Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus[1]

This standard is issued under the fixed designation E2307; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—The title and address for Reference GA-600 were updated editorially in November 2016.

INTRODUCTION

A perimeter fire barrier is the perimeter joint protection that provides fire resistance to prevent passage of fire from floor to floor within the building at the opening between the exterior wall assembly and the floor assembly. A perimeter fire barrier is a unique building construction detail not addressed by other fire test methods.

Among its other functions, a perimeter fire barrier impedes the vertical spread of fire from the floor of origin to the floor(s) above, at the building's exterior perimeter and accommodates various movements such as those induced by thermal differentials, seismicity, and wind loads.

This test method describes criteria and test methods used to determine the fire resistance of perimeter fire barriers when subjected to standard fire exposure conditions using the intermediate-scale, multistory test apparatus (ISMA). The use of the multi-story test apparatus and this test method are intended to simulate a possible fire exposure on a perimeter fire barrier.

1. Scope

1.1 This test method measures the performance of the perimeter fire barrier and its ability to maintain a seal to prevent fire spread during the deflection and deformation of the exterior wall assembly and floor assembly during the fire test, while resisting fire exposure from an interior compartment fire as well as from the flame plume emitted from the window burner below. The end point of the fire-resistance test is the period of time elapsing before the first condition of compliance is reached as the perimeter fire barrier is subjected to a time-temperature fire exposure.

1.2 The fire exposure conditions used are those specified by this test method for the first 30 min of exposure and then conform to the Test Methods E119 time-temperature curve for the remainder of the test in the test room.

1.3 This test method specifies the heating conditions, methods of test, and criteria for evaluation of the ability of a perimeter fire barrier to maintain the fire resistance where a floor and exterior wall assembly are juxtaposed to a perimeter joint.

1.4 Test results establish the performance of perimeter fire barriers during the fire-exposure period and shall not be construed as having determined the suitability of perimeter fire barriers for use after that exposure.

1.5 This test method does not provide quantitative information about the perimeter fire barrier relative to the rate of leakage of smoke or gases or both. While it requires that such phenomena be noted and reported when describing the general behavior of perimeter fire barrier during the fire-resistance test, such phenomena are not part of the conditions of compliance.

1.6 Potentially important factors and fire characteristics not addressed by this test method include, but are not limited to:

1.6.1 The performance of the perimeter fire barrier constructed with components other than those tested, and

1.6.2 The cyclic movement capabilities of perimeter fire barriers other than the cycling conditions tested.

1.7 This test method is used to measure and describe the response of materials, products or assemblies to heat and flame under controlled conditions but does not by itself incorporate all factors required for the fire-hazard or fire-risk assessment of the materials, products, or assemblies under actual fire conditions.

1.8 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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[1] This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.11 on Fire Resistance.

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1.9 The text of this test method references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.10 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E84 Test Method for Surface Burning Characteristics of Building Materials

E108 Test Methods for Fire Tests of Roof Coverings

E119 Test Methods for Fire Tests of Building Construction and Materials

E176 Terminology of Fire Standards

E511 Test Method for Measuring Heat Flux Using a Copper-Constantan Circular Foil, Heat-Flux Transducer

E631 Terminology of Building Constructions

E1529 Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies

E1966 Test Method for Fire-Resistive Joint Systems

2.2 *Other Documents:*

Uniform Building Code Standard No. 26-9 Method of Test for the Evaluation of Flammability Characteristics of Exterior, Non-Loadbearing Wall Assemblies Containing Combustible Components Using the Intermediate-Scale Multistory Test Apparatus[3]

NFPA 285 Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components Using the Intermediate-Scale, Multistory Test Apparatus[4]

GA-600-2015[5] Fire Resistance Design Manual, 21st Edition

3. Terminology

3.1 Terms defined in Terminology E176 and E631 shall prevail for fire standard and building terms not defined in this document.

3.2 *Definitions:*

3.2.1 *blockout, n*—a recess formed in the floor assembly to accommodate the installation of the perimeter joint protection, flush with the wearing surface of the floor assembly.

3.2.2 *curtain wall assembly, n*—either a rated or non-rated, nonbearing exterior wall assembly secured to and supported by the structural members of the building.

3.2.3 *exterior wall assembly, n*—a curtain wall or a loadbearing exterior wall that is either fire resistance rated or one that is not.

3.2.4 *floor assembly, n*—a fire resistance rated loadbearing horizontal separating element adjacent to and separate from the floor of the observation room.

3.2.4.1 *Discussion*—Floor assemblies tested in accordance with Test Methods E119 are required to be loadbearing.

3.2.5 *integrity, n*—the ability of a perimeter fire barrier, when exposed to fire from two sides, to prevent the passage of flame and hot gases through it and the occurrence of flames on its unexposed sides as determined by using a cotton pad.

3.2.6 *maximum joint width, n*—the widest opening of the perimeter joint as defined by the test sponsor.

3.2.7 *minimum joint width, n*—the narrowest opening of the perimeter joint as defined by the test sponsor.

3.2.8 *movement cycle, n*—the change between the minimum and the maximum joint widths.

3.2.9 *nominal joint width, n*—the specified opening of the perimeter joint as defined by the test sponsor that is selected for test purposes.

3.2.10 *observation room, n*—the second-story room of the ISMA.

3.2.11 *perimeter fire barrier, n*—the perimeter joint protection that provides fire resistance to prevent the passage of fire from floor to floor within the building at the opening between the exterior wall assembly and the floor assembly. The boundaries are the edge of the floor assembly and the interior face of the exterior wall assembly in contact with the perimeter joint protection.

3.2.11.1 *Discussion*—For the purpose of this standard, a knee wall is not to be considered as part of the exterior wall.

3.2.12 *perimeter joint, n*—the linear void located between a juxtaposed exterior wall assembly and floor assembly to accommodate various movements induced by thermal differentials, seismicity, wind loads, and misalignments of the floor and wall during construction.

3.2.13 *perimeter joint protection, n*—a fire-resistive joint system located between the exterior wall assembly and the floor assembly that fills the perimeter joint.

3.2.13.1 *Discussion*—Fire-resistive joint system is defined in Test Method E1966.

3.2.14 *separating element, n*—a floor assembly or exterior wall assembly.

3.2.15 *splice, n*—the connection or junction within the length of a perimeter joint protection.

3.2.15.1 *Discussion*—A splice is a result of the device or method used to connect or join multiple lengths of the perimeter joint protection.

3.2.16 *supporting construction, n*—the arrangement of separating elements forming the intersection into which the perimeter joint protection is installed.

3.2.17 *test assembly, n*—the complete assembly of the test specimen together with the test apparatus.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] International Conference of Building Officials Inc., 5360 Workman Mill Rd., Whittier, CA 90601.

[4] National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101.

[5] Gypsum Association, 6525 Belcrest Road, Suite 480, Hyattsville, Maryland 20782.

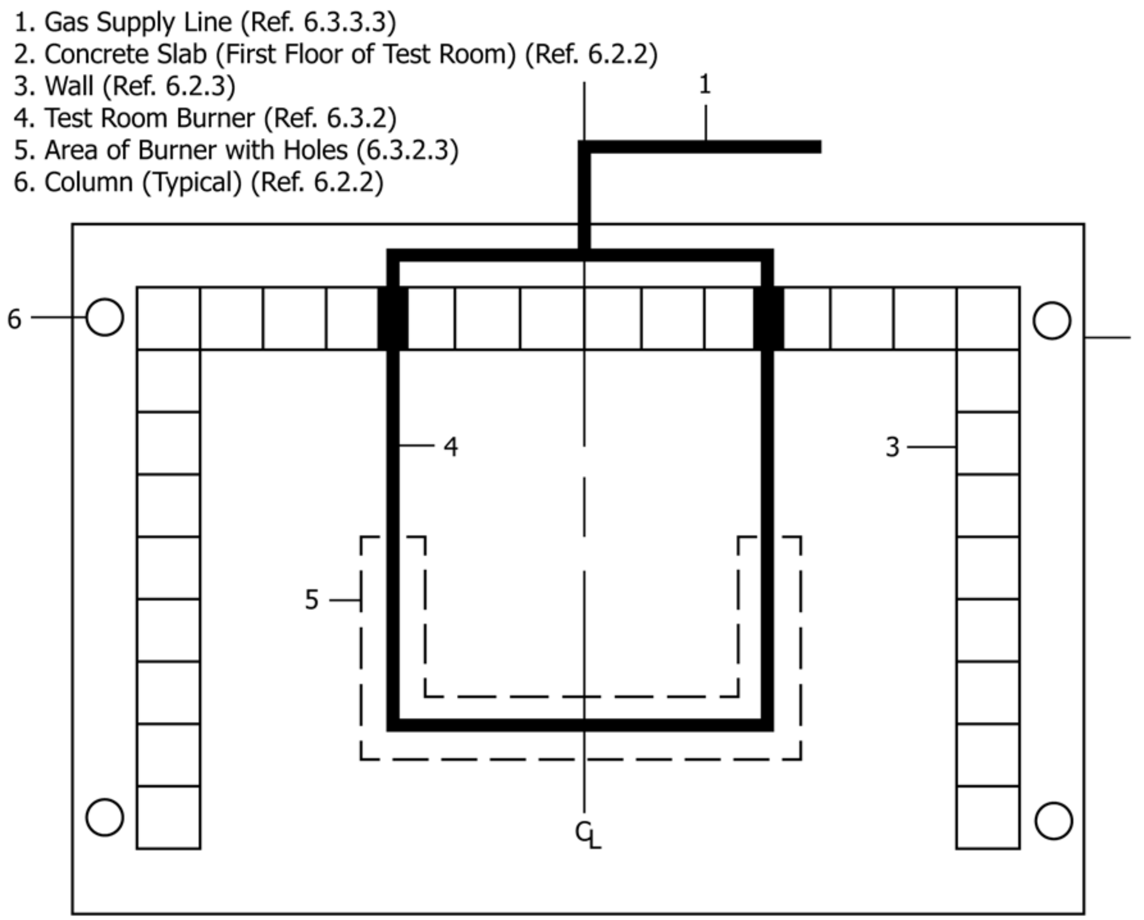


FIG. 1 Plan View of Test Room Burner Positioned in Test Room (See 6.3.2 for Dimensions)

3.2.18 *test room, n*—the first-story room of the ISMA.

3.2.19 *test specimen, n*—the specific test details of the perimeter fire barrier.

4. Summary of Test Method

4.1 This test method describes the following test sequence and procedure:

4.1.1 When the maximum joint width does not equal the minimum joint width, the perimeter fire barrier is movement cycled before being fire tested.

4.1.2 A perimeter joint protection and its supporting construction are conditioned and fire tested.

4.1.3 During the fire test, the integrity of the perimeter joint protection and its supporting construction is determined by use of a cotton pad.

5. Significance and Use

5.1 This test method provides for the following measurements and evaluations:

5.1.1 Movement capacity of the perimeter fire barrier.

5.1.2 Loadbearing capacity of the perimeter joint protection is optional.

5.1.3 Ability of the perimeter fire barrier to resist the passage of flames and hot gases.

5.1.4 Transmission of heat through the perimeter fire barrier.

5.2 This test method does not provide the following:

5.2.1 Evaluation of the degree to which the perimeter fire barrier contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion,

5.2.2 Measurement of the degree of control or limitation of the passage of smoke or products of combustion through the perimeter fire barrier,

NOTE 1—This test method does not measure the quantity of smoke or hot gases through the floor assembly, the wall assembly, or the perimeter joint protection.

5.2.3 Measurement of flame spread over the surface of the perimeter fire barrier,

NOTE 2—The information in 5.2.1 through 5.2.3 are determined by other suitable fire test methods. For example, Test Method E84 is used to determine 5.2.3.

