UL 2079

STANDARD FOR SAFETY

Tests for Fire Resistance of Building Joint Systems

UL Standard for Safety for Tests for Fire Resistance of Building Joint Systems, UL 2079

Fifth Edition, Dated August 26, 2015

Summary of Topics

This revision of ANSI/UL 2079 dated July 29, 2020 was issued to include optional air leakage test minimum joint length; 20.1

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated April 17, 2020.

No Text on This Page

AUGUST 26, 2015
(Title Page Reprinted: July 29, 2020)

ANSI/UL 2079-2020

UL 2079

Standard for Tests for Fire Resistance of Building Joint Systems

First Edition – November, 1994
Second Edition – January, 1997
Third Edition – July, 1998
Fourth Edition – October, 2004

Fifth Edition

August 26, 2015

This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through July 29, 2020.

The most recent designation of ANSI/UL 2079 as an American National Standard (ANSI) occurred on July 29, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These tests are applicable to joint systems of various materials and construction that are intended for use in linear openings between adjacent fire resistive structures.

1.2 The fire endurance ratings for joint systems are intended to register performance during the period of fire exposure and are not intended to be interpreted as having determined the acceptability of the joint systems for use before or after fire exposure. The intent of these methods is to develop data to assist others in determining the suitability of the joint systems where fire resistance is required.

1.3 These requirements are intended to evaluate the length of time that the types of joint systems specified in 1.1 will contain a fire during a predetermined test exposure. The test evaluates the joint system's resistance to heat and, in some instances, to a hose stream, while carrying an applied load if the assembly is load bearing. The method of testing also includes optional air leakage tests to determine the rate of air leakage through joint systems resulting from a specified air pressure difference applied across the surface of the joint systems.

1.4 Under these requirements a joint system is subjected to a standard fire exposure controlled to achieve specified temperatures throughout a specified time period. This exposure by itself is not intended to be representative of all fire conditions; conditions vary with changes in the amount, nature and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment.

1.5 All joint systems are cycled through their intended range of movement prior to fire exposure to demonstrate the joint system's range of movement and the impact of the joint system during movement on the adjacent fire resistive structures. Joint systems are required to be loaded to their designed live load capacity during the fire test. For tests of wall-to-wall and head-of-wall joint systems, the fire test is followed by the application of a specified standard hose stream.

1.6 These requirements cover the measurement of the transmission through the joint system of heat and gases sufficiently hot to ignite cotton waste.

1.7 These requirements provide a relative measure of fire performance of comparable assemblies under these specified fire exposure conditions. Any variation from the construction or conditions that are tested, such as method of assembly and materials, is not within the scope of this test method.

1.8 Tests for evaluating the suitability of poured or formed-in-place materials for use in joint systems under non-fire conditions are found in the Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle), ASTM C719.

1.9 Tests for evaluating the suitability of joint systems other than those with poured or formed-in-place materials under non-fire conditions are found in the Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems, ASTM E1399/E1399M.

1.10 Tests for determining the hourly fire endurance ratings of walls and floors are found in the Standard for Fire Tests of Building Construction and Materials, UL 263. Standard UL 263 shall be permitted to be used to determine the hourly fire endurance rating of walls and floors with control joints.

1.11 Tests for determining the surface burning characteristics of building materials, based on the rate of flame spread, are found in the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723.

1.12 The results of these tests represent one factor in assessing fire performance of joint systems. These requirements prescribe a standard fire exposure for comparing the performance of joint systems. Application of these test results to predict the performance of actual building construction requires careful evaluation of test data.

1.13 The method of testing also includes optional air leakage tests to determine the rate of air leakage through fire resistive joint systems resulting from a specified air pressure difference applied across the surface of the systems. The results obtained from the optional air leakage tests are expressed in cubic feet per minute (cubic meter per second) per lineal foot (lineal meter) of opening. The results are intended to develop data to assist authorities having jurisdiction, and others, in determining the acceptability of joint systems with reference to the control of air movement through the assembly.

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

1.15 An L rating may also be established for a fire resistive joint system. The L rating is based on the amount of air leakage through the test sample.

1.16 A W rating may also be established for a fire resistive joint system. The W rating is based on the water resistance of the test sample.

2 Units of Measurement

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

3 Undated 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 CONTROL JOINT – A device or designed feature that provides a continuous transition in linear openings within a fire resistive structure and that does not exceed a maximum joint width of 5/8 in (16 mm). A control joint system consists of the device or designed construction feature but does not include the fire resistive structure in which it is installed.

4.3 FIELD SPLICE – The technique utilized at the point of installation to join two or more lengths of a joint system or a joint system component material.

4.4 JOINT SYSTEM – A device or designed construction feature that provides a continuous transition in linear openings between adjacent fire resistive structures. A joint system consists of the device or designed construction feature but does not include the fire resistive structure in which it is installed.

4.5 LINEAR OPENING – A discontinuity between or within fire resistive structures.

4.6 MANUFACTURED SPLICE – The technique utilized at the point of manufacture to join two or more lengths of a joint system component material.

4.7 MAXIMUM JOINT WIDTH – The greatest width to which the joint system is designed to extend taking into consideration all axes of movement.

4.8 MINIMUM JOINT WIDTH – The narrowest width the joint system is designed to accommodate.

4.9 MOVEMENT CAPABILITY– The range of movement that a joint system is designed to accommodate without diminishing its fire resistive performance.

4.10 NOMINAL JOINT WIDTH – The width of the linear opening specified in practice and in which the joint system is installed.

4.11 STRUCTURE – The fire resistive floor and/or wall segments between which the joint system is installed.

4.12 TEST ASSEMBLY– The complete assembly of the joint system and the structure in which it is installed.

TEST ASSEMBLY

5 General

5.1 The structure and joint system are to be representative of the construction for which fire endurance rating is desired with respect to materials, workmanship, and details such as dimensions of parts. The joint system is to be installed in accordance with the manufacturer's specified fabrication procedure for conditions representative of those found in building construction.

