IS 12777 (1989): Method for Classification of Flame Spread of Products [CED 36: Fire Safety]

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(Reaffirmed 2000)

Indian Standard

METHOD FOR CLASSIFICATION OF FLAME SPREAD OF PRODUCTS

भारतीय मानक

उत्पादों के ज्वाला फैलाव के वर्गीकरण की पद्धति

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 5

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on 20 February 1989, after the draft finalized by the Fire Safety Sectional Committee had been approved by the Civil Engineering Division Council.

The use of flammable surface finishes on walls and ceilings affects the safety of equipment of buildings and these tend to spread the fire even though structural elements may be fire resistant. It is essential, therefore, to know the property of rate of flame spread for the products. Method for classification of flame spread of products was earlier covered in IS 1642 : 1960 which was based on a very simple test method. Based on the development in the field of fire test, this test has been developed in UK which will ensure better results. This has been adopted in this standard deleting the provision from IS 1642 : 1988 'Code of practice for fire safety of buildings (general): Materials and details of construction (*first revision*)'.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

METHOD FOR CLASSIFICATION OF FLAME SPREAD OF PRODUCTS

1 SCOPE

1.1 This standard specifies a method of test for measuring the extent of flame spread along the surface of a specimen of a material or a product oriented in the vertical position, under the influence of external radiant heat flux; and a classification system based on the rate and the extent of the flame spread. It provides data suitable for comparing the performances of essentially flat materials, composites or assemblies which are used primarily as the exposed surfaces of walls or ceilings.

The test results relate only to the behaviour of specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

2 TERMINOLOGY

2.0 For the purpose of this standard, the following terminology shall apply.

2.1 Essentially Flat Surface

A surface from which specimens, that have a surface irregularity of less than ± 3 mm from a flat plane, can be obtained.

2.2 Exposed Surface

The surface of the product subjected to heating conditions of the test.

2.3 Flame Front

The leading edge of the coherent visible flame on the surface of the specimens in the direction of flame spread; that is, the boundary between the visible flame and the unburnt specimen surface.

2.4 Flame Spread

The farthest extent of flame front displacement from the vertical edge of the specimen nearer to the radiating surface, along the horizontal reference line, at any instant during a test.

2.5 Radiant Heat Output (from a Point on a Surface)

Quotient of the radiant heat leaving an element of the surface containing the point by the area of that element.

2.6 Radiant Heat Flux (at a Point on a Surface)

Quotient of the radiant heat incident on an element of the surface containing the point by the area of that element.

2.7 External Radiant Heat Flux

The radiant heat flux incident at a point on the surface from an external radiant heat source.

2.8 Flashing

Existence of flame on or over the surface of the specimen for periods of less than 1 s.

2.9 Sustained Flaming

Existence of flame on or over the surface of the specimen for periods of over 3 s.

2.10 Transitory Flaming

Existence of flame on or over the surface of the specimen for periods between 1 and 3 s.

3 TEST SPECIMENS

3.1 Number of Specimens

A minimum of nine specimens, representative of the product, shall be provided for a test.

3.2 The Exposed Surface

The product shall be tested on that face which will normally be exposed in practice, taking account of the following:

a) If it is possible for either or both the faces to be exposed in use then, if the faces are different, or if the core to those faces is asymmetrical, both faces shall be tested.

b) If the face of the product contains a surface irregularity that is specifically directional, such as corrugations which may, in practice, run horizontally or vertically, the product shall be tested in both orientations.

c) If the exposed face contains distinct areas of different surface finish or texture, the appropriate number of specimens shall be provided for each distinct area of such finish or texture to be evaluated.

3.3 Size of Specimens

3.3.1 With the following exception, the specimens shall be rectangular of length 900 ± 3 mm and width 228 $^{+\ 0}_{-\ 3}$ mm. However, if specimens are being prepared with a view to achieving only a class 1 standard of performance, then it is permissible for the length of the specimen to be reduced to a minimum of 250 mm. If transitory flaming is exhibited by any short specimen to the end of the specimen, then full size specimens shall be tested. Where reduced specimen lengths are used, the remaining length shall be a filler piece comprising a panel of non-combustible board, the surface of which shall be level with the surface of the specimen. The use of reduced size specimens shall be reported.

3.3.2 When the product is of insufficient size to allow the specimen size to be achieved in the direction of either length or width or both, it is permissible for smaller pieces of the product to be placed adjacent to each other to obtain the required dimension(s) provided that an essentially flat surface can be achieved and it is considered that such a procedure does not have any influence on the flame spread. The use of such specimens shall be reported.