5.2.4 Durability of the test specimen under actual service conditions, including the effects of cycled temperature,

5.2.5 Effects of a load on the movement cycling of the perimeter fire barrier established by this test method,

5.2.6 Rotational, vertical, and horizontal shear capabilities of the test specimen,

5.2.7 Any other attributes of the test specimen, such as wear resistance, chemical resistance, air infiltration, water-tightness, and so forth, and

(1) Window Burner (see 6.3.3)
(2) Slot in Burner (see 6.3.3.2)
(3) Gas Supply Line (see 6.3.3.3)
(4) Perimeter Joint Protection (see 3.2.13)
(5) Window (see 7.3.9)
(6) Test Room in Test Apparatus (see 3.2.18)
(7) Observation Room in Test Apparatus (see 3.2.10)
(8) Horizontal Centerline of Burner (see 6.3.3.5)
(9) Vertical Centerline of Burner (see 6.3.3.5)
(10) Window Burner Location During Test (see 6.3.3.5)
(11) Exterior Wall Assembly or Calibration Wall (see 7.3 and 9.2)
(12) Test Apparatus (ISMA) (see 6.2)
(13) Floor Assembly (see 7.4)
(14) Floor of Observation Room (see 6.2.4.2)
(15) Roof Slab (see 6.2.2)
(16) Floor of Test Room (see 6.2.2)
(17) Window Sill Height (see 7.3.9.2)

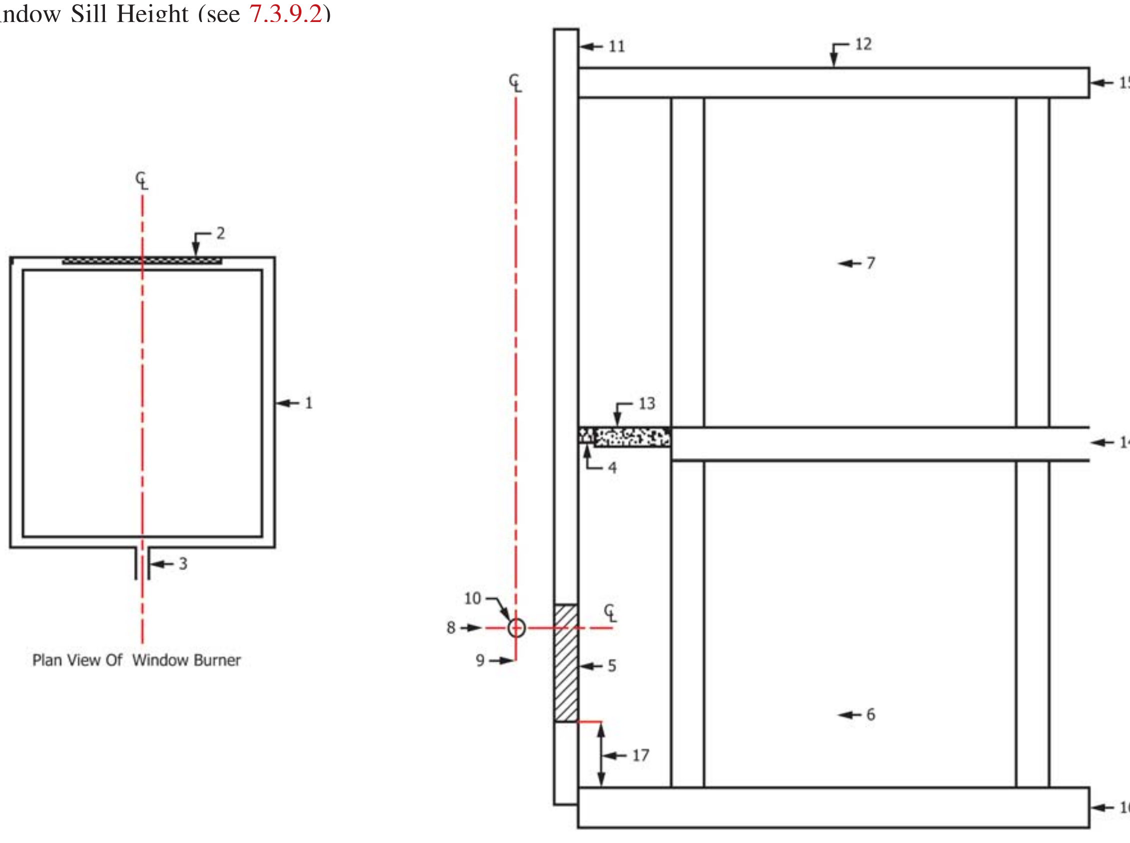


FIG. 2 Plan View of Window Burner and Side Elevation View of Window Burner Location

5.2.8 A measurement of the capability of the test specimen to resist:

5.2.8.1 Flame propagation over the exterior faces of the test specimen,

5.2.8.2 Spread of flame within the combustible core component of the exterior wall assembly from one story to the next,

NOTE 3—Some exterior wall assemblies are made from sandwich panels, which use EPS foam or other similar materials that are combustible.

5.2.8.3 Spread of flame over the interior surface (room side) of the test specimen from one story to the next, and

NOTE 4—While it is a failure to have fire on the interior surface of the observation room, this test method does not provide a measurement of that flame spread.

5.2.8.4 Lateral spread of flame from the compartment of fire origin to adjacent spaces.

NOTE 5—The exterior wall assembly, floor assembly, and perimeter joint protection are individual components. The capabilities of individual components are not part of this specific test method's Conditions of Compliance.

5.3 In this test method, the test specimens are subjected to one or more specific test conditions. When different test

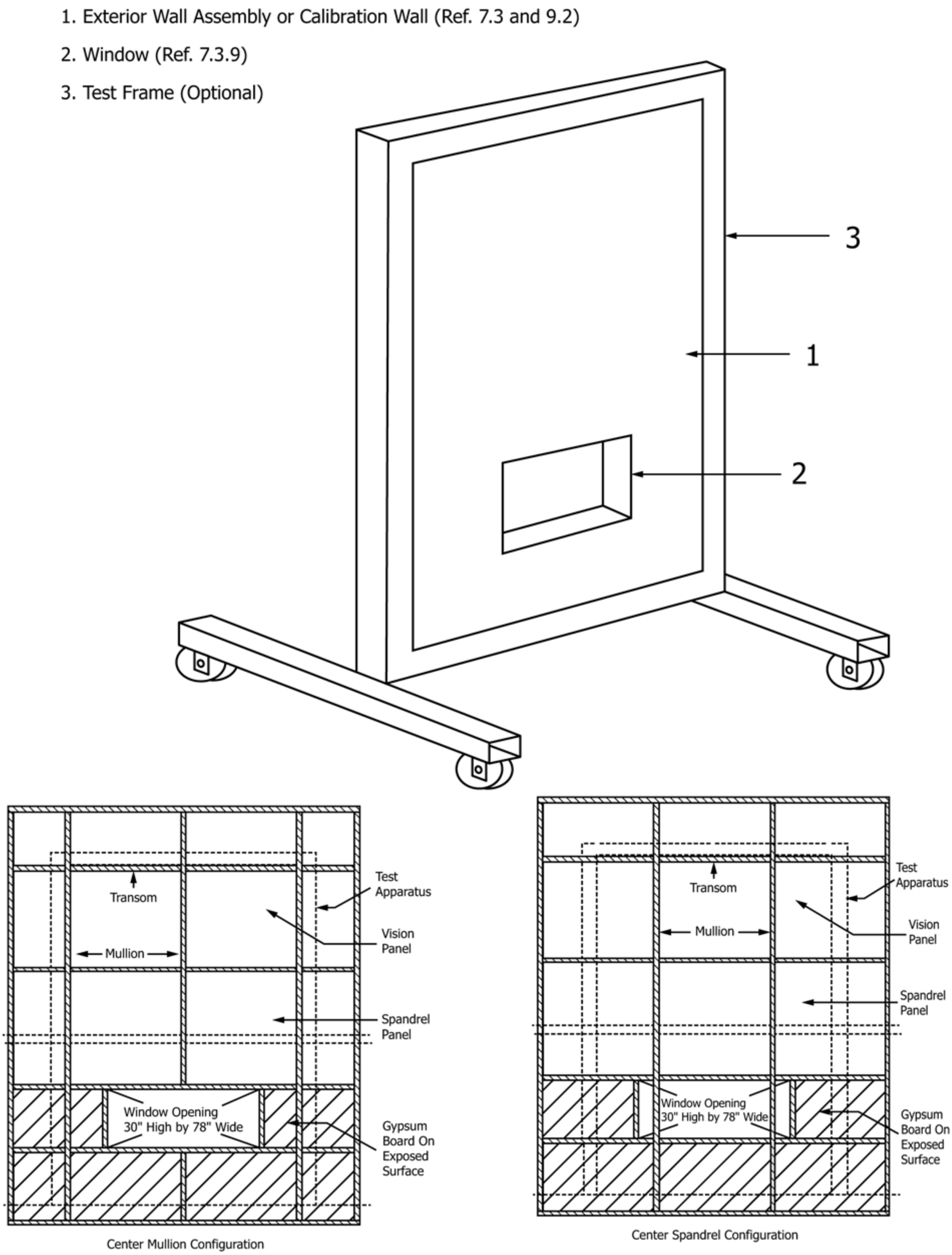


FIG. 3 Example of an Exterior Wall Assembly with Window Opening in a Test Frame (See 7.3.1)

conditions are substituted or the end-use conditions are changed, it is not always possible by, or from, this test method to predict changes to the characteristics measured.

5.4 This test method is not intended to be used as the only test method in the selection of a perimeter fire barrier. It is not intended as a specification for all attributes required by a

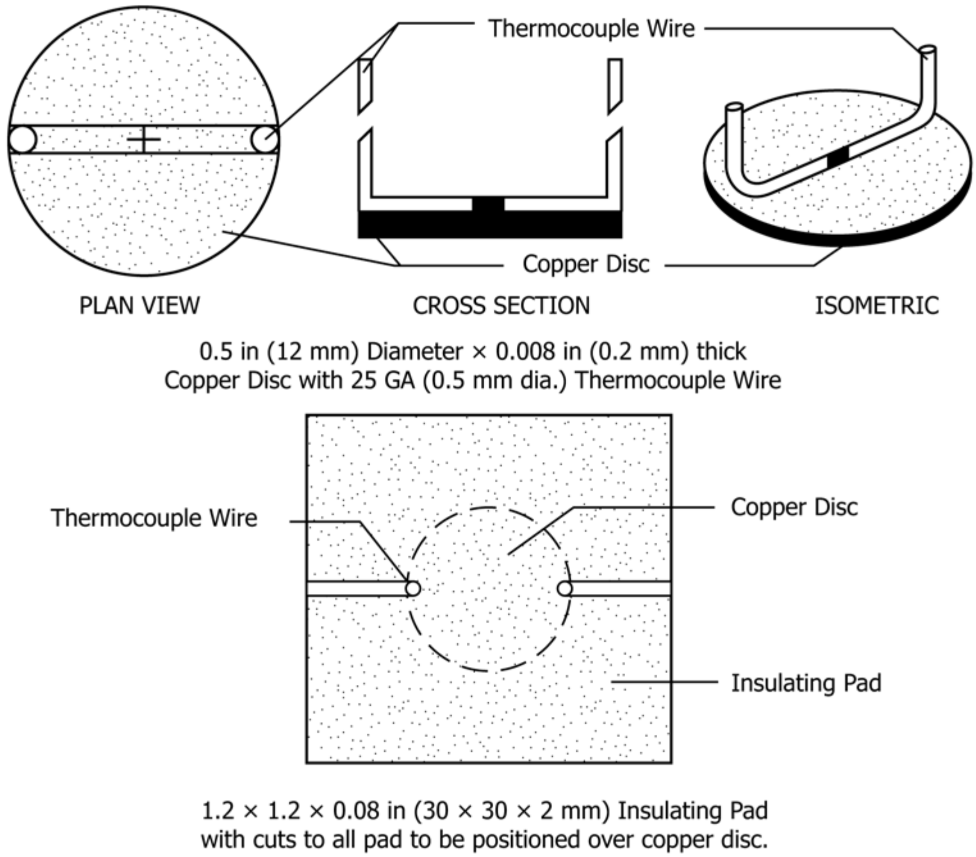


FIG. 4 Typical Copper Thermocouple Disc and Insulating Pipe (See 6.6 and 6.7)

