BRITISH STANDARD

BS 476 : Part 7 : 1997
Incorporating Corrigendum No. 1

Fire tests on building materials and structures

Part 7. Method of test to determine the classification of the surface spread of flame of products

ICS 13.220.50

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee FSH/21, Reaction to fire tests, upon which the following bodies were represented:

Association of Building Component Manufacturers
Association of Roof Light Manufacturers
Autoclaved Aerated Concrete Products Association
British Carpet Manufacturers Association Ltd.
British Iron and Steel Producers Association
British Plastics Federation
British Railways Board
British Resilient Flooring Manufacturers Association
British Rigid Urethane Foam Manufacturers' Association
British Wood Preserving and Damp-proofing Association
Chemical Industries Association
Chief and Assistant Chief Fire Officers Association
Department of Health
Department of the Environment (Building Research Establishment)
Department of the Environment (Property and Buildings Directorate)
Department of the Environment for Northern Ireland
Eurisol (UK Mineral Wool Association)
European Phenolic Foam Association
Fibre Cement Manufacturers Association Limited
Flat Glass Manufacturers' Association
GAMBICA (BEAMA Ltd.)
Gypsum Products Development Association
Home Office
Institute of Fire Safety
Institution of Fire Engineers
London Fire and Civil Defence Authority
Loss Prevention Council
National Council of Building Material Producers
National GRP Construction and Engineering Federation
Polyethylene Foam Insulation Association
Queen Mary and Westfield College
RAPRA Technology Ltd.
Specialist Ceilings and Interiors Association Ltd.
Thermal Insulation Manufacturers and Suppliers Association (TIMSA)
Timber Research and Development Association
Warrington Fire Research Centre
Wood Panel Industries Federation
Wood Wool Slab Manufacturers Association
Co-opted members

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Textile Technology Group
University of Edinburgh

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CI	March 2014	Information added to Foreword

Contents

Foreword

This part of BS 476 is published by BSI Standards Limited, under licence from The British Standards Institution.

This standard has been superseded by the current BS EN 13823, but it has been retained based on legitimate need for the standards within non-EU markets.

This Part of BS 476 has been prepared by Technical Committee FSH/21. It supersedes BS 476 : Part 7 : 1987, which is withdrawn, but both the 1971 and 1987 editions will still be made available on request since they are referred to in building regulations and other legislative documents.

NOTE. Upon publication of BS 476 : Part 7 : 1996, BSI Customer Services Department will respond to purchase orders for BS 476 : Part 7 by supplying the 1996 edition. Copies of the 1987 or 1971 editions may be obtained by quoting the number 'BS 476/7/87' or 'BS 476/7/71' respectively.

This revision has been prepared with the aim of improving the repeatability and reproducibility of the test results by clarifying procedures and by giving additional guidance to test operators. The changes incorporated into this revision are not expected to cause changes in material classifications.

In this method, specimens of the product (material, composite or assembly) are subjected to a specified heating and ignition regime. The test takes account of the combined effect of factors such as ignition characteristics and the extent to which the flame spreads over the surface of the product under opposed flow conditions. The influence of any underlying materials on these factors, in relation to their ability to influence the rate of fire growth, is also taken into account The test result is a function of the distance and rate of, the lateral spread of flame; and this is classified according to performance as classes 1 to 4.

A series of new reaction to fire tests is under development in ISO/TC92/SC1, Reaction to fire tests. The UK is participating in this work, which will define small-scale, intermediate-scale and large-scale tests for ignitability, heat release rate and flame propagation. ISO 5658 will cover spread of flame: Part 1 giving guidance on spread of flame and Part 2 measuring opposed flow lateral spread of flame along the surface of a specimen of a product in the vertical position. Part 2 will be implemented as BS 476 : Part 14. The radiant panel used in ISO 5658-2 is smaller than that in this Part of BS 476 but, by inclining the panel to the specimen at 15°, the heat flux at the hot end of the specimen is increased to 50 kW/m^2. Part 3 of ISO 5658, which is also under development, refers to this procedure as the LIFT (lateral ignition and flame spread test) and it is expected to provide more fundamental data for mathematical modelling than ISO 5658-2 or this Part of BS 476.