3.3.3 All the specimens of thickness less than or equal to 50 mm shall be tested at full thickness. If the product is of a thickness greater than 50 mm, and it will not fit into the specimen holder, its thickness shall be reduced by cutting away the unexposed face of the product to reduce the thickness to a minimum of 50 mm.

3.4 Construction of Specimens

3.4.1 When the product is a surface coating, it shall be applied to the selected substrate, using a method and application rate recommended for its use.

3.4.2 When the product is a material or composite which would normally be attached to a substrate, it shall be tested in conjunction with a selected substrate, using the specified fixing technique.

3.4.3 When cutting specimens from products with irregular surfaces, the highest point of the surface shall be arranged to be in contact with the pilot flame when the specimen is in its test position.

3.5 Conditioning

3.5.1 All specimens shall be conditioned to constant mass (*see* Note) at a temperature of 27 ± 2°C and a relative humidity of 50 ± 10 percent and maintained in this condition until required for testing.

NOTE — Constant mass is considered to be attained when two successive weighing operations, carried out at an interval of 24 h, do not differ by more than 0·1 percent of the mass of the specimen, or 0·1 g, whichever is the greater.

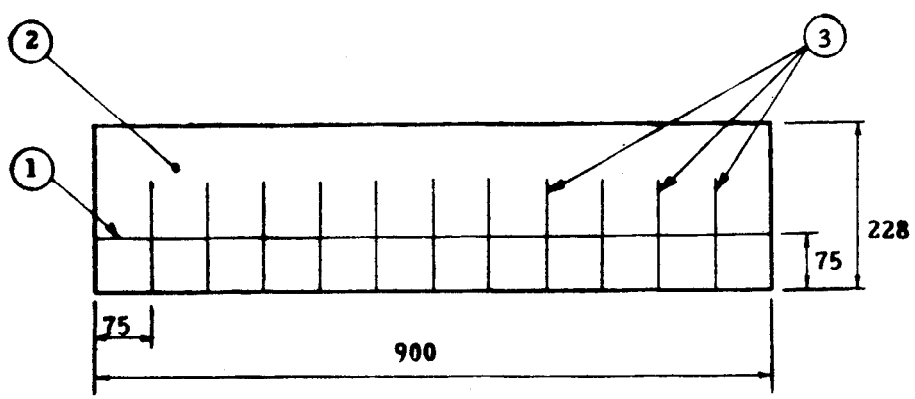
3.5.2 Backing boards shall be conditioned for at least 12 h before use in the conditions specified in **3.5.1**.

3.6 Preparation of Specimens

3.6.1 The exposed surface of each specimen shall be ruled at intervals of 75 mm, by putting visible markings parallel to the width of the specimen. These markings shall be referred to as vertical reference lines.

A horizontal reference line shall similarly be drawn on the exposed surface of the specimen, parallel to the length of the specimen at a distance of 75 mm from the lower edge.

Figure 1 shows the details of the reference lines on the exposed surface of the specimen.



All dimensions in millimetres.

