भारतीय मानक ब्यूरो
(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)
BUREAU OF INDIAN STANDARDS
(Ministry of Consumer Affairs, Food & Public Distribution, Govt. of India)

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व्यापक परिचालन मसौदा

हमारा संदर्भ : सीईडी 36/टी-57 **02 मई 2025**

तकनीकी समिति: अग्नि सुरक्षा विषय समिति, सीईडी 36

प्राप्तकर्ता :

1. **सिविल अभियांत्रिकी विभाग परिषद, सीईडीसी के सभी सदस्य**
2. **अग्नि सुरक्षा विषय समिति, सीईडी 36**
3. **रुचि रखने वाले अन्य निकाय।**

महोदय/ महोदया,

निम्नलिखित मानक का मसौदा संलग्न हैं:

प्रलेख संख्या	शीर्षक
सीईडी 36(27909)WC	**भवन जोड़ प्रणालियों की अग्नि प्रतिरोध क्षमता - परीक्षण की विधि का भारतीय मानक मसौदा,** (आईसीएस: 13.220.50)

कृपया इस मसौदे का अवलोकन करें और अपनी सम्मतियाँ यह बताते हुए भेजे कि यह मसौदा प्रकाशित हो तो इन पर अमल करने में आपको व्यवसाय अथवा कारोबार में क्या कठिनाइयां आ सकती हैं।

सम्मतियाँ भेजने की अंतिम तिथि: 02 जून 2025

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यह प्रालेख भारतीय मानक ब्यूरो की वैबसाइट **www.bis.gov.in** पर भी उपलब्ध हैं।

धन्यवाद।

भवदीय
ह/-

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भारतीय मानक ब्यूरो
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WIDE CIRCULATION DRAFT

Our Reference: CED 36/T-57 **02 May 2025**

TECHNICAL COMMITTEE: FIRE SAFETY SECTIONAL COMMITTEE, CED 36

ADDRESSED TO:

1. All Members of Civil Engineering Division Council, CEDC
2. All Members of Fire Safety Sectional Committee, CED 36
3. All others interested.

Dear Sir/ Madam,

Please find enclosed the following draft:

Doc No.	Title
CED 36(27909)WC	**Draf Indian Standard Fire Resistance of Building Joint Systems — Method of Test**, (ICS: 13.220.50)

Kindly examine the attached draft and forward your views stating any difficulties which you are likely to experience in your business or profession if this is finally adopted as National Standard.

Last Date for Comments: 02 June 2025

Comments if any, may please be made in the enclosed format and emailed at **ced36@bis.gov.in** or sent at the above address. Additionally, comments may be sent online through the BIS e-governance portal, **www.manakonline.in**.

In case no comments are received, or comments received are of editorial nature, kindly permit us to presume your approval for the above document as finalized. However, in case comments, technical in nature are received, then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

The document is also hosted on BIS website **www.bis.giv.in**.

Thanking you,

Yours faithfully,

Sd/-

Dwaipayan Bhadra
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Civil Engineering Department
Email: ced36@bis.gov.in
Phone: +91-11 2323 5529

Encl: As above

FORMAT FOR SENDING COMMENTS ON THE DOCUMENT

[Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/ table/figure, etc, be stated on a fresh row. Information/comments should include reasons for comments, technical references, and suggestions for modified wordings of the clause. **Comments through e-mail to ced36@bis.gov.in shall be appreciated**.]

Doc. No.: CED 36(27909)WC **BIS Letter Ref**: CED 36/T-57

Title: Draft Indian Standard Fire Resistance of Building Joint Systems — Method of Test

Last date of comments: **02 June 2025**

Name of the Commentator/ Organization: _____

Clause/ Para/ Table/ Figure No. commented	Type of Comment (Technical/ Editorial/ General)	Comments/Modified Wordings	Justification of Proposed Change

NOTE- Kindly insert more rows as necessary for each clause/table, etc.

BUREAU OF INDIAN STANDARDS

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Draft Indian Standard

FIRE RESISTANCE OF BUILDING JOINT SYSTEMS — METHOD OF TEST

(ICS: 13.220.50)

Fire Safety Sectional Committee, CED 36	**Last Date for Comments: 02 June 2024**

FOREWORD

(Formal clauses shall be added later)

Linear building joints seal are used with the intention to join individual structural elements to accommodate movements, dimensional tolerances, inadequate designs and to avoid constrictions in the building (examples of such cases could be the profile of structure which gets formed after creep and shrinkage of concrete). In addition, there may be inherent environmental factors at play such as humidity, temperature changes, wind, seismic forces, etc.

Building codes requires all these gaps between structural elements to be sealed at all levels by fire-resistant sealant material of equal fire rating as that of structural element to prevent fire and smoke propagation from one floor to another. This standard covers the method of fire resistance tests to assess the performance of such building joint systems.

While arriving at the fire resistance rating of the joint systems, it is very important to consider and accommodate movement forces on to it either due to design requirements or due to external factors. It is important that these joints along with their fire resistance rating also accommodate movement so that any extreme conditions in fire are considered.

The method of fire resistance test of various structural elements of buildings is covered in IS/ISO 834-1: 1999 ‘Fire resistance tests elements of building construction: Part 1 General requirements’.

In the formulation of this standard, significant assistance was derived from the following standards:

- ASTM E1966 Standard Test Method for Fire-Resistive Joint Systems
- UL 2079 Tests for Fire Resistance of Building Joint Systems

An informatory Annex D on engineering judgement (EJ), also known as “Technical Evaluations or TEs”, towards assessing the performance of fire resistance of building joint systems has been included for enabling users to prepare and issue EJ’s based on sound engineering principles. The guidelines provided in Annex D aims to instil common practice of issuing and accepting the engineering judgements related to fire resistance of building joint systems. In preparation of these guidelines on EJs, significant assistance was derived from ‘International Firestop Council Guidelines’ for engineering judgements (EJ) or TEs of tests for fire resistance of building joint systems.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

BUREAU OF INDIAN STANDARDS

Working Draft

FIRE RESISTANCE OF BUILDING JOINT SYSTEMS — METHOD OF TEST

1 SCOPE

1.1 This standard is applicable to joint systems of various materials and construction that are intended for use in linear openings between adjacent fire resistive structures and/or compartments.