Attention is drawn to the Health and Safety at Work etc. Act 1974, and the need to ensure that the method of test specified in this standard is carried out under suitable environmental conditions to provide adequate protection to personnel against the risk of fire and inhalation of smoke and/or toxic products of combustion.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 18 and a back cover.

Method

1 Scope

This Part of BS 476 specifies a method of test for measuring the lateral spread of flame along the surface of a specimen of a product orientated in the vertical position under opposed flow conditions, and a classification system based on the rate and extent of the spread of flame. It provides data suitable for comparing the end-use performances of essentially flat materials, composites or assemblies, which are used primarily as the exposed surfaces of walls or ceilings.

Annex A gives guidance to operators carrying out this method of test. Annex B discusses the effect of thermal characteristics on the performance of assemblies and gives advice on the construction and preparation of test specimens. Annex C gives information on the validation of this method.

NOTE. 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.

2 Normative references

This Part of BS 476 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Part of BS 476 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

3 Definitions

For the purposes of this British Standard, the definitions given in BS 4422 : Part 1 : 1987, Part 2 : 1990, and Part 5 : 1989, and BS 476 : Part 10 : 1983 apply, together with the following:

3.1 exposed surface(s)

Surface(s) of the product subjected to the heating conditions of the test

3.2 spread of flame

Propagation of a flame front over the surface of a product under the influence of imposed irradiance.

3.3 flame front

Furthest extent of travel of a coherent flame along the reference line marked on the test specimen.

3.4 irradiance (at a point on a surface)

Total thermal radiant flux incident on an infinitesimal element of the surface containing the point, divided by the area of that element.

3.5 essentially flat surface

Surface from which specimens can be obtained that have an irregularity from a flat plane which is less than ± 3 mm.

3.6 flashing

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

3.7 transitory flaming

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

3.8 sustained flaming

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

3.9 radiant exitance (at a point on a surface)

Quotient of the radiant flux leaving an clement of the surface containing the point, divided by the area of that element.

3.10 material

Single substance or uniformly dispersed mixture, e.g. metal, stone, timber, concrete, mineral fibre, polymers.

3.11 product

Material, composite or assembly about which information is required.

3.12 substrate

Material used, or representative of that used, immediately beneath a surface in end-use; e.g. fibre cement board beneath a floor covering.

3.13 assembly

Fabrication of materials and/or composites that can contain air gaps.

3.14 composite

Combination of materials which are generally recognized in building constructions as discrete entities, e.g. coated or laminated materials.

3.15 thin film

Discrete surface layer or coating having a thickness less than or equal to 50 μm.

4 Suitability of a product for testing

4.1 Surface characteristics

4.1.1 A product shall have one of the following characteristics to be suitable for evaluation by this method:

a) an essentially flat exposed surface;

b) a surface irregularity that is evenly distributed over the exposed surface (see **A.1**), provided that both of the following apply:

1) at least 50 % of the surface of a representative square area of 270 mm × 270 mm lies within a depth of 6 mm from a plane taken across the highest points on the exposed surface; and

2) any cracks, fissures or holes do not exceed 6.5 mm in width or a depth of 10 nun, and the total area of such cracks, fissures or holes at the surface does not exceed 30 % of a representative square area of 270 mm × 270 mm of the exposed surface.

4.1.2 Where a product has areas of its surface which are distinctly different, but each of these separate areas satisfies the surface characteristics specified in **4.1.1**a, then more than one surface spread of flame test shall be conducted to evaluate the product fully.

4.1.3 When an exposed surface does not conform to the requirements of **4.1.1**, it shall be modified to conform to the requirement of **4.1.1**a, and this shall be stated in the report. A prefix D shall be added to the spread of flame classification of any product which has been tested in a modified form, in accordance with **11.4**.