1. Horizontal reference line 2. Exposed surface 3. Vertical reference lines

FIG. 1 DETAILS OF HORIZONTAL AND VERTICAL REFERENCE LINES ON THE EXPOSED SURFACE OF THE SPECIMEN

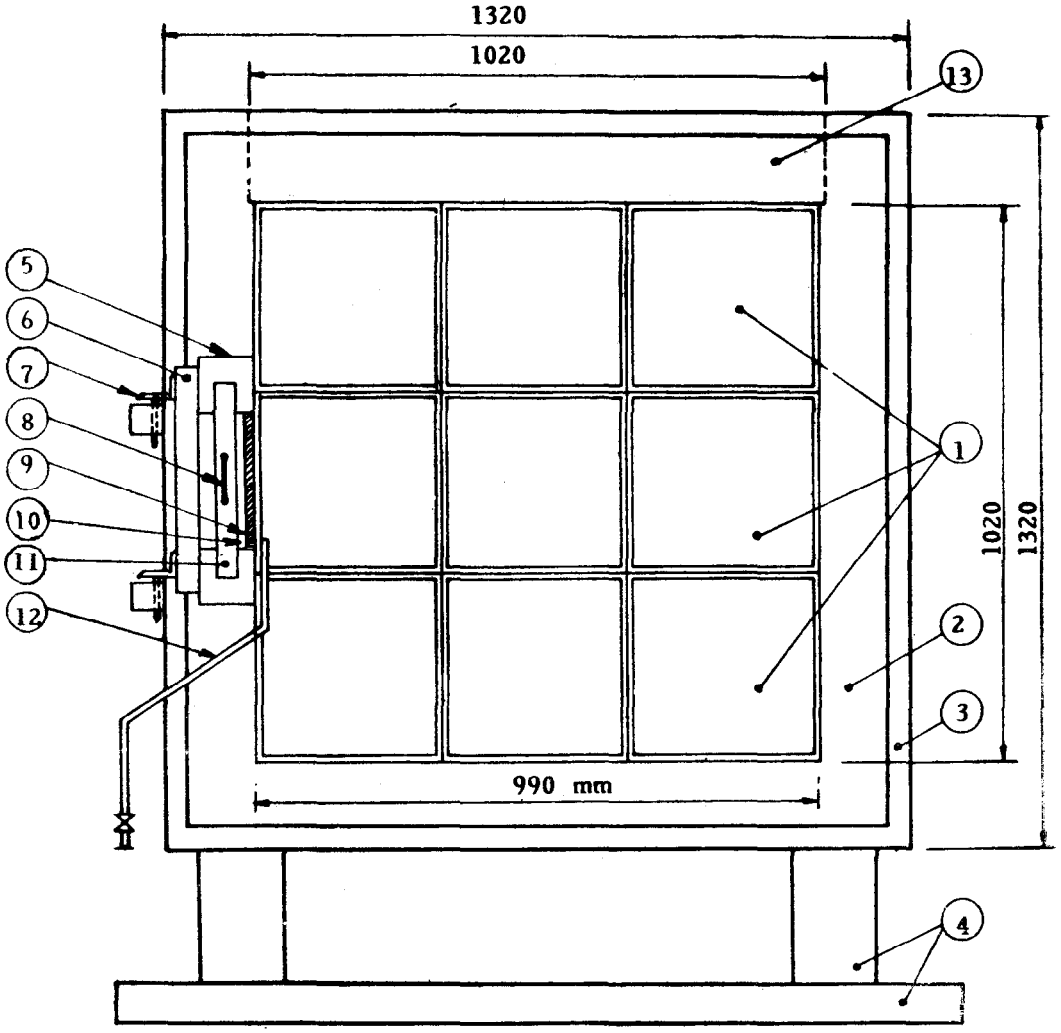
3.6.2 The specimens shall be mounted on suitable specimen supports which shall be designed in such a manner that the exposed surface of the specimens of thickness up to 50 mm shall be in the required plane with respect to the radiating surface, during the test.

It is permissible to use backing boards for specimens of thickness less than 50 mm to maintain the desired plane of the exposed surface of the specimen during the test. The backing boards shall be rectangular and of same dimensions as those of the specimens but of thicknesses 25 mm, 12 mm and 6 mm which may be reused after storing in a conditioned environment for at least 12 h, if they are not contaminated.