1.2 The fire resistance ratings for joint systems are intended to assess 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 be able to 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 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 determining the hourly fire resistance ratings of walls and floors are found in IS/ISO 834-1.

1.9 Tests for determining the surface burning characteristics of building materials, based on the rate of flame spread, are found in IS 12777.

1.10 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.

NOTE — A guidance on providing engineering judgement based on test is given in Annex D for information only.

1.11 The method of testing also includes 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 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.

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

1.12 The method of testing also includes water leakage tests to determine the ability of fire resistive joint systems to resist the passage of water under a 914 mm (3 ft) pressure head. This method does not evaluate the ability of uncured joint systems to resist such exposure.

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 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No.	**Title**
IS 8757: 2021	Glossary of terms associated with fire safety (second revision)
IS / ISO 834-1: 1999	Fire resistance tests elements of building construction: Part 1 General requirements
IS 12777	Standard for Test for Surface Burning Characteristics of Building Materials

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 8757 and the following shall apply:

3.1 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 16 mm (5/8 in). 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.

3.2 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.

3.3 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.

3.4 Linear Opening — A discontinuity between or within fire resistive structures.

3.5 Manufactured Splice — The technique utilized at the point of manufacture to join two or more lengths of a joint system component material.

3.6 Maximum Joint Width — The greatest width to which the joint system is designed to extend taking into consideration all axes of movement.

3.7 Minimum Joint Width — The narrowest width the joint system is designed to accommodate.

3.8 Movement Capability — The range of movement that a joint system is designed to accommodate without diminishing its fire resistive performance.

3.9 Nominal Joint Width — The width of the linear opening specified in practice and in which the joint system is installed.

3.10 Structure — The fire resistive floor and/or wall segments between which the joint system is installed.

3.11 Test Assembly — The complete assembly of the joint system and the structure in which it is installed.

4 TEST ASSEMBLY

4.1 General

4.1.1 The structure and joint system shall be representative of the construction for which fire resistance 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.

4.1.2 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 610 mm (24 in). For vertical assemblies, the minimum separation between adjacent joint opening edges is to be 457 mm (18 in). Reduction of the minimum separation distances is acceptable when it is demonstrated that the reduced separation distance does not affect test results.

4.1.3 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 305 mm (12 in). The minimum separation between splices in a joint system shall be 914 mm (36 in). Reduction of the minimum separation distances is acceptable when it is demonstrated that the reduced separation distance does not affect test results.

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

4.1.5 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.

4.2 Floor-to-Floor Joint Systems

4.2.1 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 1.5 times the thickness of the floor or 305 mm (12 in), whichever is greater.

4.2.2 The minimum length of the joint system exposed to fire is to be 914 mm (36 in), 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 3.7 m (12 ft)

4.3 Wall-to-Wall Joint Systems

4.3.1 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 1.5 times the thickness of the wall or 305 mm (12 in), whichever is greater.

4.3.2 The minimum length of the joint system exposed to fire is to be 914 mm (36 in) 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 2.7 m (9 ft)

4.3.3 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 resistance rating is tested.

4.4 Floor-to-Wall Joint System

4.4.1 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 305 mm (12 in) beyond each surface of the floor structure.

4.4.2 The minimum length of the joint system exposed to fire is to be 914 mm (36 in) 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 3.7 m (12 ft).

4.5 Head-of-Wall Joint System

4.5.1 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 305 mm (12 in) beyond each surface of the wall structure.

4.5.2 The minimum length of the joint system exposed to fire is to be 914 mm (36 in) 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 2.7 m (9 ft).

4.5.3 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 resistance rating is tested.

5 CONDITIONING

5.1 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 percent relative humidity at 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 percent to 75 percent relative humidity at 23 °C ± 3 °C.

NOTE — 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 needs to be continued only until the structure has developed sufficient strength to retain the joint system securely in position.

5.2 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.

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

5.4 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 resistance characteristics of the test assembly, or both, from those produced as a result of drying in accordance with the procedures specified in **5.1**.

5.5 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 as per **16.5**.

5.6 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 shall consist of any one of the conditions specified in Table 1. A movement cycle is to consist of the joint system width being nominal, maximum, minimum and then nominal.

Table 1 Conditions of Test Specimen Cycling
(*Clause* 5.6)

Sl No.	**Minimum Number of Cycles**	**Minimum Cycling Rate** (cycles per min)
(1)	(2)	(3)
i)	500	1
ii)	500	10
iii)	100	30

5.7 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.

5.8 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.

5.9 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.

NOTE — 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 **5.1** to **5.5** prior to fire testing.

6 FIRE RESISTANCE TEST

6.1 Test Furnace

6.1.1 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.

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

6.2 Time-Temperature Curve

The conduct of fire endurance tests of joint systems is to be controlled by the standard time-temperature curve shown in Fig. 1.