4.2 Thermally unstable products

In cases where the test method is inadequate for assessing products that react in particular ways under exposure to the specified heating conditions (see **9.2.3**), provision shall be made either to apply a suffix to the result (see clause **11** and item j) of clause **12**) or to prohibit an assessment being made because the product is unsuitable for testing by this method.

NOTE. Products showing these characteristics do not necessarily behave poorly in fire situations and should be assessed by other test methods.

5 Test specimens

5.1 Number of specimens

A minimum of six and a maximum of nine test specimens shall be provided, and they shall be representative of the exposed surface of the product.

5.2 The exposed surface

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

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

b) If the face of the product contains a surface irregularity that is specifically directional, e.g. 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, then the appropriate number of specimens shall be provided for each distinct area of such finish or texture to be evaluated.

5.3 Size of specimens

5.3.1 Except where the specimens are expected to achieve a class 1 standard, the specimens shall be rectangular and 885^{+0}_{-5} mm × 270^{+0}_{-5} mm. Only where specimens are being prepared with a view to achieving a class 1 standard of performance, shall the length of the specimen 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 made up of 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.

NOTE. A class 1 standard of performance may be anticipated by the manufacturer where the specimen is substantially non-combustible, or where regulations prohibit the use of class 2, 3 and 4 materials.

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

5.3.3 All specimens shall be tested at full thickness providing they fit into the specimen holder. If the product is of such a thickness that 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.

5.4 Construction of specimens

5.4.1 When the product is a thin film, it shall be apphed to an appropriate substrate (see annex B), using a method and application rate recommended by the manufacturer for its use. The laboratory shall determine whether a product incorporates a thin film on its surface, and shall note if this is the case.

5.4.2 When the product is a material or composite which would normally be attached to a substrate, it shall be tested in conjunction with the appropriate substrate (see annex B), using the fixing technique recommended by the manufacturer, e.g. bonded with the appropriate adhesive or mechanically fixed.

5.4.3 When cutting specimens from products with irregular surfaces (see **4.1.1**b), 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.

5.5 Conditioning

5.5.1 All specimens shall be conditioned to constant mass at a temperature of 23 ± 2 °C, and a relative humidity of 50 ± 10 %, 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 % of the mass of the specimen, or 0.1 g, whichever is the greater.

5.5.2 Backing boards and spacers (see **5.7**) shall be conditioned for at least 12 h before use in the conditions specified in **5.5.1**.

5.6 Preparation of specimens

5.6.1 *Reference line*

The exposed face of each specimen shall be marked on its surface with a reference line along its length and (95 ± 3) mm above its bottom edge. To assist in the observation of flame travel, the specimen shall be marked at intervals along its length with lines normal to the reference line and at the intervals shown in figure 7.

NOTE. Special provisions may be required for certain types of material which may be affected by the marking.

5.6.2 *Products without air gaps*

Where a product is normally used without an air gap behind it, then the unexposed face of the specimen shall be placed directly on, and in direct contact with, a backing board without any adhesion or mechanical fixing.

5.6.3 *Products with air gaps*

Where a product is normally used with an air gap behind it, then the specimen shall be placed over the spacers positioned around its perimeter and mounted onto a backing board so that a (25 ± 1) mm enclosed air gap is provided between the unexposed face of the specimen and the backing board.

5.7 Backing boards and spacers

5.7.1 The backing boards shall be rectangular, 885^{+0}_{-5} mm × 270^{+0}_{-5} and shall be made of non-combustible insulation board of oven-dry density (825 ± 125) kg/m^3 and nominal thickness 12 mm.

5.7.2 Spacers used to form air gaps within an assembly shall be of the same material as the backing boards and shall be (25 ± 1) mm thick and approximately 20 mm wide.

5.7.3 Backing boards and/or spacers used to back the specimens shall be re-used after storing in the conditioning atmosphere for at least 12 h (see **5.5.2**), only if they are not contaminated. If there is any doubt about the condition of a backing board or spacer it shall be discarded.