4 APPARATUS

4.1 General

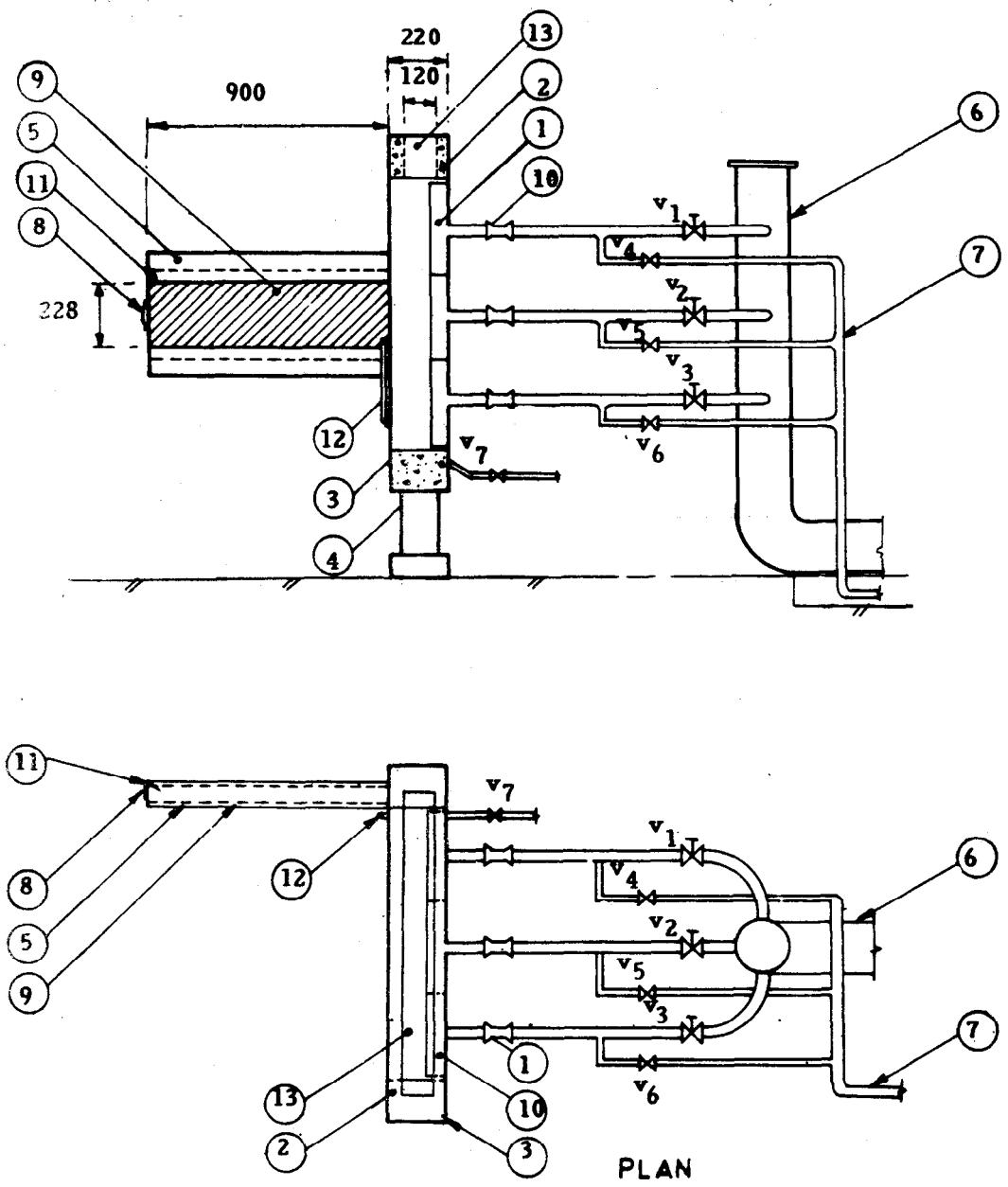
The apparatus shall consist essentially of an external radiant heat source mounted vertically in a refractory surround and firmly supported on a frame work; an arrangement to bring the specimen in the desired position quickly; and a pilot burner. Suitable fuel and air supply controls shall also be provided to ensure proper combustion at the radiating surface. Figures 2 to 4 show the salient features of a typical apparatus.



All dimensions in millimetres.

1. Gas fired radiant panels, 9 numbers
2. Castable refractory surround
3. Metal framework
4. Supports
5. Specimen holder guides
6. M. S. channel
7. M. S. angle
8. Handle
9. Specimen
10. Backing board
11. Specimen holder
12. Pilot burner
13. Groove in surround (2)