5.2 Multiple joint systems shall not be installed and tested simultaneously in a test assembly unless adequate separation is maintained between adjacent joint systems to prevent the influence of one joint system on another. For horizontal assemblies, the minimum separation between adjacent joint opening edges is to be 24 in (610 mm). For vertical assemblies, the minimum separation between adjacent joint opening edges is to be 18 in (457 mm). Reduction of the minimum separation distances is acceptable when it is demonstrated the reduced separation distance does not affect test results.

5.3 A joint system shall have a manufactured splice and a field splice tested. When the technique of the manufactured splice is the same as the field splice, only the field splice need be tested. The minimum distance that a splice has to the nearest furnace wall is to be 12 in (305 mm). The minimum separation between splices in a joint system shall be 36 in (914 mm). Reduction of the minimum separation distances is acceptable when it is demonstrated the reduced separation distance does not affect test results.

5.4 A joint system is to be tested at the maximum joint width.

5.5 Joint systems that are designed to be load bearing are to have a superimposed load applied to the joint system throughout the fire test. The superimposed load is to simulate the maximum design load for the joint system.

6 Floor-to-Floor Joint Systems

6.1 Floor-to-floor joint systems are designed for installation in linear openings between adjacent floor structures. The minimum distance that a joint system has to be the nearest furnace wall parallel with its length shall be 1-1/2 times the thickness of the floor or 12 in (305 mm), whichever is greater.

6.2 The minimum length of the joint system exposed to fire is to be 36 in (914 mm) if the length of the joint system exposed to fire is at least ten times greater than the maximum joint width. For joint systems

having a length to maximum joint width ratio which is less than ten to one, the minimum length of the joint system exposed to fire is to be 12 ft (3.7 m).

7 Wall-to-Wall Joint Systems

7.1 Wall-to-wall joint systems are designed for installation in linear openings between adjacent wall structures. The minimum distance that a joint system has to the nearest edge of the test frame parallel with its length shall be 1-1/2 times the thickness of the wall or 12 in (305 mm), whichever is greater.

7.2 The minimum length of the joint system exposed to fire is to be 36 in (914 mm) if the length of the joint system exposed to fire is at least ten times greater than the maximum joint width. For joint systems having a length to maximum joint width ratio which is less than ten to one, the minimum length of the joint system exposed to fire is to be 9 ft (2.7 m).

7.3 Asymmetrical joint systems are to be tested from both sides unless the joint system is designed for fire exposure on only one side or it is documented that the side with the lower fire endurance rating is tested.

8 Floor-to-Wall Joint Systems

8.1 Floor-to-wall joint systems are designed for installation in horizontal linear openings between floor and wall structures. The wall structure used for the test assembly is to extend a minimum of 12 in (305 mm) beyond each surface of the floor structure.

8.2 The minimum length of the joint system exposed to fire is to be 36 in (914 mm) if the length of the joint system exposed to fire is at least ten times greater than the maximum joint width. For joint systems having a length to maximum joint width ratio which is less than ten to one, the minimum length of the joint system exposed to fire is to be 12 ft (3.7 m).

9 Head-of-Wall Joint Systems

9.1 Head-of-wall joint systems are designed for installation in vertical linear openings between wall and floor or roof structures. The floor or roof structure used for the test assembly is to extend a minimum of 12 in (305 mm) beyond each surface of the wall structure.

9.2 The minimum length of the joint system exposed to fire is to be 36 in (914 mm) if the length of the joint system exposed to fire is at least ten times greater than the maximum joint width. For joint systems having a length to maximum joint width ratio which is less than ten to one, the minimum length of the joint system exposed to fire is to be 9 ft (2.7 m).

9.3 Asymmetrical joint systems are to be tested from both sides unless the joint systems are designed for fire exposure on only one side or it is documented that the side with the lower fire endurance rating is tested.

10 Conditioning

10.1 When required to provide a condition representative of the anticipated construction conditions, the structure and joint system shall be conditioned prior to fire testing. The structure is not required to be conditioned with the joint system. The condition is to be established by storage in air having 50% relative humidity at 73° F (23° C). When conditioning to this level cannot be accomplished the test shall be conducted when the dampest portion of the structure and joint system have achieved equilibrium resulting from storage in air having 50 to 75% relative humidity at 73 ±5°F (23 ±3°C).

Exception: When an equilibrium condition is not achieved within a 12-month conditioning period; or if the construction is such that hermetic sealing resulting from the conditioning has prevented drying of the interior of the structure or joint system, then the conditioning need be continued only until the structure has developed sufficient strength to retain the joint system securely in position.

10.2 The relative humidity within hardened concrete shall be determined with a method that uses an electric sensing element. The relative humidity within a structure or joint system made of materials other than concrete shall be determined with an approved method such as one that uses an electric sensing element.

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

10.4 If, during conditioning of the specimen, it becomes necessary to use accelerated drying techniques, it is the responsibility of the laboratory conducting the test to avoid procedures that will significantly alter the structural or fire endurance characteristics of the test assembly, or both, from those produced as a result of drying in accordance with the procedures specified in 10.1.

10.5 Within 72 h prior to the fire test, information on the actual moisture content and distribution within the test assembly is to be obtained. If the moisture condition of the test assembly is capable of changing significantly from the 72 h sampling condition prior to test, the sampling is to be made not later than 24 h prior to the test. This information is to be included in the report. See Report of Results, Section 33.

10.6 Each joint system is to be subjected to movement cycling prior to the fire test. The joint system is to be installed at its nominal width. The movement cycling is to consist of any one of the conditions specified in Table 10.1. A movement cycle is to consist of the joint system width being nominal, maximum, minimum and then nominal.