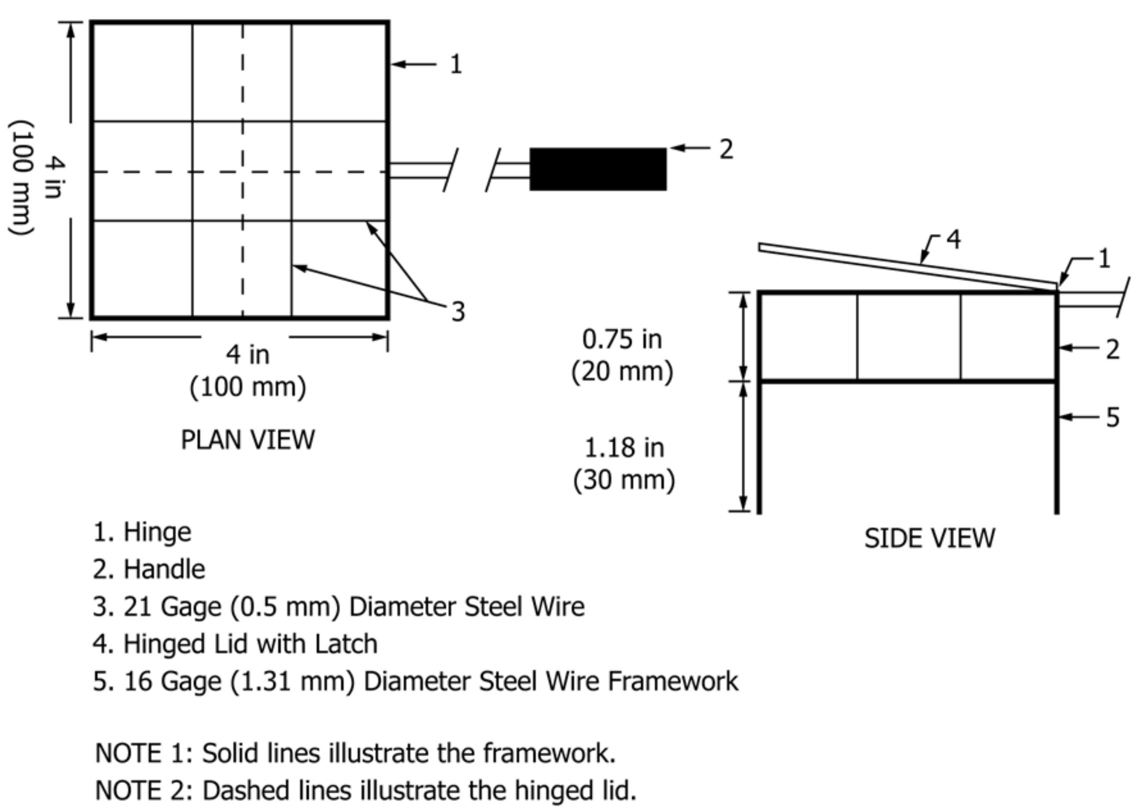


FIG. 5 Typical Cotton Wool Pad Holder (See 6.8.2)

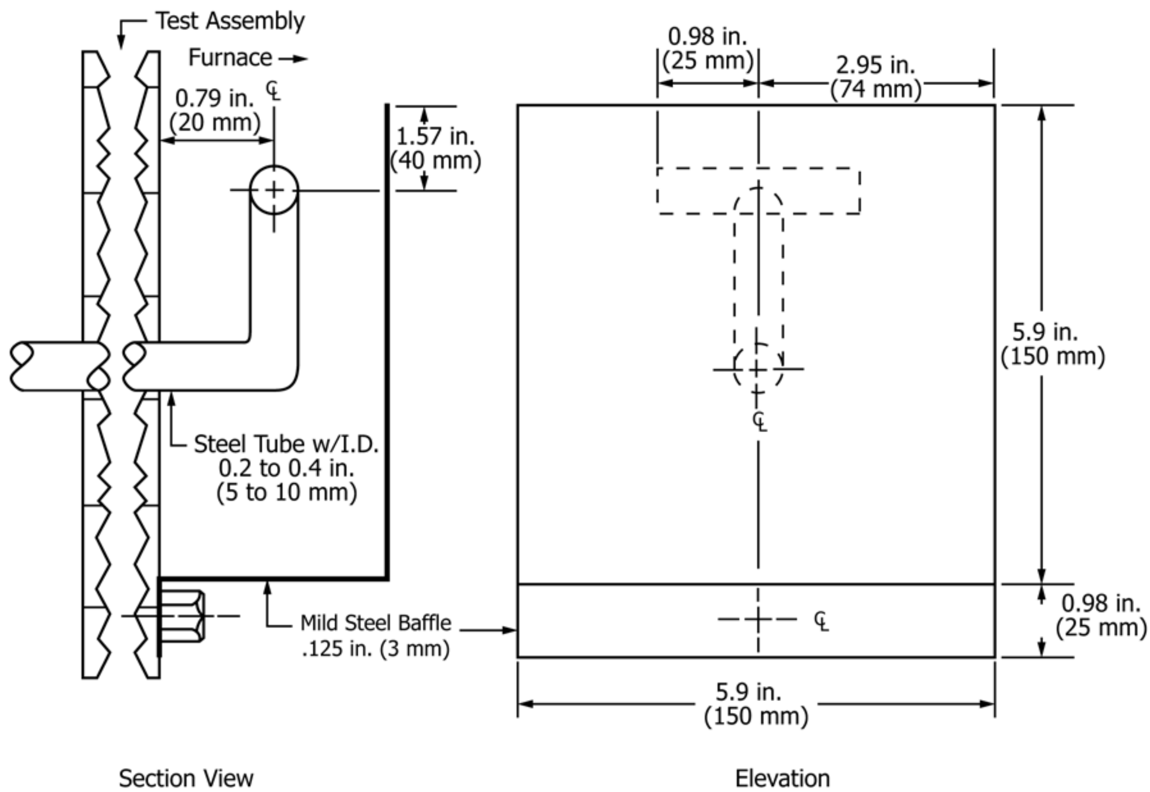


FIG. 6 T-Shaped Sensor (See 6.10.1.1)

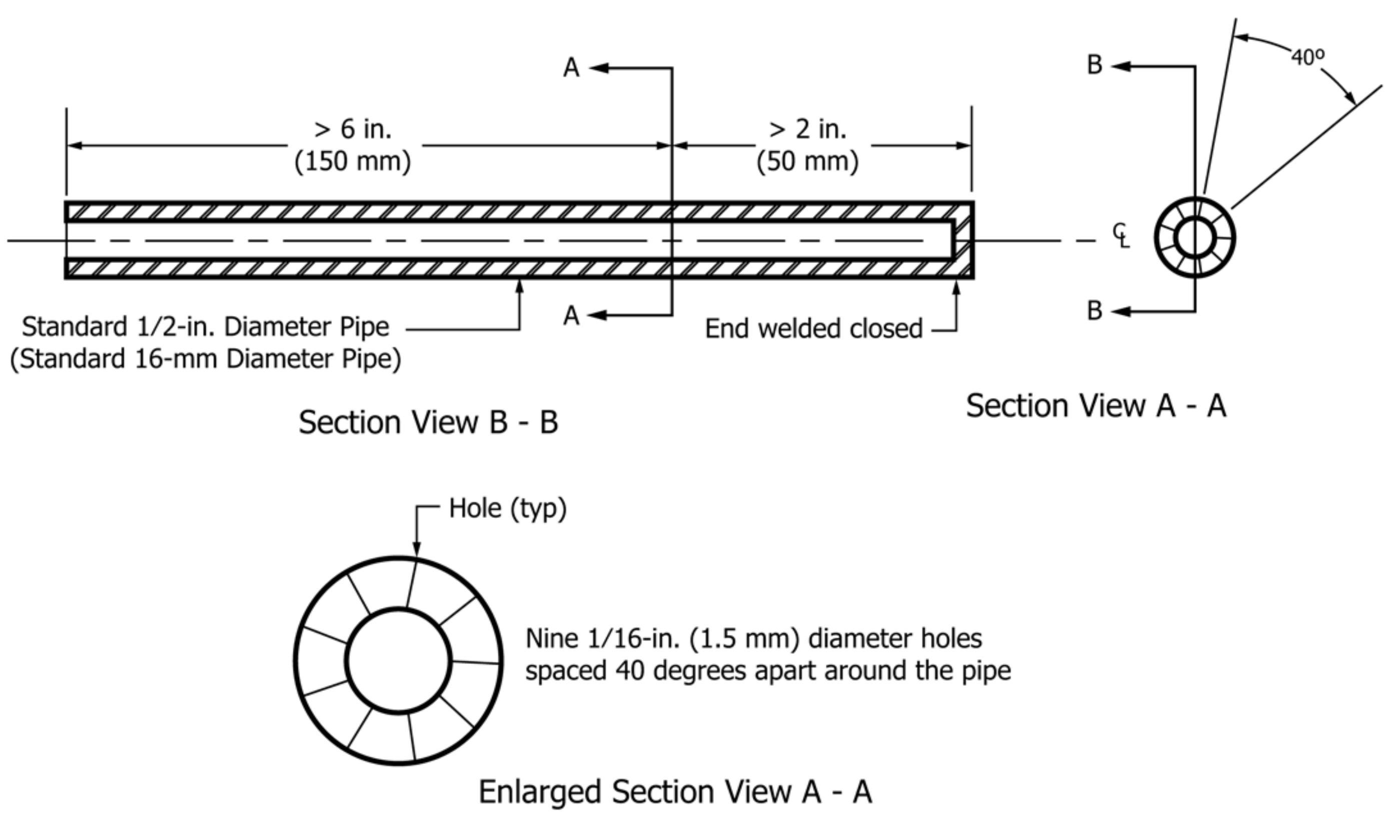


FIG. 7 Tube Sensor (See 6.10.1.2)

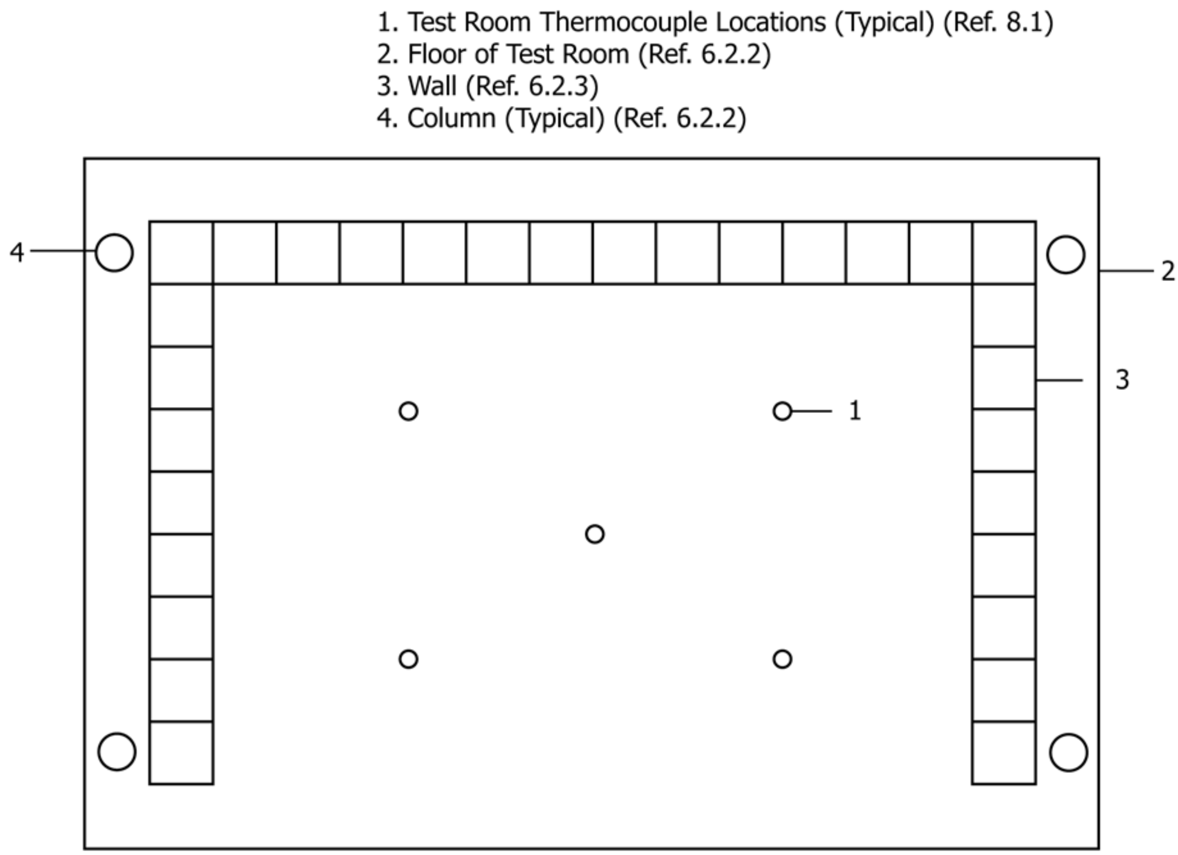


FIG. 8 Exposed Thermocouple Layout on Underside of Observation Room Floor in Test Room (See 8.1)

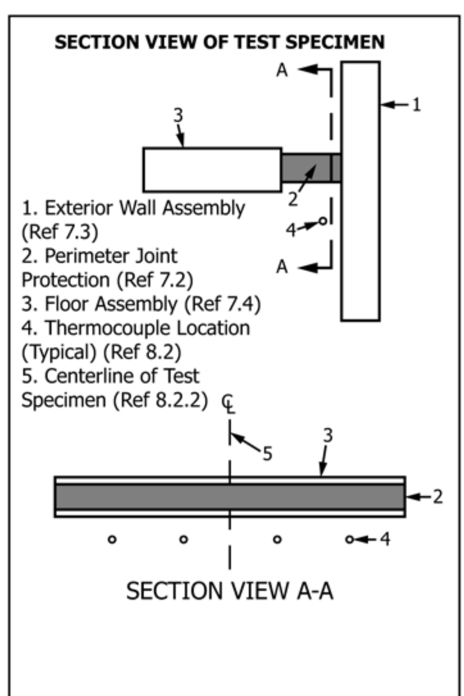


FIG. 9 Exposed Thermocouple Layout in Test Room (See 8.2)

perimeter fire barrier, or any of its individual components, in order for a perimeter fire barrier to be used in a particular application.