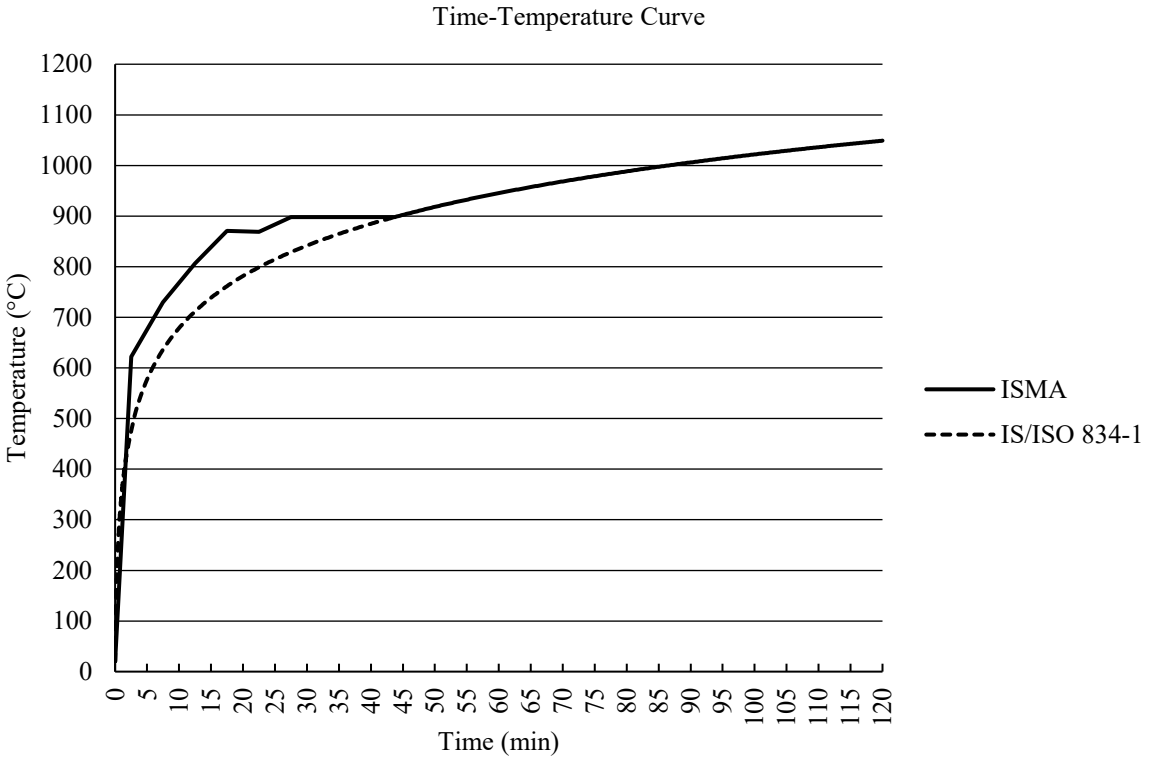

FIG. 1 ISMA OR IS/ISO 834-1 TIME-TEMPERATURE CURVES

For a more precise definition of the time-temperature curve, *see* Annex A.

7 FURNACE TEMPERATURES

7.1 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.

7.2 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 305 mm (12 in)

7.3 The time constant of the protected thermocouple assembly is to be within the range of 5.0 min to 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 0.82 mm^2 (18 AWG) chromel-alumel wires, mounting the leads in porcelain insulators and inserting the assembly into a standard weight 13 mm (1/2 in) [21.3 mm (0.84 in) 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, 13 mm (1/2 in) from the sealed end.

7.4 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 305 mm (12 in) below the principle horizontal surface of the test assembly at the beginning of the test.

7.5 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 152 mm (6 in) away from the exposed surface of the test assembly at the beginning of the test.

7.6 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 914 mm (36 in). The junction of each thermocouple is to be placed at a point 305 mm (12 in) below the exposed horizontal surface of the test assembly and 152 mm (6 in) away from the exposed vertical surface of the test assembly at the beginning of the test.

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

7.8 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 percent of the corresponding area under the standard time-temperature curve for fire tests of 1 h or less duration,

b) 7.5 percent 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 percent of the corresponding area under the standard time-temperature curve for fire tests exceeding 2 h in duration.

8 FURNACE PRESSURE

8.1 The differential pressure between the exposed and unexposed surfaces of the test assembly at the elevations specified in **8.7** is to be calculated based on measurements taken at the locations specified in **8.4** or **8.5**, 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.

8.2 The pressure sensors are to be either of the "T" type or the "tube" type as illustrated in Fig. 2 and are to be manufactured from stainless steel.