Table 10.1
Conditions of test specimen cycling

Minimum number of cycles	Minimum cycling rate (cycles per min)
500	1
500	10
100	30

10.7 The cycle range is to be the same as the movement capability, in direction and magnitude, for which the joint system is designed. Only those components of the joint system which are subject to movement need be cycled.

10.8 After movement cycling, the joint system is to be allowed to stabilize, untouched, at the maximum joint width position. After stabilization, the joint system is to be examined and any indication of stress, deformation or fatigue of the joint system is to be noted, photographed and reported.

10.9 The joint system is to be removed from the movement cycling apparatus, installed in the structure at the maximum joint width without allowing any alteration which will enhance its thermal performance, and fire tested within 96 h after completion of the movement cycling.

Exception: Joint systems to be evaluated for a W rating are to be removed from the movement cycling apparatus, installed in the structure at the maximum joint width without allowing any alteration which will enhance its water resistance or thermal performance, and Water Leakage testing shall be initiated within 96 h after completion of the movement cycling. The joint systems shall then be reconditioned in accordance with 10.1 –10.5 prior to fire testing.

FIRE ENDURANCE TEST

11 Test Furnace

11.1 The construction details of the test furnace depend on the nature of the test to be conducted. Provisions are made for fuel burners, gas exhaust, observation ports and devices for monitoring and controlling the furnace conditions. The furnace is to be equipped with an adequate number of burners arranged in such a way as to provide uniform fire exposure of the test assembly and joint system.

11.2 The furnace lining shall consist of materials with densities less than 62 lb/ft^3 (1000 kg/m^3). The lining materials shall have a minimum thickness of 2 in (50 mm) and shall constitute at least 70% of the internally exposed surface of the furnace.

12 Time-Temperature Curve

12.1 The conduct of fire endurance tests of joint systems is to be controlled by the standard time-temperature curve shown in Figure 12.1. The points on the curve that determine its character are:

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

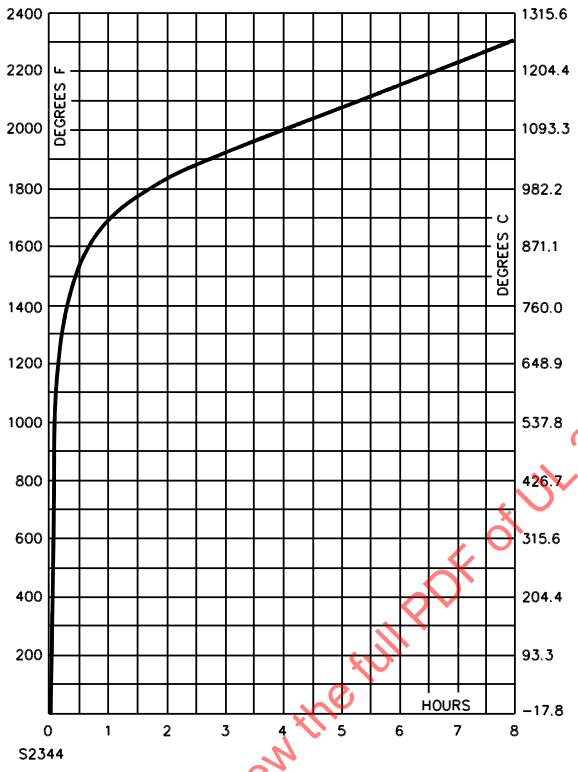
g) 2000°F (1093°C) at 4 h

h) 2300°F (1260°C) at 8 h

For a more precise definition of the time-temperature curve, see Appendix A – Standard Time-Temperature Curve for Control of Fire Tests.

Figure 12.1

Time-temperature curve



13 Furnace Temperatures

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

13.2 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 (305 mm).

13.3 The time constant of the protected thermocouple assembly is to be within the range of 5.0 – 7.2 min. A typical thermocouple assembly complying with this time constant requirement is one that is 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 1/2 in (13 mm) [0.84 in (21.3 mm) outside diameter] black wrought iron, black wrought 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.

13.4 For tests of floor-to-floor joint systems, at least three furnace thermocouples, with at least nine thermocouples per each 100 ft^2 (9.3 m^2) of exposed surface area, are to be used. The junction of each thermocouple is to be placed 12 in (305 mm) below the principle horizontal surface of the test assembly at the beginning of the test.

13.5 For tests of wall-to-wall joint systems, at least three furnace thermocouples, with at least nine thermocouples per each 100 ft^2 (9.3 m^2) of exposed surface area, are to be used. The junction of each thermocouple is to be placed 6 in (152 mm) away from the exposed surface of the test assembly at the beginning of the test.

13.6 For tests of floor-to-wall and head-of-wall joint systems, at least three furnace thermocouples are to be used with a maximum spacing between thermocouples of 36 in (914 mm). The junction of each thermocouple is to be placed at a point 12 in (305 mm) below the exposed horizontal surface of the test assembly and 6 in (152 mm) away from the exposed vertical surface of the test assembly at the beginning of the test.

13.7 The temperatures are to be read at intervals not exceeding 5 min throughout the fire test.

13.8 The temperature of the furnace is to be controlled so that the area under the measured time-temperature curve, obtained by averaging the results from the thermocouple readings, is within:

a) 10% of the corresponding area under the standard time-temperature curve for fire tests of 1 h or less duration,

b) 7.5% of the corresponding area under the standard time-temperature curve for fire tests longer than 1 h but not longer than 2 h; and

c) 5% of the corresponding area under the standard time-temperature curve for fire tests exceeding 2 h in duration.