FIG. 2 DETAILS OF THE EXTERNAL RADIANT HEAT SOURCE AND THE SPECIMEN HOLDER

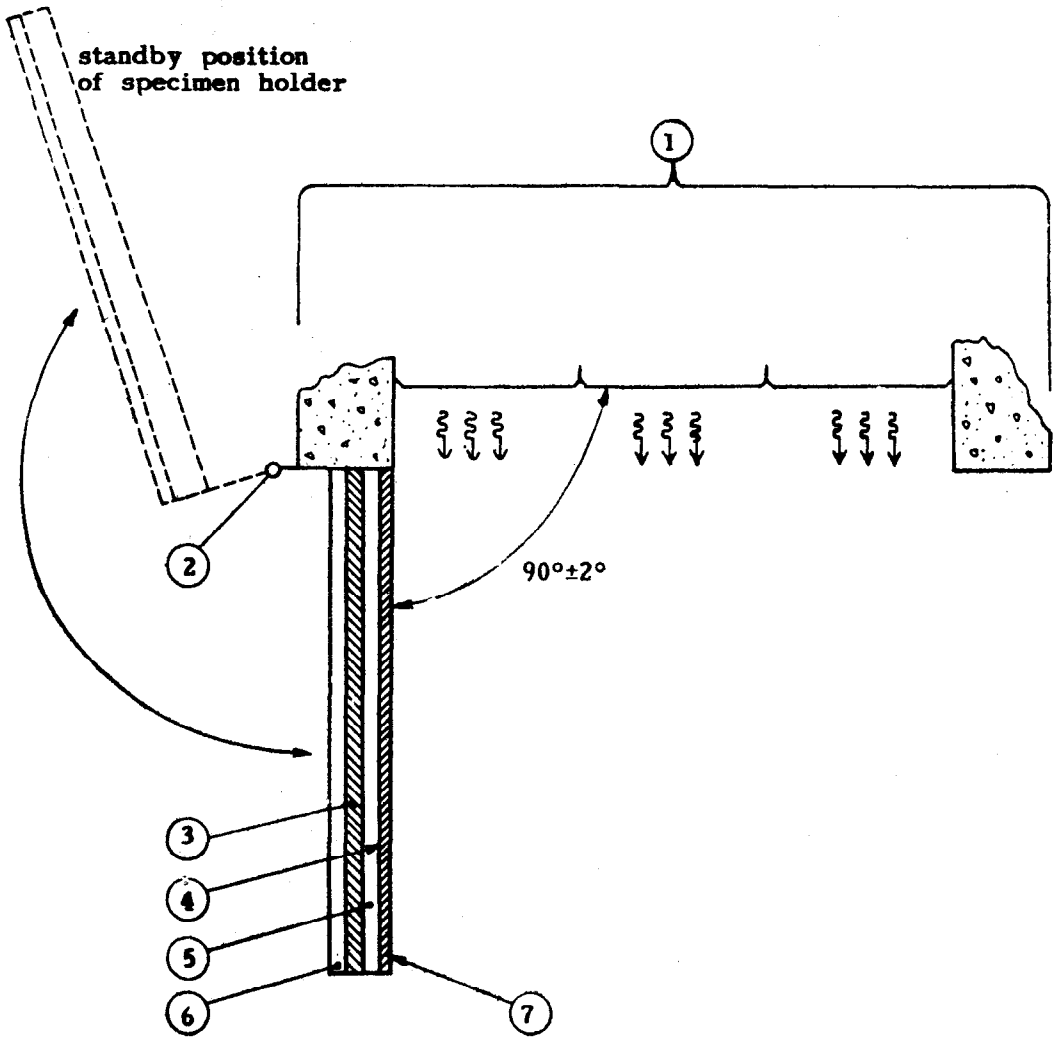


All dimensions in millimetres.

1. Gas fired radiant panels, 9 numbers
2. Castable refractory surround
3. Metal framework
4. Supports
5. Specimen holder guides
6. Air supply line
7. Fuel supply line
8. Handle
9. Specimens
10. Venturi mixer
11. Specimen holder
12. Pilot burner
13. Groove in surround (2)

v_1 — v_7 valves

FIG. 3 GENERAL VIEWS OF THE SURFACE SPREAD OF FLAME TEST APPARATUS



All dimensions in millimetres.

1. External radiant heat source
2. Pivot
3. Specimen holder
3. Specimen
5. Backing board
6. Guides
7. Exposed surface

FIG. 4 STANDBY AND TEST POSITIONS OF THE SPECIMEN HOLDER WITH RESPECT TO THE RADIATING SURFACE OF THE EXTERNAL RADIANT HEAT SOURCE

4.2 The External Radiant Heat Source

4.2.1 The external radiant heat source shall have a radiating surface of dimensions 1 000 ± 50 mm square and shall be designed to provide the required radiant heat output. The flaming occurring on the radiating surface shall not project by more than 50 mm under operational conditions.

4.2.2 The external radiant heat source shall be fitted with a refractory concrete surround, projecting 150 mm beyond the radiating surface. The surround shall intimately contain the source and any small gaps between the surround and the individual gas fired radiant panels comprising the external radiant heat source shall be tightly packed with a flexible non-combustible insulating material.

4.3 Specimen Holder

4.3.1 The specimen holder shall be designed to provide a rigid non-combustible insulation backing on which the specimens can be mounted.

4.3.2 The specimen holder shall be rectangular and shall be capable of sliding smoothly into the guides provided on one vertical edge of the external radiant heat source.

4.3.3 The specimen holder guides shall be hinged to the metal framework around the external radiant heat source and shall be capable of being swung into the test position from the stand-by position quickly.

4.3.4 The specimen holders, backing boards and the guides shall enable the exposed surface of the specimen to be brought in the test position, such that the face of the guides towards the external radiant heat source, the exposed surface of the specimen and the vertical surface of the refractory surround normal to the radiating surface shall all be in the same plane.

4.4 Pilot Burner

The pilot burner shall consist of a steel tube with an orifice of 3·0 mm internal diameter. The burner shall be designed in such a way that with the specimen in the test position, the centre of the orifice of the burner shall be:

a) 8 ± 2 mm in front of the exposed surface of the specimen,

b) 6 ± 2 mm above the lower edge of the exposed surface of the specimen, and

c) 15 ± 5 mm from the vertical edge of the specimen surface closer to the external radiant heat source (*see* Fig. 4).