6. Apparatus

6.1 The test apparatus described in 6.2 shall be located inside a test facility. The facility shall have provisions for supplying fresh combustion make-up air during the test. The facility shall be constructed to allow for the exhaust of the combustion by-products during the test, while not inducing airflow on the exterior face of the test specimen. The test facility shall protect the test apparatus and test specimen from weather conditions such as wind and rain.

6.2 *Test Apparatus:*

6.2.1 The ISMA consists of a two-story test structure consisting of a test room and observation room (See Fig. 2.). Each room in the test apparatus is square having inside length and width dimensions (unfinished and unprotected by any fire resistive materials) of 120 ± 0.5 in. (3048 ± 13 mm) and a height (unfinished and unprotected by any fire resistive materials) of 84 ± 0.5 in. (2134 ± 13 mm).

NOTE 6—The test apparatus is similar to the one used in U.B.C. Standard No. 26-9 and NFPA 285.

6.2.2 The floors and roof of the test apparatus shall be supported by columns and beams of a size that will support the load of the floor and roof. These supports shall be located outside of both the test room and the observation room. The floor of the observation room shall be 8 ± 0.5 in. (203 ± 13 mm) thick (See Fig. 8.).

6.2.3 The three permanent non-bearing walls that form each room of the test apparatus shall support the insulation defined in 6.2.4.1 during the entire fire-resistance test.

NOTE 7—Concrete block, 8 ± 0.5 in. (203 ± 13 mm) thick, has been found to be acceptable.

6.2.4 No insulation is required in the observation room; but the interior surfaces of the test room shall be insulated.

6.2.4.1 Insulate the interior face of the walls forming the test room with one layer of nominal 0.625-in. (15.9-mm) thick, Type X gypsum wallboard and one layer of nominal 1.5-in. (38-mm) thick ceramic fiber insulation, having a minimum density of 8 lb/ft^3 (128 kg/m^3), on the interior face. The maximum insulation thickness permitted on each face is 2.5 in. (64 mm). Insulate the underside of the floor of the observation room in the same manner, except the portion that is designated the "floor assembly," which is adjacent to the perimeter joint protection, shall not be insulated (See Fig. 2 and 7.4.).

6.2.4.2 Insulate the floor of the test room with two layers of nominal 0.625-in. (15.9-mm) thick, Type X gypsum wallboard.

6.2.5 Each room shall have one access opening with a width and height of nominal 3.5 by 6.75 ft (1.07 by 2.06 m). The access opening of the test room shall be capable of being closed during tests while the access opening of the observation room shall remain open during tests.

6.2.5.1 Additional access openings are permitted in the observation room for instrumentation and video; however, they shall be closed during the test.

6.3 *Burners:*

6.3.1 The test apparatus in 6.2shall be equipped with two gas-fired burners.

6.3.2 *Test Room Burner:*

6.3.2.1 Position the test room burner inside the test room. Construct the test room burner (See Fig. 1) as follows:

6.3.2.2 Use a nominal 2-in. (51-mm) OD steel pipe. The test room burner shall be rectangular shaped with its longitudinal axis at least 78.75 in. (2000 mm) long and its transverse axis at least 60 in. (1524 mm) wide. Extend 72 ± 1 in. (1829 ± 25 mm) of the test room burner into the test room.

6.3.2.3 Drill upward facing nominal diameter 0.125-in. (3.2-mm) holes in the pipe. Locate the holes in the front "U" shaped portion of the test room burner. Start holes at a nominal location of 42 in. (1066 mm) from the back wall on both sides of the gas supply pipes and continue across the front gas supply pipe. Place the holes nominally 1 in. (25 mm) on center.

NOTE 8—The holes drilled are nominal because they are made using a conventional ⅛-in. drill bit, therefore, their size is dependent upon the tolerances of the drill bit.

6.3.2.4 Support the test room burner so that it is level and its horizontal centerline is 30 ± 1 in. (762 ± 25 mm) above the floor of the test room.

6.3.2.5 Center the test room burner in the test room using Fig. 1 for reference.

6.3.2.6 Equip the test room burner with a gas supply line that is located outside the test apparatus. Wrap the entire gas supply pipe system with a single layer of nominal 1-in. (25-mm) thick ceramic fiber blanket, with a minimum density of 8 lb/ft^3 (128 kg/m^3).

6.3.3 *Window Burner:*

6.3.3.1 Construct the window burner (See Fig. 2) as follows:

NOTE 9—The window burner is similar to the one used in U.B.C. Standard No. 26-9 and NFPA 285 and is similar to the burner used in the "Spread of Flame Test" portion of Test Methods E108.

6.3.3.2 The window burner shall be rectangular shaped. Use a 60 ± 0.5-in. (1524 ± 13-mm) long piece of nominal 2-in. (51-mm) OD pipe for the front of the burner. Cut an upward facing slot having a width and length measuring 0.5 ± 0.06 in. (13 ± 1.5 mm) by 44 ± 0.5 in. (1118 ± 13 mm), respectively, in the top of the pipe.

6.3.3.3 Supply the window burner with gas at both ends using nominal 1-in. (25-mm) OD pipe and a "T" junction at the back of the window burner to provide uniform gas pressure at the burner slot.

6.3.3.4 Wrap the window burner, including the slot, and the entire gas supply pipe system with a layer of nominal 1-in. (25-mm) thick ceramic fiber insulation, with a minimum density of 8 lb/ft^3 (128 kg/m^3).

6.3.3.5 Position the window burner so that the slot is facing up and parallel with the exterior wall assembly. Align the horizontal center of the window burner slot with the window's horizontal centerline (See Fig. 2.). Locate the horizontal centerline of the window burner 9 ± 0.5 in. (229 ± 13 mm) below the window header's surface on the exterior of the test room. Place the window burner's vertical centerline a maximum of 6 in. (152 mm) from the exterior face of the exterior wall assembly. The window burner's exact distance from the wall's exterior face of the exterior wall assembly shall be determined during the calibration procedure, as specified in 9.6.

6.4 *Cycling Apparatus*—Equipment (or device) shall be used that is capable of inducing movement of a perimeter fire barrier as specified in Table 3.

6.5 *Test Room and Exterior Wall Assembly Thermocouples:*

6.5.1 All thermocouples shall be a bare wire type.

6.5.2 The twelve test room thermocouples used to measure the temperatures in the test room, reference the thermocouples in 8.1, 8.2 and 8.3, shall be 18 gage Type K (See Figs. 8 and 9.).

6.5.3 The 14 exterior wall assembly thermocouples used to measure the temperatures on the exterior face of the exterior wall assembly shall be 20 gage Type K (See Fig. 10.).

6.6 *Copper Disc Thermocouples:*

6.6.1 The copper disc thermocouples shall be covered by pads as specified in 6.7 and shall:

6.6.1.1 Have a wire diameter of not more than 0.03 in. (0.7 mm), and

6.6.1.2 Be brazed to the center of the face of a copper disk having the following nominal measurements: 0.5 in. (12 mm) diameter and 0.008 in. (0.2 mm) thick (See Fig. 4.).

6.7 *Thermocouple Insulating Pads:*

6.7.1 Refractory fiber pads shall have the following properties:

6.7.1.1 Length and width of 1.20 ± 0.02 in. (30 ± 0.5 mm),

6.7.1.2 Thickness of 0.08 ± 0.02 in. (2 ± 0.5 mm), and

6.7.1.3 Density of 56.2 ± 6.2 lb/ft^3 (900 ± 100 kg/m^3).

6.7.2 When necessary, shape the pads by wetting, forming, and then drying them to provide complete contact on contoured surfaces.

6.8 *Cotton Pads:*

6.8.1 The cotton pad's nominal size shall be 4 by 4 by 0.75 in. (100 by 100 by 19 mm). Cotton pads are to consist of new, undyed, and soft cotton fibers, without any admixture of artificial fibers. Each cotton pad shall weigh 3 to 4 g. The cotton pads are to be conditioned prior to use by drying in an oven at 212 ± 9°F (100 ± 5°C) for at least 30 min. After drying, the cotton pads shall be stored in a desiccator for up to 24 h immediately prior to use.

6.8.2 The frame used to hold the cotton pad is to be formed of No. 16 AWG (1.31-mm) steel wire and is to be provided with a handle that will reach all points of the test specimen accessible from the observation room (See Fig. 5.).

TABLE 1 Gas and Heat Flow Rates

Time Interval	Test Room Burner SCFM (m^3/min)	Test Room Burner Btu/min (kW)	Window Burner SCFM (m^3/ min)	Window Burner Btu/min (kW)
0:00 - 5:00	38.0 (1.08)	39 064 (687)	0.0 (0.00)	0 (0)
5:00 - 10:00	38.0 (1.08)	39 064 (687)	9.0 (0.25)	9252 (163)
10:00 - 15:00	43.0 (1.22)	44 204 (777)	12.0 (0.34)	12 336 (217)
15:00 - 20:00	46.0 (1.30)	47 288 (831)	16.0 (0.45)	16 448 (289)
20:00 - 25:00	46.0 (1.30)	47 288 (831)	19.0 (0.54)	19 532 (343)
25:00 - 30:00	50.0 (1.42)	51 400 (904)	22.0 (0.62)	22 616 (398)

6.9 *Loading System:*

6.9.1 Use equipment, or device, capable of inducing a desired load upon the perimeter joint protection.

6.10 *Pressure-Sensing Probes*—Except for the diameters of the steel tubes, tolerances are ±5 % of dimensions shown in Fig. 6 or Fig. 7.

6.10.1 The pressure-sensing probes shall be either:

6.10.1.1 A T-shaped sensor as shown in Fig. 6, or

6.10.1.2 A tube sensor as shown in Fig. 7.

6.11 *Differential Pressure Measurement Instruments:*

6.11.1 The differential pressure measurement instrument shall be:

6.11.1.1 A manometer or transducer, and

6.11.1.2 Capable of reading in graduated increments of no greater than 0.01 in. H_2O (2.5 Pa) with a precision of not less than ± 0.005 in. H_2O (±1.25 Pa).

6.12 *Calibration Instrumentation:*

NOTE 10—More information about the Gardon gage is contained in Test Methods E511 and E1529.

6.12.1 Flow rate measurement equipment shall be provided for each of the burners.

7. Test Specimen

7.1 The test specimen shall be representative of the construction for which the fire-resistance rating is desired with respect to materials, workmanship, and details. Install the test specimen according to the manufacturer's specified procedure for conditions representative of those found in building construction.

7.2 *Perimeter Joint Protection:*

7.2.1 Test each perimeter joint protection with manufactured and field splices. When the technique of the manufactured splice is the same as the field splice, test only one splice. The minimum distance between a splice and the nearest side wall of the observation room shall be 1.5 times the thickness of the supporting construction or 12 in. (305 mm), whichever is greater. The minimum separation between splices within a test specimen shall be 36 in. (914 mm).

7.2.2 Fire test all perimeter joint protection at its maximum joint width.

7.2.3 The perimeter joint protection shall be at least 13 ft (4.06 m) long.

7.2.4 When the perimeter joint protection has vertical or horizontal butt joints or seams as part of its design, these joints or seams shall be installed according to the manufacturer's instructions.