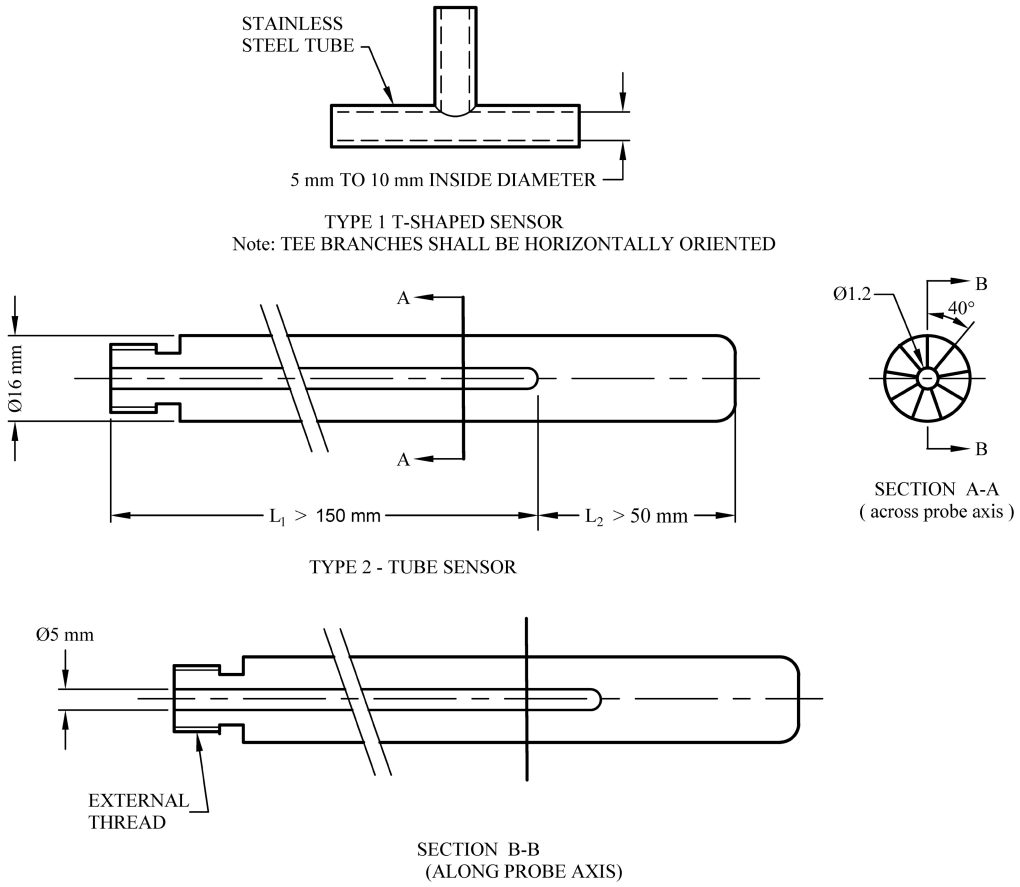

FIG. 2 PRESSURE SENSORS

8.3 The differential pressure is to be measured by means of a manometer or equivalent transducer capable of reading pressure in increments of 2.5 Pa water (0.01 in) with a measurement precision of 1.25 Pa water (0.005 in). 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.

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

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

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

8.7 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 305 mm (12 in) below the exposed horizontal surface of the test assembly shall not fall below a minimum of 2.5 Pa water (0.01 in) 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 mid-height of the exposed vertical surface of the test assembly shall not fall below a minimum of 2.5 Pa water (0.01 in) above atmospheric pressure after the initial 10 min of fire exposure.

8.8 After the initial 10 min of fire exposure, the furnace pressure, at the locations specified in **8.7**, shall not be less than 2.5 Pa water (0.01 in) for an aggregate time period exceeding:

a) 10 percent of the fire exposure for fire test of 1 h or less duration
b) 7.5 percent of the fire exposure for fire tests longer than 1 h but not longer than 2 h; and
c) 5 percent of the fire exposure for fire tests exceeding 2 h in duration

9 TEMPERATURES OF THE UNEXPOSED SURFACE

9.1 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 Annex B.

9.2 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 25 mm (1 in). The hot junction of the thermocouple is to be placed approximately under the centre 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 0.82 mm^2 (18 AWG) and are to be electrically insulated with heat-resistant and moisture-resistant coatings

9.3 Temperature readings are to be taken at not less than seven points for each minimum 2.7 m (9 ft) long joint system and at not less than five points for each joint system that is less than 2.7 m (9 ft) 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 centreline of the joint system. For tests of joint systems, no thermocouple is to be placed within 1.5 times the thickness of the test assembly or 305 mm (12 in), 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 25 mm (1 in) 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 25 mm (1 in) 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 25 mm (1 in) 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 percent of the area within any 152 mm (6 in) diameter circle, unless the fasteners extend through the joint system

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

10 INTEGRITY

10.1 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.

10.2 The nominal 100 mm × 100 mm × 19 mm (4 × 4 × 3/4 in) cotton waste pads are to consist of new, undyed and soft cotton fibres, without any admixture of artificial fibres, and each pad is to weigh approximately 3 g to 4 g. The pads are to be conditioned prior to use by drying in an oven at 100 °C ± 5 °C (212 °F ± 9 °F) for at least 30 min. After drying, the pads shall be stored in a desiccator for up to 24 h.

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

10.4 The cotton waste pad is to be held directly over an observed crack or hole in the joint system, approximately 25 mm (1 in) 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.

10.5 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.

11 CONDUCTION OF FIRE RESISTANCE TEST

11.1 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.

11.2 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 10 °C to 32 °C (50 – 90°F). The velocity of air moving horizontally across the unexposed surface of the test sample, measured immediately before the test begins, is not to exceed 1.3 m/s (4.4 ft/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.

11.3 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.

11.4 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.

11.5 The fire test is to be continued until failure occurs or until the test specimen has withstood the test conditions for the desired fire resistance rating that satisfies all the applicable conditions of acceptance in **16**.

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

12 HOSE STREAM TEST

12.1 Test Assembly

12.1.1 For wall-to-wall and head-of-wall joint systems, a duplicate test assembly which has been conditioned and movement cycled (see Conditioning, **5**) 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.

12.1.2 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 **11**. The hose stream test is to be conducted within 10 min of completion of the fire test.

12.2 Conduct of Hose Stream Test

12.2.1 The stream is to be delivered through a 64 mm (2-1/2 in) hose and discharged through a National Standard playpipe of corresponding size equipped with a 29 mm (1-1/8 in) 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 2.

Table 2 Pressure and Duration of Hose Stream Test
(*Clause* 12.2.1)

Sl No.	**Hourly Fire Rating Time,** min	**Water Pressure at Base of Nozzle,** kPa (Psi)	**Duration of Application of Exposed Area**[1)] s/m^2 (s/ft^2)
(1)	(2)	(3)	(4)
i)	240 ≤ time < 480	310 (45)	32 (3.0)
ii)	120 ≤ time < 240	210 (30)	16 (1.5)
iii)	90 ≤ time < 120	210 (30)	9.7 (0.90)
iv)	time < 90	210 (30)	6.5 (0.60)

[1)] 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.

12.2.2 The nozzle orifice is to be 6.1 m (20 ft) from the centre of the exposed surface of the joint system if the nozzle is so located that, when directed at the centre, 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 centre of the joint system. When so located its distance from the centre of the joint system is

to be less than 6.1 m (20 ft) by an amount equal to 305 mm (1 ft) for each 10 degree of deviation from the normal.

13 AIR LEAKAGE TEST

13.1 Test Assembly

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 914 mm (36 in). 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 resistance test. The joint system is to be tested for air leakage at the maximum joint width.