4.5 Fuel and Air Supplies

4.5.1 The fuel supply to the external radiant heat source shall be from a bank of bottled LPG cylinders of 14·2 kg capacity, to ensure a constant fuel supply for a minimum period of 2 h.

The air supply shall be taken from outside the test environment.

The fuel and air flowrates shall be sufficient to provide the required external radiant heat flux distribution over the exposed surface of the specimen to be achieved.

4.5.2 The fuel and air supply network to the external radiant heat source shall contain suitable pressure regulators, control valves, manometers or other suitable static pressure indicating instruments, gas flowmeters and safety devices.

4.5.3 The fuel supply to the pilot burner shall be LPG. The pilot flame shall be a luminous diffusion flame. The contact height of the pilot flame on the exposed surface of the specimen shall be between 75 mm and 100 mm.

4.6 Test Environment

The apparatus shall be located in an enclosed environment essentially free from draughts. The dimensions of the enclosure shall provide the following minimum clearances for the panel:

a) 5 m in front,

b) 1 m behind,

c) 6 m floor to ceiling, and

d) 2·5 m on either side (measured from the panel centre).

To extract the combustion products from the external radiant heat source and the specimen, a suitable extraction system may be provided, which shall not cause significant change in the environment around the apparatus during the course of the test.

NOTE — In order to minimize the spread of toxic products and protect the operator, as far as possible, the space above the panel may be partitioned off from the test of the environment by a hood. This should be designed in such a way that its lower edge is at least 2·4 m above the floor and all parts of the front of the hood are at least 1·5 m from the vertical plane containing the panel face and at least 1·8 m from the upper edge of the panel. It is also permissible to employ a radiation screen alongside the radiating surface to protect the observer. This may take the form of either a movable screen or a permanent structure and should not be within a distance of 1·3 m from the centre nor extend further than 1·4 m in front of the radiating surface.

5 ANCILLARY EQUIPMENT

5.1 The Heat Flux Transducer

The heat flux transducer shall be capable of measuring radiant heat flux within the range 10 kW/m² to 50 kW/m². The sensing surface receiving radiation and possibly to a small extent convection, shall be flat, circular, not more than 10 mm in diameter and coated with a durable matt black finish. The sensor shall be contained within a water-cooled body, the front face of which shall be of highly polished metal, flat, coinciding with the plane of the sensing surface and circular, with a diameter of about 25 mm.

The radiant heat shall not pass through any window before reaching the sensing surface. The transducer shall be robust, simple to set up and use, insensitive to draughts and stable in calibration. The transducer shall have an accuracy of within 3 percent, repeatability within 0·5 percent and shall be calibrated at at an appropriate periodic frequency.

5.2 Millivolt Measuring Device

The millivolt measuring device shall be compatible with the output from the radiometer specified in **5.1**. It shall have a full-scale deflection, sensitivity and accuracy to enable the radiant heat flux measured by the heat flux transducer to be resolved to 0·05 kW/m².

5.3 Optical Pyrometer

The optical pyrometer used for checking the uniformity of the radiating surface shall be capable of measuring the temperature to within ±10°C at 1 000°C.

5.4 Timing Device (Timer)

The timing device shall be capable of recording elapsed time to nearest second, and shall be accurate to within 1 s in 1 h.

5.5 Calibration Board

5.5.1 The calibration board shall be rectangular of length 900 mm, width 228 mm and thickness 25 mm. It shall be constructed as shown in Fig. 5 from a non-combustible insulation asbestos millboard. It shall be capable of accommodating, at six positions along its length, a heat flux transducer as specified in **5.1**. The sensing surface of the heat flux transducer shall be centred at the height specified for the horizontal reference line on the specimens (*see* **3.6.1**) and at the distances along the calibration board from the vertical edge of the specimen holder closer to the external radiant heat source, as specified in Table 1. The plane of the sensing surface shall coincide with the exposed face of the calibration board.

5.5.2 If only one heat flux transducer is used during calibration, then the holes cut in the board to accommodate the face of the heat flux transducer, that is, the sensor along with its water jacket, shall be provided with infill discs of the board material. The radiant heat flux at each point shall then be measured consecutively with one heat flux transducer.

