure conditions of 68°F (20°C), 50% relative humidity and 29.92 in Hg (101.325 kPa) for the purpose of determining and reporting the air leakage rates.

7.8.2 The ambient air leakage rate of the test sample (L_A) shall be determined by subtracting the extraneous chamber air leakage chamber air leakage rate (Q_{La}) from the total metered airflow rate (Q_{Ma}).

7.8.3 The elevated temperature air leakage rate of the test sample (L_E) shall be determined by subtracting the average extraneous chamber air leakage rate [(Q_{La} + Q_{Le})/2] from the total metered airflow rate (Q_{Me}).

7.8.4 The test sample opening area (A_{test}) shall be measured to within ±0.1 in^2 (65 mm^2) and recorded.

8 Water Leakage Test

8.1 Test sample

8.1.1 Each representative construction type of a penetration firestop for which the water leakage rating is desired is to be tested. The sample shall be conditioned as described in 5.2 both before and after completion of the water leakage test.

8.2 Test chamber

8.2.1 The water leakage test chamber is to consist of a well-sealed vessel sufficient to maintain pressure with one open side against which the test assembly is sealed. The leakage test chamber is to have the ability to place water within the chamber. When the test method requires a pressure head greater than provided by the water within the test chamber, the test chamber is to be provided with means to attach a pressurized pneumatic or hydrostatic supply.

8.2.2 When a pneumatic supply is being used, the water leakage test chamber is to be provided with at least one static pressure tap to measure pressure within the test chamber. The pressure tap is to be located a minimum of 1 in (25 mm) above the top surface of the water placed inside the water leakage test chamber.

8.2.3 The temperature of the test fixture is to be within a range of 50 to 90°F (10 to 32°C).

8.2.4 When the test method requires a pressure head greater than provided by the water within the test chamber, the air pressure within the water leakage test chamber is to be measured at a minimum frequency of 15 s. The pressure within the water leakage test chamber is to be measured by means of a manometer or equivalent transducer capable of reading pressure within an accuracy of 1% of the specified pressure.

8.3 Test setup

8.3.1 Penetrating items are to be installed as specified in 5.1.1.2.

8.3.2 The water leakage test chamber is to be sealed to the test sample. Nonhardening mastic compounds, pressure-sensitive tape or rubber gaskets with clamping devices are permitted to be used to seal the water leakage test chamber to the test assembly.

8.3.3 Water, with a permanent dye, is to be placed in the water leakage test chamber. The water is to cover the firestopping materials to a minimum depth of 6 in (152 mm).

8.3.4 The top of the penetrating item is to be sealed by whatever means necessary when the top of the penetrating item is to be immersed under water. The seal is to prevent passage of water into the penetrating item.

8.3.5 The water leakage test chamber is to be pressurized using pneumatic or hydrostatic pressure when the test method requires a pressure head greater than that provided by the water inside the water leakage test chamber.

8.3.6 A white indicating medium is to be placed immediately below the penetration firestop.

8.3.7 The minimum pressure within the water leakage test chamber shall be 3 ft of water (1.3 psig) applied for a minimum of 72 h. The pressure head shall be measured at the horizontal plane at the top of the water seal.

8.3.8 Subsequent to the water leakage test, and conditioning as specified in 5.2, the firestop assembly shall be tested as specified in Sections 5 and 6.

8.4 Recorded test data

8.4.1 The leakage of water through the penetration firestop is to be noted by the presence of water or dye on the indicating media or on the underside of the test sample.

9 Environmental Exposure Tests for Intumescent Material

9.1 General

9.1.1 Intumescent fill, void or cavity material shall comply with the Expansion pressure test, 9.4, and with the Expansion factor test, 9.5, following exposure to the required environmental exposures specified in 9.2 and, as applicable, to the supplemental environmental exposures specified in 9.3.

9.2 Required environmental exposures

9.2.1 Intumescent fill, void or cavity material is to be exposed to the following conditions:

a) Accelerated Aging – Samples of the material are to be placed in a circulating air-oven at 158 ±5°F (70 ±2.7°C) for 270 days or at 176 ±5°F (80 ±2.7°C) for 135 days.

b) High Humidity – Samples of the material are to be placed in a controlled humidity of 97 – 100% at 95 ±3°F (35 ±1.5°C) for 180 days.

9.2.2 Following exposure to specified conditions in 9.2.1, the material is to be subjected to the Expansion pressure test, 9.4, and to the Expansion factor test, 9.5.