13.2 Apparatus

13.2.1 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 managed so that air is not discharged directly on to the joint system or on to the 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 305 mm (12 in).

13.2.3 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 152 mm (6 in) 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.

13.3 Conduction of Air Leakage Test

13.3.1 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 **13.3.3** and again after the elevated temperature air leakage test specified in **13.3.4**, the extraneous chamber leakage is to be measured.

13.3.2 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 24 °C ± 11 °C (75 ± 20 °F). The air flow into the test chamber is to be adjusted to provide a positive test pressure differential of 75 Pa water (0.30 in) 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 2.5 Pa water (0.01 in) with a measurement precision of 1.25 Pa water (0.005 in). 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).

13.3.3 For the ambient temperature air leakage test, the temperature of the test assembly and the air temperature in the chamber are to be 24 °C ± 11 °C (75 ±20°F). The air flow into the test chamber is to be adjusted to provide a positive test pressure differential of 75 Pa water (0.30 in) 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).

13.3.4 For the elevated temperature air leakage test, the test to determine total metered air flow (Q_t) at ambient temperature as specified in **13.3.3** is to be repeated but with the air temperature in the chamber increased to 204 °C ± 5 °C (400 ± 10°F). The temperature of the exposed face of the test sample prior to the conduct of the test is to be 24 °C ± 11 °C (75 ± 20°F). The air temperature in the chamber is to be increased so that it reaches 177 °C (350 °F) within 15 min and 204 °C (400 °F) within 30 min. When stabilized at the prescribed air temperature of 204 °C ± 5 °C (400 ± 10 °F), the air flow through the air flow metering system and the test pressure difference are to be measured and recorded.

13.4 Air Leakage Rate Calculation

13.4.1 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.

13.4.2 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.

14 WATER LEAKAGE TEST

14.1 Test Sample

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 **4.2** to **4.5** as appropriate. The sample shall be conditioned as described in **5** both before and after completion of the water leakage test.

14.2 Test Chamber

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

14.2.2 The width of the test chamber must be equal to or greater than the exposed length of the test sample. See Fig. 3**.**

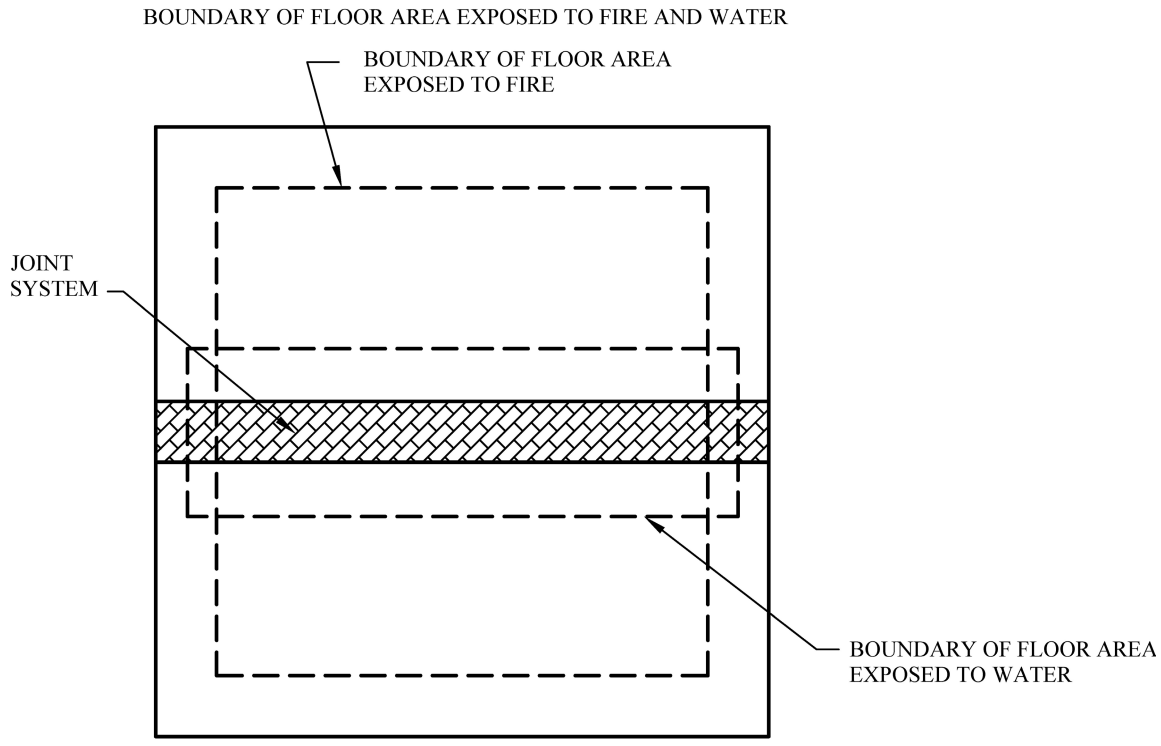

FIG. 3 SAMPLE FOR WATER LEAKAGE TEST

14.2.3 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 25 mm (1 in) above the top surface of the water placed inside the water leakage test chamber.

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

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

14.3 Test Setup

14.3.1 Joint systems are to be installed as specified in **4.1**.

14.3.2 The water leakage test chamber is to be sealed to the test sample. Non-hardening 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.

14.3.3 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 152 mm (6 in).

14.3.4 The top of the joint system is to be 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.

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

14.3.6 A white indicating medium is to be placed immediately below the fire resistive joint system.

14.3.7 The minimum pressure within the water leakage test chamber shall be 914 mm (3 ft) of water [8.96 kPa (1.3 psi)] applied for a minimum of 72 h. The pressure head shall be measured at the horizontal plane at the top of the water seal.

14.3.8 Subsequent to the water leakage test, and conditioning as specified in **5**, the joint system shall be subjected to the fire resistance test as specified in **11** and the hose stream test as specified in **13**.