7.3 *Exterior Wall Assemblies:*

7.3.1 The exterior wall assembly shall be a construction agreed upon by the test sponsor and laboratory (See Fig. 3.).

7.3.2 The exterior wall assembly shall be representative of that used in common construction practice.

7.3.3 The exterior wall assembly shall be secured to the test apparatus at each end. These fastening details to the test apparatus and those elsewhere within the test specimen shall be representative of that used in practice.

TABLE 2 Average Calibration Values

	Time (min)					
	0-5	5-10	10-15	15-20	20-25	25-30
Test Room Average °F (°C) using TC's in 8.1	1151 (622)	1346 (730)	1482 (806)	1600 (871)	1597 (869)	1648 (898)
Interior Face of Exterior Wall Assembly Average °F (°C) using TC's in 8.3	1065 (574)	1298 (703)	1433 (778)	1578 (859)	1576 (858)	1655 (902)
TC #2 - 6 ft (1829 mm) above Top of Floor of Test Room on Exterior Face of Exterior Wall °F(°C)	602 (317)	870 (466)	952 (511)	992 (533)	1046 (563)	1078 (581)
TC #3 - 7 ft (2134 mm) above Top of Floor of Test Room on Exterior Face of Exterior Wall Assembly °F(°C)	679 (359)	1015 (546)	1121 (605)	1183 (639)	1245 (674)	1296 (702)
TC #4 - 8 ft (2438 mm) above Top of Floor of Test Room on Exterior Face of Exterior Wall Assembly °F(°C)	646 (341)	971 (521)	1096 (591)	1174 (634)	1245 (674)	1314 (712)
TC #5 - 9 ft (2743 mm) above Top of Floor of Test Room on Exterior Face of Exterior Wall Assembly °F(°C)	577 (302)	858 (459)	982 (528)	1063 (573)	1135 (613)	1224 (662)
TC #6 - 10 ft (3048 mm) above Top of Floor of Test Room on Exterior Face of Exterior Wall Assembly °F(°C)	521 (272)	765 (407)	875 (469)	949 (509)	1007 (542)	1106 (597)
TC #7 - 11 ft (3353 mm) above Top of Floor of Test Room on Exterior Face of Exterior Wall Assembly °F(°C)	472 (244)	690 (366)	787 (419)	856 (458)	913 (489)	1010 (543)
Calorimeter 7 ft (2134 mm) above Top of Floor of Test Room W/in.^{2} (W/cm^2)	5.81 ± 1.29 (0.9 ± 0.2)	12.26 ± 2.58 (1.9 ± 0.4)	16.13 ± 3.23 (2.5 ± 0.5)	18.7 ± 3.87 (2.9 ± 0.6)	21.94 ± 4.52 (3.4 ± 0.7)	24.52 ± 5.16 (3.8 ± 0.8)
Calorimeter 8 ft (2438 mm) above Top of Floor of Test Room W/in.^{2} (W/cm^2)	6.45 ± 1.29 (1.0 ± 0.2)	12.90 ± 2.58 (2.0 ± 0.4)	16.77 ± 3.23 (2.6 ± 0.5)	20.65 ± 3.87 (3.2 ± 0.6)	23.87 ± 4.52 (3.7 ± 0.7)	25.81 ± 5.16 (4.0 ± 0.8)
Calorimeter 9 ft (2743 mm) above Top of Floor of Test Room W/in.^{2} (W/cm^2)	5.16 ± 1.29 (0.8 ± 0.2)	9.68 ± 1.94 (1.5 ± 0.3)	12.90 ± 2.58 (2.0 ± 0.4)	16.13 ± 3.23 (2.5 ± 0.5)	19.35 ± 3.87 (3.0 ± 0.6)	21.94 ± 4.52 (3.4 ± 0.7)

TABLE 3 Conditions of Test Specimen Cycling

Movement Type	Minimum Cycling Rates (cpm)	Minimum Number of Movement Cycles
Thermal	1	500
Wind Sway	10	500
Seismic	30	100
Combined	30	100
	followed by:	
	10	400

NOTE 1—The terms used for movement are indicative of the cyclic rate in expansion and contraction of the perimeter joint and not of the magnitude or direction of movement.

7.3.4 Details of the erection shall follow the manufacturer's instructions and shall be typical of actual use.

7.3.5 Prior to the test, the exterior wall assembly and its components shall be conditioned as outlined in Section 10.

7.3.6 The minimum height and width of the exterior wall assembly shall be 17.5 by 13.33 ft (5.34 by 4.06 m wide).

7.3.7 The exterior wall assembly shall extend as follows:

7.3.7.1 Below the floor of the test room a minimum of 2 in. (51 mm),

7.3.7.2 Above the top of the test apparatus a minimum of 24 in. (610 mm), and

7.3.7.3 Past the inside edges of both sidewalls of the apparatus a minimum of 12 in. (305 mm).

7.3.8 The exterior wall assembly shall completely close the front face of the test apparatus except for a simulated window opening in the test room.

7.3.9 The window shall:

7.3.9.1 Have a height and width measuring 30 by 78 in. (762 by 1981 mm) with a tolerance of ±0.5 in. (±13 mm). The exterior wall assembly shall include two layers of nominal 0.625-in. (15.9-mm) thick Type X gypsum wallboard covering an area extending downward from a horizontal line at the elevation of the window lintel to the bottom of the exterior wall assembly minus the window opening. The gypsum wallboard shall be located and fastened as shown on Fig. 14.

1. Roof Slab (Ref. 6.2.2)
2. Column (Ref. 6.2.2)
3. Floor of Observation Room (Ref. 6.2.2)
4. Floor of Test Room (Ref. 6.2.2)
5. Window Opening (Ref. 9.2.2)
6. Visual Face of Calibration Wall (Ref. 9.2)
7. Vertical Centerline of Test Wall (Ref. 9.4.1)
8. Thermocouple #1 Location (Ref. 9.4.1.1)
9. Thermocouple #2 Location (Ref. 9.4.1.2)
10. Thermocouple #14 Location (Ref. 9.4.1.4)

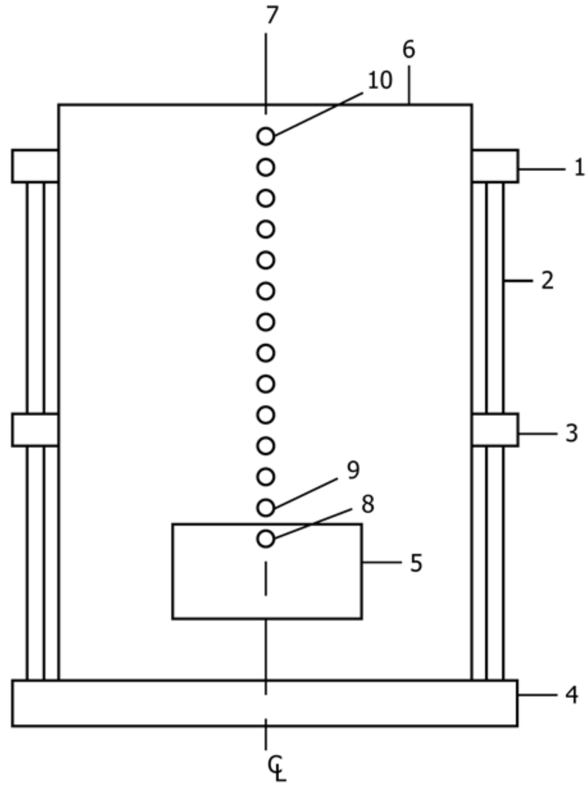
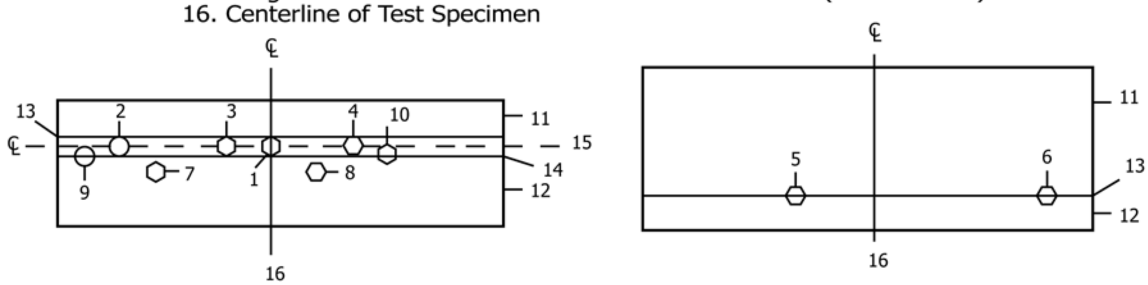


FIG. 10 Thermocouple Layout on Visual Exterior Face of Calibration Wall (See 9.4)

1. Splice Thermocouple (Ref. 12.2.4.1)
2. Longitudinal Centerline Thermocouple (Ref. 12.2.4.2)
3. Longitudinal Centerline Thermocouple (Ref. 12.2.4.2)
4. Longitudinal Centerline Thermocouple (Ref. 12.2.4.2)
5. Junction Thermocouple - Exterior Wall Assembly & Perimeter Joint Protection (Ref. 12.2.4.3)
6. Junction Thermocouple - Exterior Wall Assembly & Perimeter Joint Protection (Ref. 12.2.4.3)
7. Floor Assembly Thermocouple (Ref. 12.2.4.4)
8. Floor Assembly Thermocouple (Ref. 12.2.4.4)
9. Junction Thermocouple - Floor Assembly & Perimeter Joint Protection (Ref. 12.2.4.5)
10. Junction Thermocouple - Floor Assembly & Perimeter Joint Protection (Ref. 12.2.4.5)
11. Exterior Wall Assembly (Ref. 7.3)
12. Floor Assembly (Ref. 7.4)
13. Junction of Exterior Wall Assembly and Perimeter Joint Protection (Ref. 12.2.4.3)
14. Junction of Floor Assembly and Perimeter Joint Protection (Ref. 12.2.4.5)
15. Longitudinal Centerline of Perimeter Joint Protection (Ref. 12.2.4.2)
16. Centerline of Test Specimen



Plan View of Observation Room Floor at Perimeter Joint Treatment

Interior Elevation View of Observation Room Floor

FIG. 11 Layout of Unexposed Surface Thermocouples (See 12.2)

7.3.9.2 For the calibration wall, have a sill height of 30 ± 0.5 in. (762 ± 13 mm), and for the exterior wall assembly, the position of the window shall be documented in relation to the bottom of the floor assembly that abuts the perimeter joint protection.