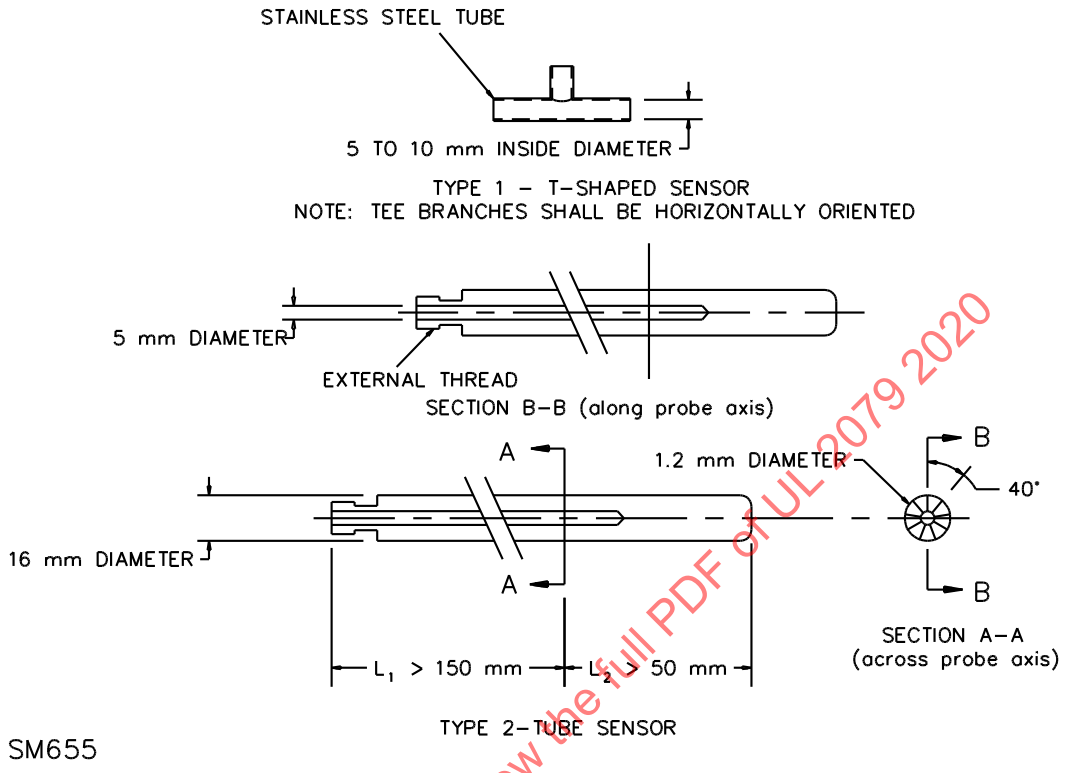
14 Furnace Pressure

14.1 The differential pressure between the exposed and unexposed surfaces of the test assembly at the elevations specified in 14.7 is to be calculated based on measurements taken at the locations specified in 14.4 or 14.5, as appropriate, and based on the linear pressure gradient of the furnace. The linear pressure gradient of the furnace is to be determined by the difference in measured pressure of at last two pressure sensors separated by a vertical distance in the furnace. The minimum vertical distance between pressure sensors shall be one-half the height of the furnace chamber. The pressure sensors are to be located where they will not be subjected to direct impingement of convection currents. Tubing connected to each pressure sensor is to 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.

14.2 The pressure sensors are to be either of the "T" type or the "tube" type as illustrated in Figure 14.1 and are to be manufactured from stainless steel.

Figure 14.1

Pressure sensors



14.3 The differential pressure is to be measured by means of a manometer or equivalent transducer capable of reading pressure in increments of 0.01 inch water (2.5 Pa) with a measurement precision of 0.005 inch water (1.25 Pa). The differential pressure measuring instrument is to be located to minimize "stack" effects caused by vertical runs of pressure tubing between the furnace probe and instrument locations.

14.4 For horizontal exposure furnaces, the differential pressure is to be measured near the vertical centerline of two opposing furnace walls.

14.5 For vertical exposure furnaces, the differential pressure is to be measured along the furnace wall near each side of the furnace.

14.6 The differential pressures are to be read at intervals not exceeding 5 min throughout the fire test.

14.7 All components of each joint system, including splices, are to be exposed to a positive furnace pressure differential. For tests of floor-to-floor, floor-to-wall and head-of-wall joint systems, the average furnace pressure 12 in (305 mm) below the exposed horizontal surface of the test assembly shall not fall below a minimum of 0.01 inch water (2.5 Pa) above atmospheric pressure after the initial 10 min of fire exposure. For tests of wall-to-wall joint systems, the average furnace pressure at the elevation of the midheight of the exposed vertical surface of the test assembly shall not fall below a minimum of 0.01 inch water (2.5 Pa) above atmospheric pressure after the initial 10 min of fire exposure.

14.8 After the initial 10 min of fire exposure, the furnace pressure, at the locations specified in 14.7, shall not be less than 0.01 inch water (2.5 Pa) for an aggregate time period exceeding:

a) 10% of the fire exposure for fire tests of 1 h or less duration,

b) 7.5% of the fire exposure for fire tests longer than 1 h but not longer than 2 h; and

c) 5% of the fire exposure for fire tests exceeding 2 h in duration.

15 Temperatures of the Unexposed Surface

15.1 The temperatures of the unexposed surface (surface of test assembly opposite the exposure to furnace fire) are to be measured with thermocouples placed under dry, felted pads. The properties of these pads are to comply with the requirements in Appendix B.

15.2 The wire leads of the thermocouple are to have an immersion under the pad and be in contact with the unexposed surface, parallel with the longitudinal direction of the joint, for not less than 1 in (25 mm). The hot junction of the thermocouple is to be placed approximately under the center of the pad. The pad is permitted to be deformed in order to be held firmly against the surface of the joint and is to fit closely about the thermocouple. When the maximum joint width is less than the specified pad size, reduce the pad to match the maximum joint width. The pad length shall be as specified and parallel to the test specimen length. If the modified thermocouple pad cannot be placed on the contour of the surface, then no thermocouple is required at that location. The wires for the thermocouple in the length covered by the pad are not to be heavier than 18 AWG (0.82 mm^2) and are to be electrically insulated with heat-resistant and moisture-resistant coatings.