14.4 Recorded Test Data

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.

15 ENVIRONMENTAL EXPOSURE TESTS FOR INTUMESCENT MATERIAL

15.1 Environmental Exposure Tests for Intumescent Material

15.1.1 *General*

Intumescent fill, void or cavity material shall comply with the Expansion pressure test, **15.1.4**, and with the Expansion factor test, **15.1.5**, following exposure to the required environmental exposures specified in **15.1.2** and, as applicable, to the supplemental environmental exposures specified in **15.1.3.**

15.1.2 *Required Environmental Exposures*

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

a) *Accelerated Aging* — Samples of the material are to be placed in a circulating air-oven at 70 °C ± 2.7 °C (158 ± 5 °F) for 270 days.
b) *High Humidity* – Samples of the material are to be placed in a controlled humidity of 97 percent to 100 percent at 35 °C ± 1.5 °C (95 ± 3 °F) for 180 days.

15.1.2.2 Following exposure to specified conditions in **15.1.2.1**, the material is to be subjected to the expansion pressure test, **15.1.4**, and to the expansion factor test, **15.1.5**.

15.1.3 *Supplemental Environmental Exposures*

15.1.3.1 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 sulphur 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 percent of the volume of the test chamber, and an equal volume of CO_2. The test chamber is to be maintained at 35 °C ± 1.5 °C (95 ± 3°F) 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).

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 °C ± 2.7 °C (minus 40 ± 5°F) for 24 h, and then a dry atmosphere of 60 °C ± 2.7 °C (140 ± 5°F) 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 percent by volume of hydrochloric acid (HCl) in water. The fog spray is to provide 1 ml 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 21 °C ± 2.7 °C (70 ± 5°F). 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.

15.1.3.1 Following exposure, as applicable, to specified conditions in **15.1.3.1**, the material is to be subjected to the expansion pressure test, **15.1.4**, and to the expansion factor test, **15.1.5**.

15.1.4 *Expansion Pressure Test*

15.1.4.1 When tested as described in **15.1.4.2** to **15.1.4.4**, 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 percent 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 percent of the average time of the peak expansion pressure of the “as received” samples.

NOTE — 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 resistance test. The system shall meet the performance criteria for at least 75 percent of the F-rating period.

15.1.4.2 Sets consisting of five 25.4 mm ± 1.59 mm (1 ±1/16 in) 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 (that is moulded materials, caulks) are to be moulded into disks which have diameters of

25.4 mm to 50.8 mm (1 to 2 in). The range of diameters for the moulded samples shall be within 1.59 mm (1/16 in).

15.1.4.3 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.

15.1.4.4 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 300 °C ± 2.7 °C (572 ± 5 °F). The steel cylinder with the sample in it is to be placed between two sheets of aluminium foil and centred 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.

15.1.5 *Expansion Factor Test*

15.1.5.1 When tested as described in **15.1.5.2** to **15.1.5.4**, 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 percent of the average maximum expansion factor of the “as received” samples.

NOTE — 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 resistance test. The system shall meet the performance criteria for at least 75 percent of the F-rating period.

15.1.5.2 Sets consisting of five 51 mm ± 3 mm (2 ±1/8 in) 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 (that is moulded materials, caulks) are to be moulded into disks which have diameters of 50.8 mm (2 in).

15.1.5.3 A muffle furnace capable of maintaining temperatures of 300 °C ± 2.7 °C (575 ± 5^{o} F) is to be used.

15.1.5.4 The thickness of each disc is to be measured to the nearest 0.03 mm (0.001 in) 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 2 mm (0.08 in) 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 300 °C ± 2.7 °C (572 ± 5°F) 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 1.6 mm (1/16 in). The expansion factor is to be calculated using the ratio of the expanded thickness to the initial measured thickness.

16 FIRE RESISTANCE RATING

16.1 Conditions of Acceptance

16.1.1 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 181 °C (325 °F) above its initial temperature during the rating period. Additionally, for joint systems having a maximum width equal to or greater than 152 mm (6 in), 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 139 °C (250 °F). 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 25 mm (1 in) from the joint system more than 181 °C (325 °F) 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.

16.2 Corrections

16.2.1 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 **7.7**. The correction is be expressed by the following formula:

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

where,

C = Correction in the same units as I,

I = Indicated fire resistance period,

A = Area under the curve of measured average furnace temperature for the first three-fourths of the indicated period

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

L = Lag correction in the same units as A and A_s [30 °C-h (54°F-h); 1800 °C-min (3240 °F-min)]

16.3 L-Rating

The L-rating is to be reported as the largest leakage rate determined from the air leakage test. Separate ratings can be identified for each pressure or temperature exposure, or both.

16.4 W-Rating

During the water leakage test, no openings shall develop that would permit any leakage of water. For background information for W-rating *see* Annex C.

16.5 Report of Results

The performance of joint systems during the tests shall be reported. When the joint system is designed for fire exposure from one side only, the report shall so state. The report shall include the following:

a) Identification of the testing laboratory and identification of the employer of the personnel who witnessed the preparation of the samples and tests.

b) A description of the materials and construction details of the structure and joint systems including drawings depicting geometry, exact size (length, width and thickness), location and types of splices, and location of the joint systems within the test assembly. The description shall clearly indicate all information relevant to the movement and load bearing capabilities of the joint system.

c) The dates of construction, a description of the process used for conditioning the structure and joint systems and the results of the final moisture content measurements.

d) A description of the method and results of the movement cycling performed on the joint systems. The description shall identify the number of cycles and the approximate cycling rate.

e) Locations of all thermocouples, pressure probes and other instrumentation used during the fire test.

f) A description of the superimposed load applied to the joint system throughout the fire test and the basis for application of the load.