7.3.9.3 Be centered horizontally with respect to the test room, and

7.3.9.4 Be the only opening in the test room at the start of the test.

7.3.10 *Spandrel Beam:*

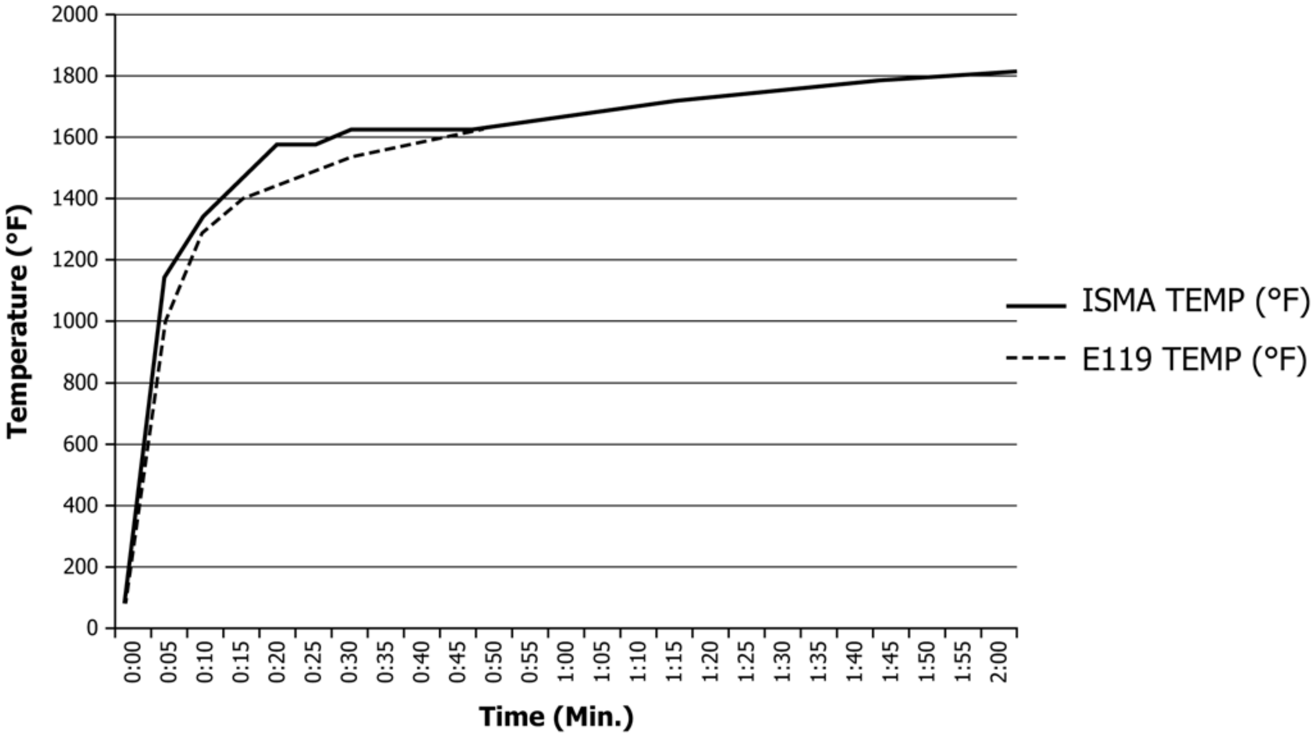


FIG. 12 ISMA / E119 Time Temperature Curves (See Note 5)

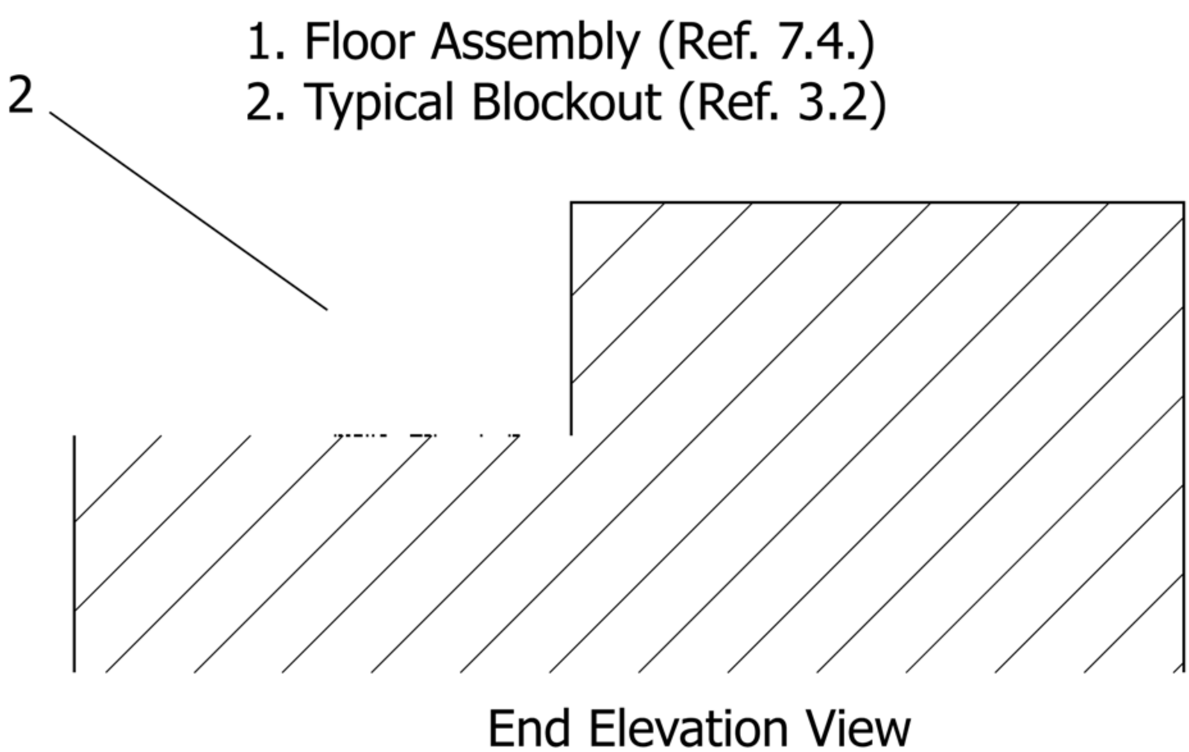


FIG. 13 Typical Blockout (See 12.2.4.3)

7.3.10.1 Secure a spandrel beam to the underside of the floor assembly construction when its use is required to represent the common construction practice attachment of the exterior wall assembly,

7.3.10.2 Extend the spandrel beam across the test room from one interior wall surface to the opposite interior wall surface of the test room.

Notes:

The base layer of the 5/8-in. Type X gypsum wallboard to be applied at right angles or parallel to vertical framing members (i.e. mullions) using nom. 1-in. screws spaced 24±1 in. on center. Space screws 1/2±1/8 in. from vertical end joints of gypsum wallboard and 3/4±1/8 in. from horizontal end joints of gypsum wallboard.

The face layer of the 5/8-in. Type X gypsum wallboard to be applied over base layer at right angles or parallel to vertical framing members (i.e. mullions) using nom. 1-5/8-in. screws spaced 12±1 in. on center. Space screws 1/2±1/8 in. from vertical end joints of gypsum wallboard and 3/4±1/8 in. from horizontal end joints of gypsum wallboard.

Stagger gypsum wallboard joints 24±1 in. on center between the base and face layers.

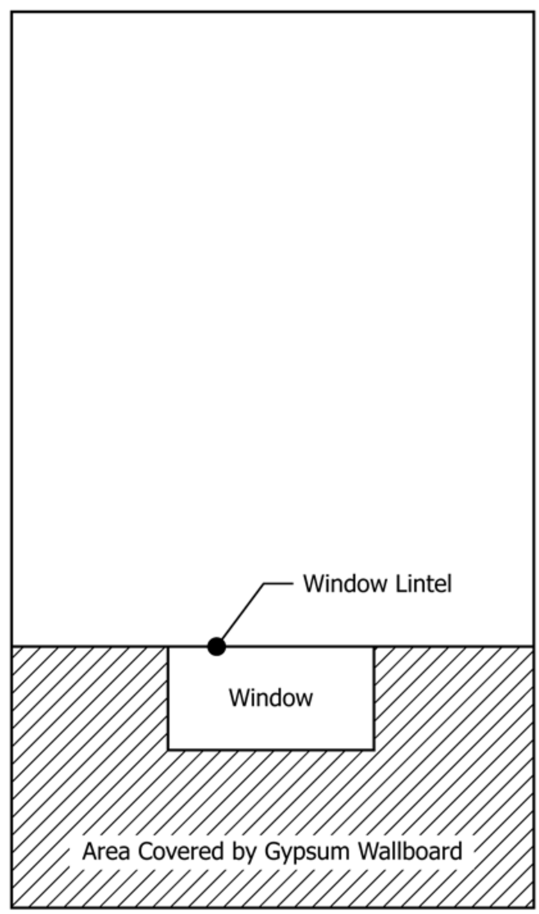


FIG. 14 Elevation View of Interior Face of the Exterior Wall Assembly Illustrating Gypsum Wallboard Location (See 7.3.9.1)

7.3.10.3 The spandrel beam shall be as used in common construction practice. Protect any outriggers and additional connections as used in common construction practice.

7.4 *Floor Assembly:*

7.4.1 The floor assembly installed into the test apparatus shall have a fire-resistance rating and representative of that used in common construction practice and be at least 12 in. (305 mm) wide and at least 13 ft (3.96 m) long.

7.4.2 The top of the floor assembly shall be located at an elevation ±0.5 in. (±13 mm) relative to the elevation of the top of the observation room floor.

8. Test Room Controls

8.1 *Test Room Thermocouples—Underside of the Observation-Room Floor:*

8.1.1 Uniformly distribute at least five bare wire thermocouples to measure the temperature at the underside of the floor of the observation room (See Fig. 8.).

8.1.2 The exposed length of the bare wire thermocouples positioned at the underside of the observation room floor shall be at least 6 in. (152 mm).

8.2 *Test Room Thermocouples Monitoring the Test Specimen:*

8.2.1 Position at least four bare wire thermocouples to measure the test room temperature in the vicinity of the test specimen (See Fig. 9.).

8.2.2 Locate the end of the bare wire thermocouple used to measure the temperatures of the side of the test specimen 6 ± 0.25 in. (305 ± 6 mm) exposed to fire from both the underside of the perimeter joint protection and the interior face of the test room of the exterior wall assembly. Locate four bare wire thermocouples 24 ± 1 in. (610 ± 25 mm) apart and symmetrically distributed from the centerline of the test assembly (See Fig. 9.).

8.2.3 Verify the distance established in 8.2.2 at intervals not exceeding 10 min during the first 30 min of the test and thereafter at intervals not exceeding 30 min.

NOTE 11—The method used to accomplish verification of thermocouple position is at the discretion of the laboratory. One possible method is to measure the distance of the thermocouple wire or tube prior to commencing the test and then extend the wire or tube until it touches the interior face of the exterior wall that is exposed to fire.

8.2.4 Whenever the distance is not as specified in 8.2.2, reset the distance to comply with 8.2.2.

8.3 *Interior Face Exterior Wall Assembly Thermocouples:*

8.3.1 Place three bare wire thermocouples on the interior face, exposed to the test room burner, of the exterior wall assembly. Locate these thermocouples on the horizontal plane that is 72 ± 1 in. (1829 ± 25 mm) above the top of the test room floor as specified in 8.3.2 through 8.3.4.

8.3.2 Place the first one on the intersection of the horizontal plane and the vertical centerline of the exterior wall assembly.

8.3.3 Place the second one on the horizontal plane 24 ± 1 in. (610 ± 25 mm) to the right of the one in 8.3.2.

8.3.4 Place the third one on the horizontal plane 24 ± 1 in. (610 ± 25 mm) to the left of the one in 8.3.2.

8.4 *Test Room Pressure:*

8.4.1 The minimum vertical distance between pressure sensors, referenced in 6.10, shall be one-half the height of the test room or locate one probe 12 inches below the exposed surface of the perimeter joint protection. Locate the pressure sensors where they will not be subjected to direct impingement of convection currents. Tubing connected to each pressure sensor horizontal both in the test room and at its egress through the test room wall shall be such that the pressure is relative to the same elevation from the inside to the outside of the test room.

9. Calibration and Standardization

9.1 *Frequency:*

9.1.1 Perform the following calibration procedure to evaluate the flow rates of the gas burners:

9.1.1.1 Prior to product testing, or

9.1.1.2 When significant changes to the gas flow systems are made (that is, new flow meters, and the like), or

9.1.1.3 Within one year prior to the test of an actual product wall assembly.

9.2 *Calibration Wall:*

9.2.1 Construct the calibration wall for the calibration test of two layers of nominal 0.625-in. (15.9-mm) thick, Type X gypsum wallboard applied to both sides of 18-gage steel studs spaced approximately 24 in. (610 mm) on centers. Tape all butt joints of the gypsum wallboard. Extend the calibration wall at least 18 ft (5.49 m) above the floor of the test room and make the calibration wall at least 14 ft (4.27 m) wide.

NOTE 12—The 21st Edition of the Gypsum Association's Fire Resistance Design Manual (GA 600 15) provides a detail of this construction designated GA File No. WP 1548.

9.2.2 Make the interior surface of the window opening of gypsum wallboard.

9.2.3 Do not use a spandrel beam.

9.2.4 Measure the distance from the inside of the back wall of the test room to the interior face of the calibration wall. Record this measurement.

9.2.5 When an opening between the test room and the calibration wall exists, fill it with a ceramic fiber material having a nominal density of at least 8 lb/ft^3.

9.3 *Preparation of Calibration Wall Construction:*

9.3.1 Before conducting the calibration test, burn away the paper facing of the gypsum wallboard on the exterior face of the calibration wall assembly.

9.3.2 To accomplish this, ignite both the test room burner and the window burner while immediately adjusting the burners to their maximum flow rates as prescribed in Table 1.