15.3 Temperature readings are to be taken at not less than seven points for each minimum 9 ft (2.7 m) long joint system and at not less than five points for each joint system that is less than 9 ft (2.7 m) long. The placement of the thermocouples is to be at the discretion of the testing laboratory. The thermocouples are to be placed at positions that will represent the greatest temperature rise during the fire such as the junctions between different parts of the joint system, at the intersection of the joint system with the floor or wall and/or on the longitudinal centerline of the joint system. For tests of joint systems, no thermocouple is to be placed within 1-1/2 times the thickness of the test assembly or 12 in (305 mm), whichever is greater, of either end of the joint system. For tests of wall-to-wall joint systems, no thermocouple is to be placed at an elevation below the neutral pressure plane of the furnace. A thermocouple is to be located on the joint system within 1 in (25 mm) of each unique type of splice. For tests of floor-to-wall joint systems, at least two additional thermocouples are to be located on the wall structure 1 in (25 mm) from the joint system. For tests of head-of-wall joint systems, at least two additional thermocouples are to be located on the underside of the floor or roof structure 1 in (25 mm) from the joint system. None of the thermocouples are to be located over fasteners such as screws, nails or staples that will be obviously higher or lower in temperature than at a more representative location if the aggregate area of the 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 joint system.

15.4 Temperature readings are to be taken at intervals not exceeding 5 min throughout the fire test.

16 Integrity

16.1 The integrity of the joint system during the fire test is to be checked for passage of flame and hot gasses using a cotton waste pad in a wire frame provided with a handle.

16.2 The nominal 4 by 4 by 3/4 in (100 by 100 by 19 mm) cotton waste pads are to consist of new, undyed and soft cotton fibers, without any admixture of artificial fibers, and each pad is to weigh approximately 3 to 4 g. The 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 pads shall be stored in a desiccator for up to 24 h.

16.3 The frame used to hold the cotton waste pad is to be formed of 16 AWG (1.31 mm^2) steel wire and is to be provided with a handle long enough to reach all points of the test assembly.

16.4 The cotton waste pad is to be held directly over an observed crack or hole in the joint system, approximately 1 in (25 mm) from the breached surface, for a period of 30 s. Small adjustments in the position of the cotton waste pad are not prohibited from being made when required to achieve the maximum effect from the hot gasses.

16.5 If no ignition (defined as glowing or flaming) of the cotton waste pad occurs during the 30-s application, the representative of the testing laboratory shall make "screening tests" involving short duration applications of the cotton waste pad to areas of potential failure and/or the movement of a single pad over and around such areas. Charring of the pad provides an indication of imminent failure, but a previously unused cotton waste pad is to be employed in the prescribed manner for an integrity failure to be confirmed.

17 Conduct of Fire Endurance Test

17.1 The test assembly is to be sealed against the furnace with an insulating gasket between the test assembly and the furnace. The open ends of the joint system are to be tightly sealed with an insulating blanket material, or equivalent. The seals at the ends of the joint system are to be checked periodically throughout the fire test and repaired, as necessary, to prevent heat loss.

17.2 The test equipment and test assembly are to be protected from any condition of wind or weather that will influence the test results. The ambient air temperature at the beginning of the test is to be within the range of 50 – 90°F (10 – 32°C). The velocity of air moving horizontally 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.

17.3 Observations of the exposed and unexposed surfaces of the test assembly and joint system are to be made throughout the fire test. All significant observations, such as deformation, spalling, cracking, burning of the joint system or its component parts and production of smoke, are to be recorded at maximum 15 min time intervals. Any significant downward deflection of the floor structure(s) and/or lateral deflection of the wall structure(s) which occurs is to be measured and recorded.

17.4 If a crack or hole is observed on the unexposed side of the joint system during the fire test, the integrity of the joint system is to be checked using a cotton waste pad. The location, time and results of each cotton waste pad application are to be recorded.

17.5 The fire test is to be continued until failure occurs or until the test specimen has withstood the test conditions for the desired fire endurance rating that satisfies all the applicable conditions of acceptance in Section 29.

17.6 The fire test is not prohibited from being continued beyond the time that the fire endurance rating is determined for the purpose of obtaining additional performance data.

HOSE STREAM TEST

18 Test Assembly

18.1 For wall-to-wall and head-of-wall joint systems, a duplicate test assembly which has been conditioned and movement cycled (see Conditioning, Section 10) is to be subjected to a fire test for a period equal to one-half of the rating period time but not more than 60 min. When required by the test sponsor the hose stream test shall be conducted on floor-to-floor and floor-to-wall joint systems. Immediately after the fire exposure, the test assembly is to be subjected to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all other parts of the exposed face, with all changes in direction being made slowly.

18.2 When required by the test sponsor the hose stream test shall be conducted on the test assembly which was constructed, conditioned and movement cycled for the fire test described in Section 17. The hose stream test is to be conducted within 10 min of completion of the fire test.

19 Conduct of Hose Stream Test

19.1 The stream is to be delivered through a 2-1/2 in (64 mm) hose and discharged through a National Standard playpipe of corresponding size equipped with a 1-1/8 in (29 mm) discharge tip of the standard-taper, smooth-bore pattern without a shoulder at the orifice. The water pressure and duration of application is to be as specified in Table 19.1.

Table 19.1
Pressure and duration of hose stream test

Hourly fire rating time, min	Water pressure at base of nozzle, psi	(kPa)	Duration of application, s/ft^2 (s/m^2) of exposed area[a]	
240 ≤ time < 480	45	(310)	3.0	(32)
120 ≤ time < 240	30	(210)	1.5	(16)
90 ≤ time < 120	30	(210)	0.90	(9.7)
time < 90	30	(210)	0.60	(6.5)

[a] The rectangular area of the structure in which the joint system is mounted is to be considered as the exposed area, as the hose stream must traverse this calculated area during application.