g) Observations of the exposed and unexposed surfaces of the test assembly during the fire test. If significant deflection of the structure occurred, the report shall indicate the location, time and magnitude of each deflection measurement. If the cotton waste pad test was used during the fire test, the report shall indicate the locations, times and results of each application of the cotton waste pad.

h) A record of all temperature and pressure measurements at the beginning of the fire test and at maximum 5 min time intervals throughout the fire test.

j) The time at which any of the end point criteria was reached on the joint system or structure, rounded to the nearest integral minute. For tests of asymmetrical wall-to-wall or head-of-wall joint systems, the side developing the lesser end point time shall govern for fire resistance rating of the joint system. The end point time shall include any necessary correction for significant variation between the measured furnace temperature and the standard time-temperature curve.

k) Details and results of the hose stream test.

m) A record of all data from the optional air leakage tests used to calculate the air leakage rate at each temperature exposure.

n) When optional water leakage test is conducted, the applied pressure head, the duration of the application of the pressure head and the occurrence or lack of water leakage.

ANNEX A

(*Clause* 6.2)

STANDARD TIME-TEMPERATURE CURVE FOR CONTROL OF FIRE TESTS

A-1 The standard time-temperature curve for control of fire tests is given in Table A-1

Table A-1 Standard Time-Temperature Curve for Control of Fire Tests
(*Clause* A-1)

Sl No.	Time	Temperature	Area above 68 °F Base		Temperature	Area above 20 °C Base	
	h:min	°F	°F, min	°F, h	°C	°C, min	°C, h
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	0:00	68	00	0	20	00	0
ii)	0:05	1 000	2 330	39	538	1 290	22
iii)	0:10	1 300	7 740	129	704	4 300	72
iv)	0:15	1 399	14 150	236	760	7 860	131
v)	0:20	1 462	20 970	350	795	11 650	194
vi)	0:25	1 510	28 050	468	821	15 590	260
vii)	0:30	1 550	35 360	589	843	19 650	328
viii)	0:35	1 584	42 860	714	862	23 810	397
ix)	0:40	1 613	50 510	842	878	28 060	468
x)	0:45	1 638	58 300	971	892	32 390	540
xi)	0:50	1 661	66 200	1 103	905	36 780	613
xii)	0:55	1 681	74 220	1 237	916	41 230	687
xiii)	1:00	1 700	82 330	1 372	927	45 740	762
xiv)	1:05	1 718	90 540	1 509	937	50 300	838
xv)	1:10	1 735	98 830	1 647	946	54 910	915
xvi)	1:15	1 750	107 200	1 787	955	59 560	993
xvii)	1:20	1 765	115 650	1 928	963	64 250	1 071
xviii)	1:25	1 779	124 180	2 070	971	68 990	1 150
xix)	1:30	1 792	132 760	2 213	978	73 760	1 229
xx)	1:35	1 804	141 420	2 357	985	78 560	1 309
xxi)	1:40	1 815	150 120	2 502	991	83 400	1 390
xxii)	1:45	1 826	158 890	2 648	996	88 280	1 471
xxiii)	1:50	1 835	167 700	2 795	1 001	93 170	1 553
xxiv)	1:55	1 843	176 550	2 942	1 006	98 080	1 635
xxv)	2:00	1 850	185 440	3 091	1 010	103 020	1 717
xxvi)	2:10	1 862	203 330	3 389	1 017	112 960	1 882
xxvii)	2:20	1 875	221 330	3 689	1 024	122 960	2 049

Sl No.	Time	Temperature	Area above 68 °F Base		Temperature	Area above 20 °C Base	
	h:min	°F	°F, min	°F, h	°C	°C, min	°C, h
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
xxviii)	2:30	1 888	239 470	3 991	1 031	133 040	2 217
xxix)	2:40	1 900	257 720	4 295	1 038	143 180	2 386
xxx)	2:50	1 912	276 110	4 602	1 045	153 390	2 556
xxxi)	3:00	1 925	294 610	4 910	1 052	163 670	2 728
xxxii)	3:10	1 938	313 250	5 221	1 059	174 030	2 900
xxxiii)	3:20	1 950	332 000	5 533	1 066	184 450	3 074
xxxiv)	3:30	1 962	350 890	5 848	1 072	194 940	3 249
xxxv)	3:40	1 975	369 890	6 165	1 079	205 500	3 425
xxxvi)	3:50	1 988	389 030	6 484	1 086	216 130	3 602
xxxvii)	4:00	2 000	408 280	6 805	1 093	226 820	3 780
xxxviii)	4:10	2 012	427 670	7 128	1 100	237 590	3 960
xxxix)	4:20	2 025	447 180	7 453	1 107	248 430	4 140
xl)	4:30	2 038	466 810	7 780	1 114	259 340	4 322
xli)	4:40	2 050	486 560	8 110	1 121	270 310	4 505
xlii)	4:50	2 062	506 450	8 441	1 128	281 360	4 689
xliii)	5:00	2 075	526 450	8 774	1 135	292 470	4 874
xliv)	5:10	2 088	546 580	9 110	1 142	303 660	5 061
xlv)	5:20	2 100	566 840	9 447	1 149	314 910	5 248
xlvi)	5:30	2 112	587 220	9 787	1 156	326 240	5 437
xlvii)	5:40	2 125	607 730	10 129	1 163	337 630	5 627
xlviii)	5:50	2 138	628 360	10 473	1 170	349 090	5 818
xlix)	6:00	2 150	649 120	10 819	1 177	360 620	6 010
l)	6:10	2 162	670 000	11 167	1 184	372 230	6 204
li)	6:20	2 175	691 010	11 517	1 191	383 900	6 398
lii)	6:30	2 188	712 140	11 869	1 198	395 640	6 594
liii)	6:40	2 200	733 400	12 223	1 204	407 450	6 791
liv)	6:50	2 212	754 780	12 580	1 211	419 330	6 989
lv)	7:00	2 225	776 290	12 938	1 218	431 270	7 188
lvi)	7:10	2 238	797 920	13 299	1 225	443 290	7 388
lvii)	7:20	2 250	819 680	13 661	1 232	455 380	7 590
lviii)	7:30	2 262	841 560	14 026	1 239	467 540	7 792
lix)	7:40	2 275	863 570	14 393	1 246	479 760	7 996
lx)	7:50	2 288	885 700	14 762	1 253	492 060	8 201
lxi)	8:00	2 300	907 960	15 133	1 260	504 420	8 407