9.3.3 Run the burners for 5 min at these maximum flow rates and then shut them off.

9.4 As a minimum, record temperature measurements at the following locations:

9.4.1 At 14 locations on the vertical centerline of the visual face of the exterior wall assembly.

9.4.1.1 Place the first bare wire thermocouple 54 ± 0.25 in. (1372 ± 6 mm) above the top of the test room floor.

9.4.1.2 Place the second bare wire thermocouple 18 ± 0.25 in. (458 ± 6 mm) above the one in 9.4.1.1.

9.4.1.3 Successively place each of the remaining bare wire thermocouples 12 ± 0.25 in. (305 ± 6 mm) above the one previously placed (See Fig. 10.).

9.4.1.4 Successively number the bare wire thermocouples on the exterior face of the exterior wall assembly 1 through 14. Number the thermocouple in the window opening #1 and the thermocouple at the top of the calibration wall #14. The higher the location of the thermocouple, the higher the number of the thermocouple.

9.4.2 Place three bare wire thermocouples on the face of the calibration wall exposed to the test room burner according to 8.3.

9.5 *Heat Flux Measurements:*

9.5.1 Measure the total heat flux at a minimum of three locations (See 6.12.).

9.5.2 Locate the devices on the face exposed to the test room burner opposite thermocouples 4, 5, and 6 referenced in 9.4.1.4.

9.5.3 Make the devices flush with the calibration wall surface that is exposed to the test room.

9.6 *Calibration Test Procedure:*

9.6.1 Start the calibration test and conduct it so that the burners are fired according to Table 1. Stabilize each burner at its assigned flow rate within 15 s of each change.

NOTE 13—The type of gas used to fuel the burners is not critical because Table 2 provides the temperatures that are to be obtained during the calibration procedure. If those temperatures obtained during the initial calibration are not within the tolerance of Table 2, then the calibration procedure is to be rerun in accordance with 9.10.

9.6.2 For tests up to 30 min in duration, follow Table 1.

9.6.3 For tests greater than 30 min in duration, follow Table 1 for the first 30 min then:

9.6.3.1 Maintain the window burner at the maximum gas flow rate in Table 1 for the remainder of the fire-resistance test.

9.6.3.2 After the first 30 min of a test, if the average temperature of the thermocouples in 8.1 in the test room is more or less than specified in the Test Methods E119 time-temperature curve, adjust the gas flow to conform to the Test Methods E119 time-temperature curve. See Fig. 8 for location of the thermocouples in 8.1 in the test room.

9.6.4 Conduct the initial calibration test with the window burner positioned so that the vertical centerline of the burner is flush with the exterior face of the wall assembly.

9.7 At the conclusion of the calibration test, compare the data obtained to the specified values in Table 2. To prevent burner changes from affecting the data, determine the average values for each time period using data from 15 s into the period through 15 s short of the end of the period. For example, if the average for the 5-10 min time interval is being processed, use the data from the actual times of 5:15 through 9:45 for the average.

NOTE 14—When the average calibration values in Table 2 are met, the time-temperature curve during the first 30 min of this fire test will be higher than the standard Test Methods E119 time-temperature curve (See Fig. 12.).

9.8 All of the determined average values for the locations shown in Table 2 shall fall within the tolerances of those specified in Table 2. The allowable tolerances for the comparison of determined average values to the specified average values in Table 2 are:

9.8.1 ±10 % for temperatures, and

9.8.2 As shown in Table 2 for the heat flux measurements.

9.9 The values for thermocouples 1 and, 8 through 14, defined by 9.4.1.4 and as shown in Fig. 10, shall be reported, but they are not used in the calibration determination.

9.10 When the actual test values are not within tolerance, do the following until the determined values are within tolerance:

9.10.1 Repeat the calibration and the gas flows, or

9.10.2 Adjust the window burner position.

9.11 Use the flow rates derived from the calibration test when it is demonstrated that the burners must follow different flow rates to attain the following:

9.11.1 The prescribed test room temperatures, or

9.11.2 Exterior temperatures and heat fluxes, or both.

9.12 When it is demonstrated that the window burner must be repositioned within 0 and 6 in. (152 mm) of the calibration wall's exterior face to attain the prescribed exterior temperatures and heat fluxes, then use the position derived from the calibration test in all subsequent testing.

10. Conditioning

10.1 Prior to testing, condition the test specimen in air having 50 % relative humidity at 73 ± 5°F (23 ± 3°C). The objective of this conditioning is for the test specimen to reach equilibrium. Do not require the supporting construction to be conditioned with the perimeter joint protection. When conditioning to these conditions cannot be accomplished, conduct the testing when the most damp portion of the supporting construction and perimeter joint protection have achieved equilibrium resulting from storage in air having 50 to 75 % relative humidity at 73 ± 5°F (23 ± 3°C).

10.1.1 *Exception*—Continue the conditioning only until the supporting construction has developed sufficient strength to retain the perimeter joint protection securely in position when the following conditions occur:

10.1.1.1 An equilibrium condition is not achieved within a twelve-month conditioning period, or

10.1.1.2 The supporting construction or perimeter joint protection is such that hermetic sealing resulting from the conditioning has prevented drying of the interior of the supporting construction.

10.2 Determine the relative humidity within hardened concrete with a method that uses an electric sensing element. Determine the relative humidity within a supporting construction or test specimen made of materials other than concrete with a method such as one that uses an electric sensing element.

10.3 Do not use wood with a moisture content greater than 13 % as determined by an electrical resistance method.

10.4 When it becomes necessary to use accelerated drying techniques, avoid procedures that will alter the characteristics of the test specimen from those produced as a result of drying according to the procedures specified in 10.1.

10.5 Within 72 h of the fire test, obtain information on the actual moisture content and distribution within the test specimen. When the moisture condition of the test specimen is capable of changing significantly from the 72-h sampling condition prior to test, make the sampling not later than 24 h prior to the test.

10.6 Any additional curing regime requested by the manufacturer and sponsor shall be followed and clearly reported.

10.7 During the cure time, the entire test construction shall be protected from weather.

11. Movement Cycling Test Procedure

11.1 The test sponsor shall provide the laboratory with the nominal, maximum, and minimum joint width values for the perimeter joint protection being tested. Require movement cycling, when the maximum joint width does not equal the minimum joint width (See 3.2.6 and 3.2.7.).

NOTE 15—A perimeter joint is considered "static" when its maximum and minimum joint widths are equal because it will not move. A perimeter joint is considered "dynamic" when the maximum joint width is greater than the minimum joint width because it is capable of movement.

11.2 Prior to the fire exposure, subject the perimeter joint protection, which meets the criteria of 11.1, to movement cycling. Use appropriate cycling apparatus (See 6.4.).

11.3 The test sponsor selects one of the four movement types desired for the movement cycle test from Table 3.

11.4 Install each perimeter joint protection at its nominal joint width either together with its supporting construction or separate from it. Cycle each perimeter joint protection according to the cyclic rate and number of movement cycles selected by the test sponsor as indicated in 11.3. One cycle consists of starting at the nominal joint width, opening to the maximum joint width, closing to the minimum joint width, and returning to the nominal joint width.

11.5 Do not allow alterations or modifications, which will enhance the thermal performance of the perimeter joint protection, during or after the movement cycling.

11.6 Examine the perimeter joint protection after movement cycling. Note, photograph, and report any indication of stress, deformation, or fatigue of the test specimen.

11.7 When a perimeter joint protection has been movement cycled separately from its supporting construction, remove it from the cycling apparatus, install it in the supporting construction, and set it at the maximum joint width prior to fire testing. This process shall not take any longer than 96 h.

12. Fire-Resistance Test Procedure

12.1 *Test Assembly:*

12.1.1 Seal the exterior wall assembly against the test apparatus with an insulating gasket between the wall assembly and the test apparatus. The length of the perimeter joint protection exposed to heat and flame shall be at least 10 ft. Seal the open ends of the test specimen against air flow. Throughout the test, check the seals at the ends of the test specimen and repair them, as necessary, to prevent air flow.

12.1.1.1 Measure the distance from the inside of the back wall of the test room to the interior face of the exterior wall assembly that faces the interior of the test room. Record the measurement.

12.1.1.2 When the distance recorded in 9.2.4 is different than the distance recorded in 12.1.1.1 by more than 2 % do not conduct the fire test. Perform another calibration test using the measurement in 12.1.1.1. After performing the re-calibration test using the distance measured in 12.1.1.1, continue the fire test procedure.

12.1.2 Protect the test equipment and test assembly from any condition of wind or weather that influences test results.

12.1.2.1 Measure the ambient air temperature at the beginning of the test; it shall be 40 to 100°F (4.5 to 37.8°C).

12.1.2.2 Measure the velocity of air moving horizontally across the surface of the test assembly, which will be unexposed to the fire in the test room, immediately before the test begins; it 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. When mechanical ventilation is employed during the test, do not direct an air stream across the surface of the test assembly.

12.1.2.3 Measure the humidity at the beginning of the test; it is to be 20 to 80 %.

12.1.3 Record all measurements in 12.1.2.

12.2 *Unexposed Surface Temperatures:*

12.2.1 Provide unexposed surface thermocouples as described in 6.6. Measure the temperatures of the unexposed surface (surface of test specimen opposite the exposure to test room fire) with thermocouples placed under thermocouple insulating pads (See 6.7.). Hold the pad against the surface and fit it about the thermocouple.

12.2.2 When necessary, deform the thermocouple pad to follow the non-planar surface profile of the test specimen.

12.2.3 Do not place unexposed surface thermocouples closer to the nearest side wall of the observation room than 1.5 times the thickness of the supporting construction or 12 in. (305 mm), whichever is greater.

12.2.4 Locate unexposed surface thermocouples on the test specimen as follows:

12.2.4.1 Place at least one on each splice of each perimeter joint protection, at the mid-point of the splice (See Fig. 11 Item 1.).

12.2.4.2 Place at least three along the longitudinal centerline of the perimeter joint protection contained between the observation room walls (See Fig. 11 Items 2, 3, 4 and 15.).

12.2.4.3 Place at least two on the adjacent floor assembly at a maximum distance "X," where X is equal to the maximum thickness of the adjacent floor assembly, from the blockout or joint edge (See Fig. 13 and Fig. 11 Items 7 and 8.).

12.2.4.4 Place at least two at the junction of the floor assembly and perimeter joint protection (See Fig. 11 Items 9, 10 and 14.).

12.2.5 When, in the opinion of the laboratory, potential weak spots are identified, attach additional unexposed surface thermocouples to these locations. An example of a weak spot is any irregularity, such as a crack or tear that has occurred to the test specimen during the cycling or the installation process.

12.2.6 Do not locate thermocouples over fasteners (such as screws, nails or staples) that will be higher or lower in temperature than at a more representative location if the aggregate area of any part of such fasteners on the unexposed surface is less than 1 % of the area within any 6-in. (152-mm) diameter circle, unless the fasteners extend through the test specimen.

12.3 For perimeter joint protection that is designed to be load bearing, apply a superimposed load to the perimeter joint protection throughout the test. The superimposed load is to simulate the maximum design load for the perimeter joint protection (See 6.9.).

12.4 Verify the operation of instrumentation on the completed test assembly.

12.5 Verify the placement of window burner.

12.6 Simultaneously start the measuring devices and data acquisition equipment at least 1 min before ignition of test room burner.

12.7 Ignite test room burner.

12.7.1 During the first 30 min of the test, fire the burners according to Table 1.

12.7.1.1 Each burner shall attain its assigned flow rate within 15 s of each change.

12.7.1.2 When it is determined by the calibration procedure that the burners need to follow slightly different flow rates to attain the prescribed test room and/or exterior temperatures and heat fluxes, then the flows derived from the calibration tests shall be used.

12.7.2 When a test duration is longer than 30 min, 12.7.2.1 Use the Test Methods E119 time-temperature curve for the test room for the remainder of the test duration beyond 30 min.

12.7.2.2 Follow flow regime for burners in Table 1 for the first 30 min. After the first 30 min of a test, if the average temperature of the test room thermocouples in 8.1 is more or less than that specified in the time-temperature curve in E119, adjust the gas flow to conform to the Test Methods E119 time-temperature curve. The gas flow into the test room shall not exceed 1.30 times the gas flow required during the 25:00 to 30:00 minute time interval. See Fig. 8 for location of the thermocouples in the test room. Leave the window burner in place and maintain its last setting (time interval 25:00 - 30:00) in Table 1 for the remainder of the test.