6 CALIBRATION

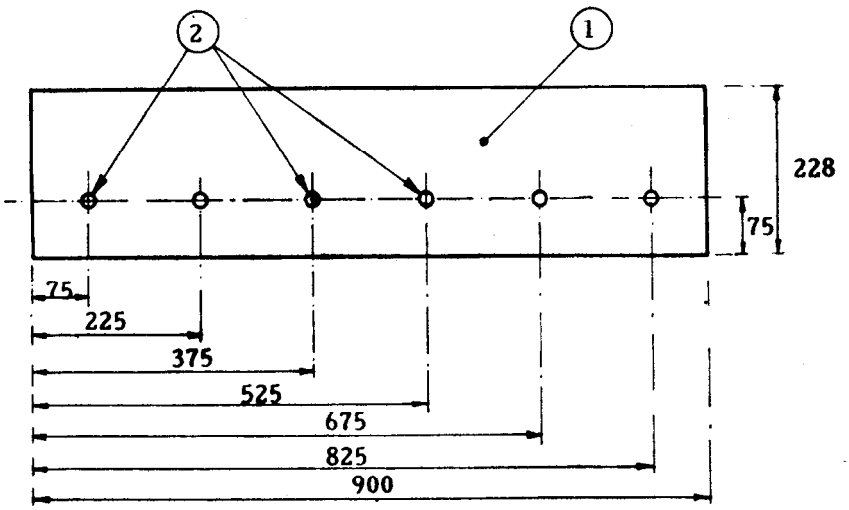
6.1 General

6.1.1 The apparatus shall be calibrated in accordance with the requirements given in Table 1. The specified values of external radiant heat flux in the plane of the exposed surface of the specimen along the horizontal reference line, shall be achieved to within a tolerance of 0·5 kW/m². Suitable calibration procedures shall be employed for checking periodically. The radiating surface shall also be checked for the uniformity of temperature by visual inspection and by an optical pyrometer.

6.2 Calibration of the External Radiant Heat Source

6.2.1 The fuel and air flowrates to the individual burner elements shall be adjusted so that there is a relatively uniform radiant heat output from the radiating surface of the external radiant heat source.

6.2.2 The calibration board shall be in thermal equilibrium before the external radiant heat flux values are determined. This shall be achieved by mounting the calibration board in place of the specimen in the specimen holder and placing these in the test position during the heating up period. External radiant heat flux at a specific distance (say, 525 mm) from the vertical edge of the calibration board closer to the radiating surface shall be recorded, a constant value of which shall be taken to denote thermal equilibrium.



All dimensions in millimetres.

1. Calibration board, 12 mm thick
2. Holes, 25ϕ, 6 numbers

FIG. 5 CALIBRATION BOARD HAVING HOLES FOR THE TEST FLUX TRANSDUCER

6.2.3 If one heat flux transducer is to be used during initial calibration according to **5.2.2**, then the external radiant heat flux at each point specified in Table 1 shall be measured consecutively over a period not exceeding 10 min.

Table 1 External Radiant Heat Flux Along the Horizontal Reference Line on the Calibration Board

(*Clauses* 5.5.1, 6.1.1 *and* 6.2.3)

Distance (*) along horizontal reference line, mm	75	225	375	525	675	825
External radiant heat flux, kW/m²	30	20	15	11	8	6

*Measured from the vertical edge of the calibration board nearer to the external radiant heat source.

6.2.4 The fuel-air flowrates to the external radiant heat source, at which the external radiant heat flux distribution in the plane of the exposed surface of the specimen is in accordance with the values given in Table 1, shall be recorded and shall be maintained during the tests.

6.2.5 At these conditions, the temperatures of different points of the radiating surface shall be measured by an optical pyrometer.

7 TEST PROCEDURE

7.1 Procedure

Following procedure shall be adopted for conducting a test:

a) Regulate the fuel — air flowrates to the external radiant heat source to attain the values as determined during the calibration runs (*see* **6.2**).

b) Allow the radiating surface to achieve uniform heating of the radiating surface, as indicated by the optical pyrometer. The stable values of the temperatures of the radiating surface shall be the same as those recorded during the calibration runs. Otherwise, the fuel-air flowrates shall be suitably adjusted.

c) Ignite the pilot flame.

d) Remove the specimen mounted on the specimen holder (including any backing boards) from the conditioning atmosphere and within 5 min, slide it into the specimen holder guides in its standby position at 90° or more from the test position (*see* Fig. 3).

e) Seal any gaps between the specimen holder guides and the exposed surface of the specimen by a non-combustible fibrous insulation material.

f) Within 5 s, swing the specimen holder and the specimen into the test position and immediately start the timing mechanism (that is, the start of the test).

g) Extinguish the pilot flame 1 min after the start of the test.

h) Terminate the test when the flame front reaches the 825 mm vertical reference line, or after 10 min has elapsed, whichever is the shorter.

j) Swing the specimen holder into its standby position and remove the remains of the specimen construction. Clean any debris from the holder.

k) Repeat the procedures given in (c) to (j) for each of the remaining specimens.