19.2 The nozzle orifice is to be 20 ft (6.1 m) from the center of the exposed surface of the joint system if the nozzle is so located that, when directed at the center, its axis is normal to the surface of the joint system. If the nozzle is unable to be so located, it shall be on a line deviating not more than 30 degrees from the line normal to the center of the joint system. When so located its distance from the center of the joint system is to be less than 20 ft (6.1 m) by an amount equal to 1 ft (305 mm) for each 10 degree of deviation from the normal.

OPTIONAL AIR LEAKAGE TEST

20 Test Assembly

20.1 The fire-resistive floors and/or wall structures and the joint system shall be representative of the construction for which air leakage rating is desired and shall be constructed, conditioned and movement cycled in the same manner as that described for the fire test assembly. The minimum length of the joint system for the air leakage tests is 36 in (914 mm). The same test assembly constructed, conditioned and movement cycled for the fire test is not prohibited from being used for the air leakage tests. When the same test assembly is used for both the air leakage tests and the fire test, the air leakage tests are to be conducted in the 96 h time period immediately preceding the fire endurance test. The joint system is to be tested for air leakage at the maximum joint width.

21 Apparatus

21.1 The air leakage test chamber is to consist of a sealed box capable of withstanding the differential test pressure with one open side into or against which the test assembly is mounted and secured for testing. The chamber is to be provided with an air supply system designed to provide an essentially constant air flow at the specified test pressure difference and temperature for a time period sufficient to obtain readings of air flow. At least one air pressure tap is to be provided to measure the chamber pressure with respect to atmospheric pressure. The air supply opening into the chamber is to be arranged so that air is not discharged directly onto the joint system or onto the air pressure tap. The chamber is to

be provided with an air flow metering system to measure the air flow into the chamber. The minimum depth of the test chamber, as measured from the exposed surface of the test assembly to the opposing surface of the chamber, is to be 12 in (305 mm).

21.2 The air temperature in the chamber is considered to be the average temperature obtained from the readings of not less than three thermocouples symmetrically distributed 6 in (152 mm) from the exposed face of the test assembly. The temperature of the test assembly is considered to be the average temperature obtained from the readings of not less than two thermocouples in contact with the exposed face of the test assembly. The temperatures are to be measured and recorded at intervals not exceeding 5 min and at the time each pressure differential is recorded.

22 Conduct of Air Leakage Tests

22.1 The test assembly is to be mounted and secured in or against the test chamber opening with the perimeter sealed. Prior to the ambient temperature air leakage test specified in 22.3 and again after the elevated temperature air leakage test specified in 22.4, the extraneous chamber leakage is to be measured.

22.2 The extraneous chamber leakage is to be measured with the top surface of the test assembly sealed using an air-impermeable sheet or cover. The temperature of the test assembly and the air temperature in the chamber are 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 inch water (75 Pa) between the test chamber and atmospheric pressure. The test pressure difference is to be measured by means of a manometer or equivalent transducer capable of reading pressure in increments of 0.01 inch water (2.5 Pa) with a measurement precision of 0.005 inch water (1.25 Pa). After the test conditions are stabilized, the air flow through the air flow metering system and the test pressure difference are to be measured and recorded. This measured air flow is designated the extraneous chamber leakage (Q_e).

22.3 For the ambient temperature air leakage test, the temperature of the test assembly and the air temperature in the chamber are 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 inch water (75 Pa) between the test chamber and atmospheric pressure. After the test conditions are stabilized, the air flow through the air flow metering system and the test pressure difference are to be measured and recorded. This measured air flow is designated the total metered air flow (Q_t).

22.4 For the elevated temperature air leakage test, the test to determine total metered air flow (Q_t) at ambient temperature as specified in 22.3 is to be repeated but with the air temperature in the chamber increased to 400 ±10°F (204 ±5°C). The temperature of the exposed face of the test sample prior to the conduct of the test is to be 75 ±20°F (24 ±11°C). The air temperature in the chamber is to be increased so that it reaches 350°F (177°C) within 15 min and 400°F (204°C) within 30 min. When stabilized at the prescribed air temperature of 400 ±10°F (204 ±5°C), the air flow through the air flow metering system and the test pressure difference are to be measured and recorded.

23 Air Leakage Rate Calculation

23.1 The barometric pressure, temperature and relative humidity of the supply air are to be measured and recorded. The air supply flow values are to be corrected to standard temperature and pressure (STP) conditions for calculation and reporting purposes.

23.2 The air leakage (Q) through the joint system at each temperature exposure is to be expressed as the difference between the total metered air flow (Q_t) and the extraneous chamber leakage (Q_e). The air leakage rate (q) through the joint system is to be expressed as the quotient of the air leakage (Q) divided by the overall length of the joint system in the test assembly.

OPTIONAL WATER LEAKAGE TEST

24 Test Sample

24.1 Each representative construction type of a fire resistive joint system for which the water leakage rating is desired is to be tested. Test sample sizes are to be the same as those specified for fire testing in Sections 6 – 9 as appropriate. The sample shall be conditioned as described in Section 10 both before and after completion of the water leakage test.