12.7.2.3 After 30 minutes and when the gas flow into the test room is less than 1.30 times the gas flow required during the 25:00 to 30:00 minute time period, control the test room burner such that the area under the Test Methods E119 time-temperature curve, obtained using the thermocouples in 8.1, is as follows: Within 10 % of the corresponding area under the Test Methods E119 time-temperature curve for fire tests of 1 h or less duration. Within 7.5 % of the corresponding area under the Test Methods E119 time-temperature curve for those over 1 h and not more than 2 h. Within 5 % of the corresponding area under the Test Methods E119 time-temperature curve for tests exceeding 2 h in duration.

12.8 Take and record unexposed surface temperatures and test room temperature readings at intervals not exceeding 1 min throughout the test.

12.9 When requested by the test sponsor or at the discretion of the laboratory, measure and record the radiation emitted from the unexposed surfaces of the perimeter fire barrier. Document the method used to collect this data.

NOTE 16—The information collected in 12.9 may be used to establish a database. This database may be used to create future test methodology and criteria.

12.10 *Termination of Test:*

12.10.1 The fire test shall be terminated for one or more of the following reasons:

12.10.1.1 Safety of personnel or impending damage to equipment.

12.10.1.2 Attainment of conditions of compliance.

12.10.1.3 Request of sponsor.

12.10.2 When requested by the sponsor and agreed to by the laboratory, continue the fire test after the conditions of compliance have been met or exceeded, to obtain additional data.

12.10.3 When a test is terminated before the conditions of compliance are met, the reason for termination shall be documented for the test report.

12.11 *Test Room Pressure:*

12.11.1 Calculate the differential pressure of the test room based on measurements taken at the specified locations and elevations, and based on the linear pressure gradient of the test room. Determine the linear pressure gradient of the test room by the difference in measured pressure of at least two pressure sensors separated by a vertical distance in the test room or use the reading obtained at the single pressure probe location described in 8.4.1.

NOTE 17—The vertical distance does not have to be specified because the pressure gradient is linear and can be calculated with any vertical distance.

12.11.2 Operate the controls such that a minimum pressure of 0.01 in. H_2O (2.5 Pa) is established at the lowest point of the perimeter joint.

12.11.3 Read and record the differential pressures at intervals not exceeding 1 min throughout the test (See 6.10 and 6.11.).

12.11.4 After the initial 10 min of fire exposure, control the furnace pressure (at the locations specified) so that it will not be less than 0.01 in. H_2O (2.5 Pa) for:

12.11.4.1 The last 25 % of the fire exposure time period and

12.11.4.2 An aggregate time period exceeding one of the following:

(1) Ten percent of the fire exposure for fire tests of 1 h or less duration,

(2) Seven and one-half percent of the fire exposure for fire tests longer than 1 h but not longer than 2 h, and

(3) Five percent of the fire exposure for fire tests exceeding 2 h in duration.

12.12 *Observations:*

12.12.1 Make observations of the exposed and unexposed surfaces of the floor assembly, perimeter joint protection, and exterior wall assembly throughout the test. At a maximum of 15-min time intervals, record observations, such as deformation, spalling, cracking, burning, and production of smoke. When requested by the test sponsor or at the discretion of the laboratory, measure and record deflection of the exterior wall assembly. Instrumentation for the measurement of deflection shall be located so as to provide data in terms of the amount and rate of deflection during and after the fire test.

12.12.2 When a crack or hole is observed on the unexposed side of the perimeter fire barrier during the test, verify its integrity according to Section 13. Record the location, time, and results of each cotton pad application.

12.12.3 Continue the test until the conditions of compliance have been exceeded or until the test specimen has satisfied all the applicable requirements in 14.2 for the desired fire-resistance rating.

12.12.4 For the development of additional data, continuing the test after the fire-resistance rating has been determined shall be permitted.

13. Integrity Test Procedure

13.1 When a crack or hole is observed, evaluate the integrity of the perimeter fire barrier during the fire-resistance test for passage of flame and hot gasses using a cotton pad in a wire frame provided with a handle (See 6.8.).

13.2 Hold the cotton pad directly over an observed crack or hole in the test specimen, approximately 1 in. (25 mm) from the breached surface, for a period of 30 ± 1 s. When required, make small adjustments in the position of the cotton pad to be in the direct path of the hot gasses.

13.3 When no glowing or flaming of the cotton pad occurs during the 30-s application, make “screening tests” that *(1)* involve 30-s duration applications of the cotton pad to areas of potential failure, or *(2)* involve the movement of the cotton pad over and around such areas.

NOTE 18—"Screening tests" are additional application of the cotton pad to areas of the perimeter fire barrier that appear to be degrading to a point where flames or hot gasses appear to be escaping (potential failure).

13.4 Where charring of the cotton pad occurs, it is only an indication of a potential failure; apply an unused cotton pad, which must glow or flame as described in 13.3 to determine the integrity failure.

14. Conditions of Compliance

14.1 *Movement Cycling Test*—When movement cycling is conducted, the perimeter joint protection shall have completed at least the minimum number of movement cycles using at least the minimum cyclic rate for the movement type selected.

14.2 *Fire-Resistance Test:*

14.2.1 *"T" Rating*—The "T" rating of the perimeter fire barrier shall be determined as the time at which one of the following conditions first occurs:

14.2.1.1 The temperature rise of any of the unexposed surface thermocouples on the unexposed face of the perimeter fire barrier or adjacent supporting construction as defined in 3.2.16 is more than 325°F (181°C) above the initial temperature, and

14.2.1.2 For maximum joint widths greater than 4 in. (102 mm), the average temperature rise as indicated by all unexposed surface thermocouples described in 12.2 is more than 250°F (139°C) above the initial temperature.

14.2.1.3 When the test is continued beyond the fire-resistance rating of the floor assembly, the unexposed thermocouples on the floor assembly in 12.2.4.3 shall not be used to determine the conditions of compliance for the perimeter fire barrier.

14.2.1.4 When the indicated fire-resistance rating of the perimeter fire barrier is 60 min or more, it shall be increased or decreased by the following correction. The correction shall compensate for significant variation of the measured test room temperature from Test Methods E119 time-temperature curve provided that the conditions of 12.7.2.3 are met. To calculate the correction factor use the thermocouples in 8.1. The correction is expressed by the following formula:

$$C = 2I(A - A_S)/3(A_S \pm L) \quad (1)$$

where:

C = correction to the indicated fire resistance in the same units as I,
I = indicated fire resistance in min,
A = area under the actual time-temperature curve for the first three fourths of the indicated fire resistance in °F·min (°C·min),
A_S = the area under the standard time-temperature curve for the first three fourths for the same part of the indicated fire resistance in °F·min (°C·min), and
L = lag correction in the same units as A and A_S, 3240°F·min (1800°C·min).

14.2.2 *"F" Rating*—The "F" rating of the perimeter fire barrier shall be determined as the time at which one of the following conditions first occurs:

14.2.2.1 Flame penetration through the perimeter joint protection or around its boundaries, or

14.2.2.2 The passage of flames or hot gases sufficient to ignite the cotton pad when applied according to Section 13.

14.3 *Integrity Test*—The perimeter fire barrier shall not have allowed the passage of flames or hot gasses sufficient to ignite the cotton pad as prescribed in Section 13.

14.4 *Load Application*—When a load is applied, the perimeter joint protection shall have sustained that load for the duration of the rating period.

15. Documentation

15.1 Documentation shall consist of the following:

15.1.1 Photographs during construction of the test specimen, during actual test (at least once every 10 min, with the time documented), and post-test to include dissection of the test specimen.

15.1.2 If requested by the test sponsor, color videotape the exterior face of the exterior wall assembly prior to, during, and post-test.

15.1.3 Before starting the test, the laboratory identification number and test date must be placed on or in front of the exterior face of the test specimen and shall be photographed.

15.1.4 If requested by the test sponsor, color videotape the unexposed surfaces of the perimeter fire barrier (exterior wall assembly/floor assembly intersection) in the second floor during the test period. The color video tape is used to assist in determination of flame penetration and/or smoke development through the perimeter fire barrier; and

15.1.5 A clock or timer depicting "real time" shall be included in all videos. The timer shall be either:

15.1.5.1 Integral to the video camera, or

15.1.5.2 A clock/timer provided it will be clearly viewed throughout the test.

16. Report

16.1 *General Information*—Include:

16.1.1 The test date and a reference (that is, project or laboratory identification) number.

16.1.2 As a minimum, the following about the laboratory or test facility:

16.1.2.1 Name and Location.

16.1.2.2 A description of the test apparatus referenced in 6.2.

16.2 Include a unique designation for each perimeter fire barrier tested. Supply the following information for each:

16.2.1 Drawings and descriptions of the supporting construction and each perimeter joint protection detailing dimensions, materials, and composition.

16.2.2 The curing time, if any, for any components of each perimeter fire barrier.

16.2.3 The moisture content and the distribution of moisture within the test specimen.

16.2.4 The shape and dimensions of recesses (blockouts) when formed in the floor assembly to secure any part of the perimeter joint protection.

16.2.5 All installation procedures provided by the test sponsor, details of the equipment used, and photographs of the installation procedure.

16.2.6 The splicing method used, including the test sponsor's instructions, and photographic documentation of the installation.

16.2.7 A description of any perimeter joint protection which contains a change in direction (that is, corner). Include the test sponsor's installation or fabrication instructions or both, and photographic documentation of the installation.

16.2.8 The exterior wall assembly and floor assembly constructions (such as the density and type of materials, moisture content, special fabrication details). Include the location of the window opening.

16.2.9 If used, describe the spandrel beam and insulation used to protect it and any other reinforcement.

16.3 *Movement Cycling Test*—When movement cycling is conducted, include the following information:

16.3.1 The nominal joint width.

16.3.2 The maximum joint width stated by the test sponsor.

16.3.3 The minimum joint width stated by the test sponsor.

16.3.4 The movement type selected by the test sponsor from Table 3.

16.3.5 The minimum number of cycles completed.

16.3.6 The cyclic rate (cpm) used.

16.3.7 Whether or not 16.3.5 and 16.3.6 for each perimeter joint protection satisfies 16.3.4.

16.3.8 Photographs of each perimeter joint protection tested before, during, and after the movement cycling.

16.3.9 Whether the perimeter joint protection was cycled either together with its supporting construction or separate from it.

16.4 *Fire-Resistance Test:*

16.4.1 For each perimeter fire barrier tested, include the following:

16.4.1.1 Length and maximum joint width used in the fire test.

16.4.1.2 The "F-rating" and "T-rating" expressed in elapsed minutes, for which the relevant conditions of compliance have been satisfied. Report the fire-resistance rating of the floor assembly used. Report what type of exterior wall assembly was used. When a fire-resistance rated exterior wall assembly was tested, indicate the rating and what test method was used to rate the exterior wall assembly.

16.4.2 Report the test room temperatures, the test room pressure data, and all time intervals when the test room temperature was limited by maximum allowable gas flow.

16.4.3 If applied, report the recorded measurement of the superimposed load applied to the perimeter joint protection, method of application, and a photographic documentation of its placement.

16.4.4 Report the recorded measurement of any deflection for each perimeter joint protection and its supporting construction, when applicable.

16.4.5 Report any observations made of the surfaces exposed and unexposed to fire, such as deformation, spalling, cracking, burning, and production of smoke.

16.4.6 Report the time and reason for termination of the test (See 12.10.).

16.5 *Integrity Test*—When the integrity test is conducted, report the results for each perimeter fire barrier. Report whether each perimeter fire barrier passed or failed. When there was no need to conduct the integrity test during the fire-resistance test, state that no integrity test was performed because it was not necessary.

17. Precision and Bias

17.1 *Movement Cycling Test*—No information is presented about either the precision or the bias of this test method for measuring the response of perimeter joint protections to a standard movement cycle test under controlled laboratory conditions because no material having an acceptable reference value has been determined.

17.2 *Fire-Resistance Test*—No information is presented about either the precision or the bias of this test method for measuring the response of perimeter joint protections to a standard fire test under controlled laboratory conditions because no material having an acceptable reference value has been determined.

17.3 *Integrity Test*—No information is presented about either the precision or the bias of this test method for measuring the response of perimeter joint protections to the integrity test under controlled laboratory conditions since the test is non-quantitative.

18. Keywords

18.1 construction gap; cycling; curtain wall; exterior wall; fire; fire resistance; fire-resistive joint system; gap; intermediate-scale; multistory test apparatus; joint; linear opening; movement; perimeter fire barrier; perimeter joint; perimeter joint protection; separating element; void