7.2 Observations During Test

7.2.1 Record the time at which the flame front crosses each intersection of a vertical reference line and the horizontal reference line (*see* **3.6.1**). Also record the displacement of the flame front along the horizontal reference line at 1·5 and 10 minutes.

7.2.2 Throughout the test, carefully observe the behaviour of the product and make a special note of the following phenomena:

a) Flashing, and

b) Transitory flaming.

During the test, also record observations of associated phenomena, such as debris falling away from the specimen and whether it is flaming or not; occurrence of intumescence, excessive charring of the surface ahead of the flame front and/or deformation of the specimen.

7.2.3 During the first one minute of the test, any softening, melting or disintegration of material resulting in the specimen slumping out of the specimen holder, the detachment of the facing from the substrate or any other behaviour which results in the exposed surface not being available for the measurement of flame spread, shall render the test on that specimen invalid.

However, should ignition of the exposed face occur during the application of the pilot flame, with a resultant flame front ahead of any such behaviour for the remaining period of application of the pilot flame, or if a flame spread in excess of 250 mm is recorded during the first 1·5 min of the test, then the test on that specimen shall be deemed valid.

If one or more invalid test results are obtained, it is permissible for up to a maximum of nine specimens to be tested in order to obtain the required six valid test results. If more than six specimens are necessary to provide a classification for the product (*see* **9.1**), a suffix '*R*' shall be added to the classification, and the reason for the suffix shall be clearly explained in the test report.

In cases, where softening and/or other behaviour, which may affect the flame spread performance of any of test specimens, occurs after extinction of the plot flame, a suffix '*Y*' shall be added to the classification and the reason for the suffix shall be clearly explained in the test report.

8 RECORDING OF RESULTS

8.1 For each of the specimens tested in accordance with **7.1**, the following shall be recorded:

a) The time at which the flame front crosses the intersection of each vertical reference line and the horizontal reference line;

b) The maximum extent of flame spread during the first 1·5 min from the start of the test;

c) The maximum extent of flame spread during the entire test, that is, 10 min or less (*see* **7.1**); and

d) The time at which the maximum extent of flame spread occurs.

8.2 If the results reported in accordance with **8.1** include invalid tests, the reason for the testing being invalid shall be reported (*see* **7.2.3**) and such results shall be clearly indicated.

9 CLASSIFICATION OF RESULTS

9.1 The results recorded in **8.1** shall be used to obtain a classification for the product according to the criteria specified in Table 2. At least 5 of the 6 test specimens for which valid test results have been obtained shall have a flame spread which does not exceed 1·5 min limit and the limit for the entire test duration, specified for the designated class.

NOTE — The remaining specimen may exceed this limit but by not more than the assigned tolerances, given in Table 2.

10 REPORT

10.1 The test report shall include the following:

a) The name and address of the testing laboratory;

b) The name and address of the sponsor;

c) The name and address of the manufacturer/supplier, if known;

d) The date of test;

e) A full description of the product (and face) tested, including trade name and/or reference number if available, its construction, nominal thickness, colour, and where appropriate, density;

NOTE — It may be helpful to provide a sketch of the product.

f) The individual test results in accordance with **8**;

g) Observations made during the test and comments on any difficulties encountered during the test (*see* **7.2.2** and **7.2.3**);

Table 2 Flame Spread Classification

(*Clause* 9.1)

Classification	Maximum Extent of Flame Spread, mm			
	At 1·5 min		For the Test Duration	
	Limit for 5 Specimens	Limit for 1 Specimen	Limit for 5 Specimens	Limit for 1 Specimen
Class 1	125	125 + 25	125	125 + 25
Class 2	175	175 + 25	390	390 + 45
Class 3	225	225 + 25	650	650 + 75
Class 4	Exceeding the limits for Class 3			

h) Details of the form in which the specimens were tested (material, composite or assembly), the specimen thickness and where appropriate, air gap, orientation, substrate, the face or faces subjected to the test, use of short specimens (**3.3.1**) and the use of short pieces to make up a specimen (**3.3.2**);

j) The derived classification according to **9**, including any suffix as appropriate; and

k) The statement : 'The test results relate only to the behaviour of the test specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use'.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

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