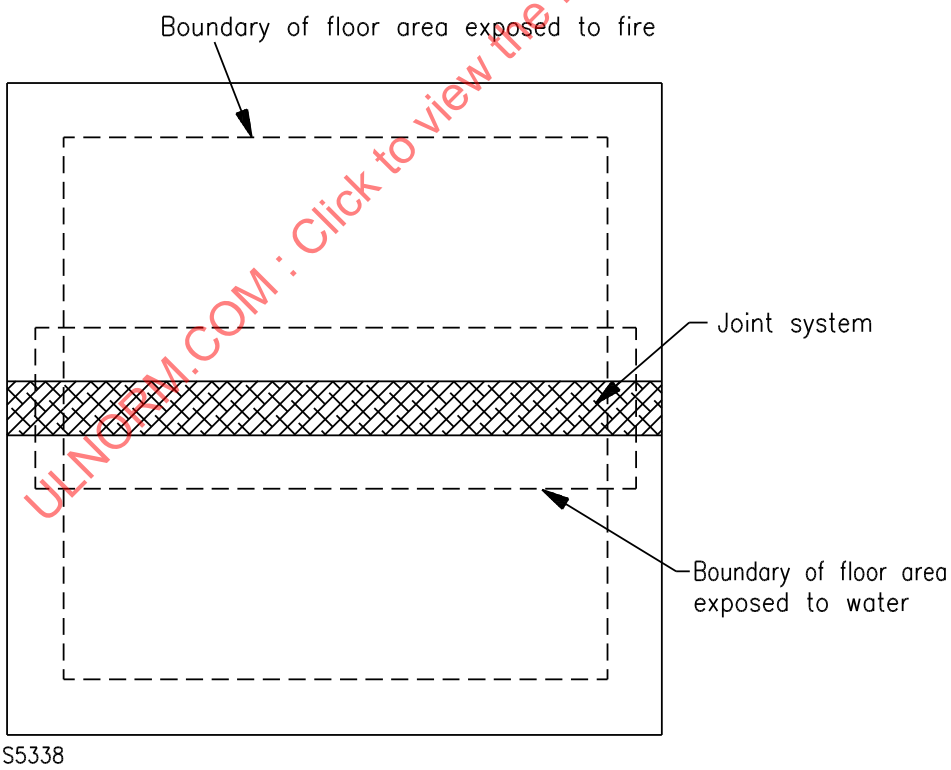
25 Test Chamber

25.1 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.

25.2 The width of the test chamber must be equal to or greater than the exposed length of the test sample. See Figure 25.1.

Figure 25.1

Boundary of floor area exposed to fire and water



25.3 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.

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

25.5 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 measured at a minimum frequency of 15 s. The pressure within the water leakage test chamber is to measured by means of a manometer or equivalent transducer capable of reading pressure within an accuracy of 1% of the specified pressure.

26 Test Setup

26.1 Joint systems are to be installed as specified in 5.1.

26.2 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.

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

26.4 The top of the joint system is to sealed by whatever means necessary when the top of the joint system is to be immersed under water. The seal is to prevent passage of water into the joint system.

26.5 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.

26.6 A white indicating medium is to be placed immediately below the fire resisitive joint system.

26.7 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.

26.8 Subsequent to the water leakage test, and conditioning as specified in Section 10, the joint system shall be subjected to the Fire Endurance Test as specified in 11 – 17 and the Hose Stream Test as specified in 18 and 20.

27 Recorded Test Data

27.1 The leakage of water through the fire resistive joint system is to be noted by the presence of water or dye on the indicating media or on the underside of the test sample.

ENVIRONMENTAL EXPOSURE TESTS FOR INTUMESCENT MATERIAL

28 Environmental Exposure Tests for Intumescent Material

28.1 General

28.1.1 Intumescent fill, void or cavity material shall comply with the Expansion pressure test, 28.4, and with the Expansion factor test, 28.5, following exposure to the required environmental exposures specified in 28.2 and, as applicable, to the supplemental environmental exposures specified in 28.3.

28.2 Required environmental exposures

28.2.1 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.

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.

28.2.2 Following exposure to specified conditions in 28.2.1, the material is to be subjected to the Expansion pressure test, 28.4, and to the Expansion factor test, 28.5.

28.3 Supplemental environmental exposures

28.3.1 The following environmental exposures shall not be required. However, when requested by the product submitter, intumescent fill, void or cavity material is to be exposed to any or all of the following environmental exposures, as specified by the product submitter:

a) Industrial Atmosphere – The sulfur dioxide (SO_2) content and carbon dioxide (CO_2) content of an industrial atmosphere is to be simulated by exposing samples of the material for 30 days to an amount of SO_2 equivalent to 1% of the volume of the test chamber, and an equal volume of CO_2. The test chamber is to be maintained at 95 ±3°F (35 ±1.5°C) and a small amount of water is to be maintained at the bottom of the chamber.

b) Salt Spray – A corrosive atmosphere is to be simulated by exposing samples of the material to a salt spray for 90 days as described in the Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117.

c) Combination Wet, Freeze and Dry Cycling – A freeze-thaw action is to be simulated by exposing samples of the material to a cycle consisting of the equivalent of rainfall at the rate of 0.7 in/h (0.005 mm/s) of water for 72 h, followed by a temperature of minus 40 ±5°F (minus 40 ±2.7°C) for 24 h, and then a dry atmosphere of 140 ±5°F (60 ±2.7°C) for 72 h. This cycle is to be conducted twelve times.

d) Acid Spray – An acidic atmosphere is to be simulated by exposing samples of the material for 5 days to a fog spray consisting of 2% by volume of hydrochloric acid (HCl) in water. The fog spray is to provide 1 to 2 mL of solution per hour for each 80 cm^2 of horizontal sample surface area.

e) Solvent Spray – A solvent atmosphere is to be simulated by spraying samples of the material with reagent grade solvents at 70 ±5°F (21 ±2.7°C). Typical solvents are acetone and toluene. The solvent spray exposure is to be applied with a typical paint spray gun until the entire surface area of the sample is completely covered with solvent that is not absorbed by the protective coating and excess solvent runs off the sample. An exposure cycle is to consist of application of the solvent, drying of the sample for 6 h, application of the solvent and drying of the sample for 18 h. The exposure cycle is to be conducted five times.

28.3.2 Following exposure, as applicable, to specified conditions in 28.3.1, the material is to be subjected to the Expansion pressure test, 28.4, and to the Expansion factor test, 28.5.

28.4 Expansion pressure test

28.4.1 When tested as described in 28.4.2 – 28.4.4, samples previously exposed to the environmental exposure conditions shall comply with the following:

a) Each sample shall maintain a peak expansion pressure within 3 standard deviations (3-σ) of the mean of the “as-received” samples, or maintain at least 90% of the average peak expansion pressure of the “as received” samples.

b) The average time of the peak expansion pressure shall fall within 3 standard deviations (3-σ) of the average time of the peak expansion pressure of the "as received" samples, or have at least 90% of the average time of the peak expansion pressure of the "as received" samples.