ANNEX B

(*Clause* 9.1)

REQUIREMENTS FOR THERMOCOUPLE PADS

B-1 The dry, felted refractory fibre[1)] pads used to cover each thermocouple on the unexposed side of the test assembly shall have the following characteristics

a) *Length and width* — For joints having a maximum width of less than 152 mm (6 in) – 50 ± 1 mm (2 ± 0.04 in). For joints having a maximum width equal to or greater than 152 mm (6 in) – 152 ±3 mm (6 ±0.12 in)

b) *Thickness*[2)] — 9.5 mm ±1.6 mm (0.375 ± 0.063 in)

c) *Density* — 300 kg/m^3 ± 3 kg/m^3 (18.7 ± 0.2 lb/ft^3)

d) *Thermal conductivity at 66 °C (150 °F)* — 0.37 ± 0.03 Btu·in/(h·ft^2·°F) [0.053 ±0.004 W/m·K]; and

e) *Hardness*[3)] *(on soft face)* — 2.25 to 4.5 (modified Brinell)

[1)] Johns-Manville Ceraform 126, or the equivalent, has been found to be an acceptable refractory fibre material.

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

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

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

where,

y = difference in indentation in mm (or inches)

ANNEX C

(*Clause* 16.4)

BACKGROUND INFORMATION FOR THE W-RATING

C-1 The 914 mm (3 ft) water pressure head was selected for two reasons:

a) To provide a safety factor of 3 for a maximum anticipated water accumulation of 305 mm (12 in).
b) To accommodate the possibility that some firestop seals will be used in walls of sub-grade buildings which could have a substantial water accumulation.

C-2 The W-rating may be applicable for building structures whose floors are subjected to incidental standing water and/or for buildings which house critical equipment like protection of information technology equipment, and/or the fire protection of telecommunications facilities.

ANNEX D

(*Foreword*, *Clause* 1.10)

GUIDANCE ON PROVIDING ENGINEERING JUDGEMENT BASED ON TEST

A-1 PREMISE OF FIRESTOP SYSTEMS

Firestop systems deter the passage of fire, hot gases and toxic smoke through openings in walls, floors and floor/ceiling assemblies for through penetrations, membrane penetrations, joints, blanks, gaps, voids and ducts. These systems are required by building codes to be tested and rated as part of an assembly in accordance with an approved test standard.

All elements of a tested and rated firestop system, including the assembly into which the system is installed, constitute a specific and inseparable engineered unit that must be utilized as such. Firestop system designs are to be tested and listed by independent testing agencies. The specific elements of each design become integral to the listing.

A-2 When field conditions differ from original design or unanticipated construction hindrances are encountered and the field conditions cannot be easily or cost effectively redesigned, design recommendations are typically made to propose alternative methods that ensure performance of the firestop system is not compromised. These are sometimes referred to as “Engineering Judgments or EJs” (also known as “Technical Evaluations or TEs”), although other terms may apply dependent upon local practice. Since these recommendations are not based upon identical designs as that which were fire tested, it is important that they be developed using sound engineering principles and good judgment.

a) Engineering Judgements (EJs) should not be used for situations where a tested system is available
b) To be issued only by a firestop manufacturer’s qualified technical personnel or in concert with the manufacturer by a knowledgeable registered Professional Engineer, Fire Protection Engineer, or an independent testing agency that provides listing services for firestop systems
c) EJs should be based upon interpolation of previously tested firestop systems that are either sufficiently similar in nature or clearly bracket the conditions upon which the judgment is to be given. Additional knowledge and technical interpretations based upon accepted engineering principles, fire science and fire testing guidelines may also be used as further support data
d) Should be based upon full knowledge of the elements of the construction to be protected and the understanding of the probable behaviour of that construction and the recommended firestop system protecting that construction if it was subjected to the appropriate Standard Fire Test method for firestops for the rating indicated on the EJ (TE)

e) Should be limited only to specific conditions and configurations upon which the EJ (TE) was issued and should be based upon reasonable performance expectations for the recommended firestop system under specified conditions

f) EJs should be accepted only for a single, specific job and project location and should not be transferred to any other job or project location without thorough and appropriate review of all aspects of the next job or location's circumstances

g) The test results obtained with separating elements of concrete or masonry may be applied to corresponding separating elements of greater thickness and density than that tested. The test results obtained with separating elements of lightweight concrete may be applied to concrete or masonry elements of greater thickness than that tested.

A-3 BASIC PRESENTATION REQUIREMENTS

Proper EJs (TEs) should:

a) be presented in appropriately descriptive written form with or without detail drawings where appropriate.

b) clearly indicate that the recommended firestop system is an EJ (TE).

c) include clear directions for the installation of the recommended firestop system.

d) include dates of issue and authorization signature as well as the issuer's name, and other relevant details.

e) reference tested system(s) upon which design (EJ or TE) is based on.

f) identify the job name, project location and firm EJ (TE) is issued to along with the non- standard conditions and rating supported by the EJ (TE).

g) have proper justification.

h) provide complete descriptions of critical elements for the firestop configuration. These should include, but not be limited to the following for Joints:

   i) Joint width (installed width, nominal)

   ii) Movement capability

   iii) Movement class (thermal, wind sway, seismic)

   iv) Accessory item(s) (that is insulation type, thickness and compression, etc.)