Exception: Should the specified conditions not be met, the material is to be subjected to the exposure condition for which the largest decrease in performance occurred. The material is then to be installed in a representative firestop system and subjected to the Fire Endurance Test. The system shall meet the performance criteria for at least 75% of the F rating period.

28.4.2 Sets consisting of five 1 ±1/16 in (25.4 ±1.59 mm) diameter discs are to be die-cut from material samples. A minimum of one set, subjected to the accelerated aging exposure, and a minimum of one set, subjected to the high humidity exposure, are to be tested. Samples are to be examined, weighed, and measured before and after exposures. An additional set of samples is to be retained "as received". Additional sets of samples subjected to the supplemental exposure conditions indicated above are to be tested when applicable. Materials for which die-cutting is not practical (i.e. molded materials, caulks) are to be molded into disks which have diameters of 1 to 2 in (25.4 to 50.8 mm). The range of diameters for the molded samples shall be within 1/16 in (1.59 mm).

28.4.3 The test apparatus is to consist of two heating plates provided with a means of adjusting the distance between the plates. The lower plate is to be connected to a strain gauge capable of measuring the pressure exerted by the expansion of the sample. The strain gauge is to be connected to a recorder that continuously records the measured pressure relative to time.

28.4.4 The samples are to be placed in a steel cylinder whose height is equal to the thickness of the sample. The inside diameter of the cylinder is to be the same size as the sample. The test apparatus is to be set such that there is an initial load of 50 to 100 N (11 to 22 lbf) and the heating plates of the apparatus are to be preheated to 572 ±5° F (300 ±2.7° C). The steel cylinder with the sample in it is to be placed between two sheets of aluminum foil and centered between the two plates of the test apparatus. As the sample heats and expands, the pressure peaks and then declines. The test is to be discontinued after a decline in pressure for at least three consecutive minutes. The expansion pressure of the sample is to be determined by subtracting the initial preloaded pressure from the maximum pressure.

28.5 Expansion factor test

28.5.1 When tested as described in 28.5.2 – 28.5.4, samples previously exposed to the environmental exposure conditions shall have an expansion factor within 3 standard deviations (3-σ) of the mean of the maximum expansion factor of the "as received" samples or have at least 90% of the average maximum expansion factor of the "as received" samples.

Exception: Should the specified conditions not be met, the material is to be subjected to the exposure condition for which the largest decrease in performance occurred. The material is then to be installed in a representative firestop system and subjected to the Fire Endurance Test. The system shall meet the performance criteria for at least 75% of the F rating period.

28.5.2 Sets consisting of five 2 ±1/8 in (51 ±3 mm) diameter discs are to be die-cut from material samples. A minimum of one set, subjected to the accelerated aging exposure, and a minimum of one set, subjected to the high humidity exposure, are to be tested. Samples are to be examined, weighed, and measured before and after exposures. An additional set of samples is to be retained "as received". Additional sets of samples subjected to the supplemental exposure conditions indicated above are to be tested when applicable. Materials for which die-cutting is not practical (i.e. molded materials, caulks) are to be molded into disks which have diameters of 2 in (50.8 mm).

28.5.3 A muffle furnace capable of maintaining temperatures of 572 ±5°F (300 ±2.7°C) is to be used.

28.5.4 The thickness of each disc is to be measured to the nearest 0.001 in (.03 mm) at five locations. The five measurements are to be averaged to obtain the average thickness. Each disc is to be placed inside a test pipe which has an inside diameter not more than 0.08 in (2 mm) larger than the disc. The disc is to be totally covered with a weight having a mass of 5 g/cm^2 (10.2 lb/ft^2). The test pipe, containing the disc, is to be placed in the muffle furnace preheated to 572 ±5°F (300 ±2.7°C) for 30 min. After 30 min, the test pipe is to be removed from the muffle furnace and cooled to ambient temperature. After cooling, the minimum and maximum height of char is to be measured to the nearest 1/16 in (1.6 mm). The expansion factor is to be calculated using the ratio of the expanded thickness to the initial measured thickness.

FIRE ENDURANCE RATING

29 Conditions of Acceptance

29.1 During the tests, the construction shall have complied with the following conditions:

a) For joint systems designed to be load bearing, the joint system shall have sustained the applied load during the rating period.

b) Transmission of heat through the joint system shall not have raised the temperature at the hottest point more than 325° F (181° C) above its initial temperature during the rating period. Additionally, for joint systems having a maximum width equal to or greater than 6 in (152 mm), the temperature rise as determined by the average of all values recorded by thermocouples placed over the joint system shall not have increased by more than 250°F (139°C). Also, for floor-to-wall and head-of-wall joint systems, transmission of heat through the joint system shall not have raised the temperature of the structure 1 in (25 mm) from the joint system more than 325°F (181°C) above its initial temperature during the rating period.

c) For tests of wall-to-wall and head-of-wall joint systems, the joint system shall have withstood the hose stream test without developing any opening that permits a projection of water from the stream beyond the unexposed surface.

d) The integrity of the joint system shall be maintained to prohibit ignition of the cotton waste pad.

30 Correction

30.1 When the indicated resistance period of the joint system is 1/2 h or longer as determined by maximum temperature rise on the unexposed surface, it shall be increased or decreased by the following correction to compensate for significant variation of the measured time-temperature curve from the standard time-temperature curve within the limits of 13.7. The correction is be expressed by the following formula:

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

in which:

C is the correction in the same units as I,

I is the indicated fire resistance period,

A is the area under the curve of measured average furnace temperature for the first three-fourths of the indicated period,

A_s is the area under the standard time-temperature curve for the same part of the indicated period; and