6 Apparatus

6.1 General

The apparatus shall consist essentially of a radiation panel mounted vertically in a surround and supported on a framework. The radiation panel shall be supplied with an gas-air mixture. A specimen holder and a pilot flame arrangement shall be mounted to one side of the apparatus. Figure 1 shows an outline diagram of a typical apparatus.

NOTE. All dimensions given in the description of the test apparatus in this clause are nominal, unless tolerances are specified.

6.2 Radiation panel and surround

6.2.1 The radiation panel shall be 850 mm square for a porous refractory-type burner block[1)] designed to give eflicient combustion of the air-gas-air mixture, with no flaming occurring on the face of the panel under operational conditions.

6.2.2 The radiation panel shall be fitted with a refractory concrete surround. This surround shall project from the face of the panel on its four edges by 50 mm. The surround shall contain the panel intimately, and any small gaps between the surround and the panel shall be tightly packed with a flexible, non-combustible insulating material.

[1)] For information on suitable radiation panels and on suppliers of the equipment contact Customer Services, BSI, 389 Chiswick High Road, London W4 4AL.

6.2.3 The radiation panel and its surround shall be supported on a framework so that the centre of the panel is (1250 ± 100) mm above floor level.

6.3 Specimen holder

6.3.1 A typical design of specimen holder is shown in figures 2a and 2b. The specimen holder shall comprise a water-cooled steel frame with water-cooled face plates. The face plates shall overlap the specimens by (20 ± 5) mm on their top and bottom edges and over the vertical edge adjacent to the radiation panel. A spring loaded clamp shall be positioned to clamp the specimen against the water-cooled face plates. The water supply to the specimen holder shall be such that the maximum temperature does not exceed 35 °C at the outlet from the specimen holder.

NOTE 1. A specimen holder that exerts a force, measured perpendicular to the plane of the specimen, of at least 25 N onto a 50 mm thick specimen has been found to be suitable. Care should be taken to ensure that the specimen is not damaged by any undue force exerted by the specimen holder.

NOTE 2. A water flow rate of approximateiy 12 l/min has been found to be adequate.

6.3.2 In the test position, the specimen holder assembly shall be located at (90 ± 2)° to the face of the radiation panel and in such a way that the faces of the top and bottom guides of the specimen holder are in the same plane as the inside face of the surround to the radiation panel. The height of the specimen holder shall be such that the reference line on the specimen (see **5.6.1**) is brought to mid-height of the radiation panel. See figure 3. The specimen holder shall be hinged to allow it to be swung horizontally, away from the face of the radiation panel between tests, i.e. from the test position to the standby position and vice-versa, as shown in figure **3**.

6.4 Pilot burner

The pilot burner shall consist of a steel tube with an internal diameter of nominal value 3.0 mm and an external diameter of nominal value 6.4 mm. 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 is positioned:

a) (28 ± 2) mm in front of the surface of the specimen;

b) (6 ± 2) mm above its exposed lower edge;

c) (15 ± 5) mm from the inside vertical edge of the specimen holder at the corner closest to the radiation panel

See figure 4 and **A.5**.

6.5 Gas and air supplies

6.5.1 The gas supply to the radiation panel shall be either natural gas or propane. The air supply shall be taken from outside the test environment.

The gas and air supplies shall be sufficient to allow the required irradiance to be achieved. See clause **8**.

6.5.2 The gas and air supply lines to the radiation panel shall contain suitable flowmeters, pressure regulators, control valves and safety devices. Figure 5 shows typical gas and air supply layouts.

6.5.3 The gas supply to the pilot burner shall be simulated town gas and shall give a luminous flame with a contact height on the specimen of between 75 mm and 100 mm.

NOTE. A gas flow rate of (1500 ± 200) ml/min has been found to be suitable.

6.6 Test environment

The apparatus shall be located in an environment essentially free from draughts and shall have a volume of at least 400 m^3 to prevent excessive heat build up. In order to avoid irradiation from surfaces and objects in the local vicinity of the apparatus, the dimensions of the enclosure shall provide for the following minimum clearances from the radiant panel:

a) 5 m in front;

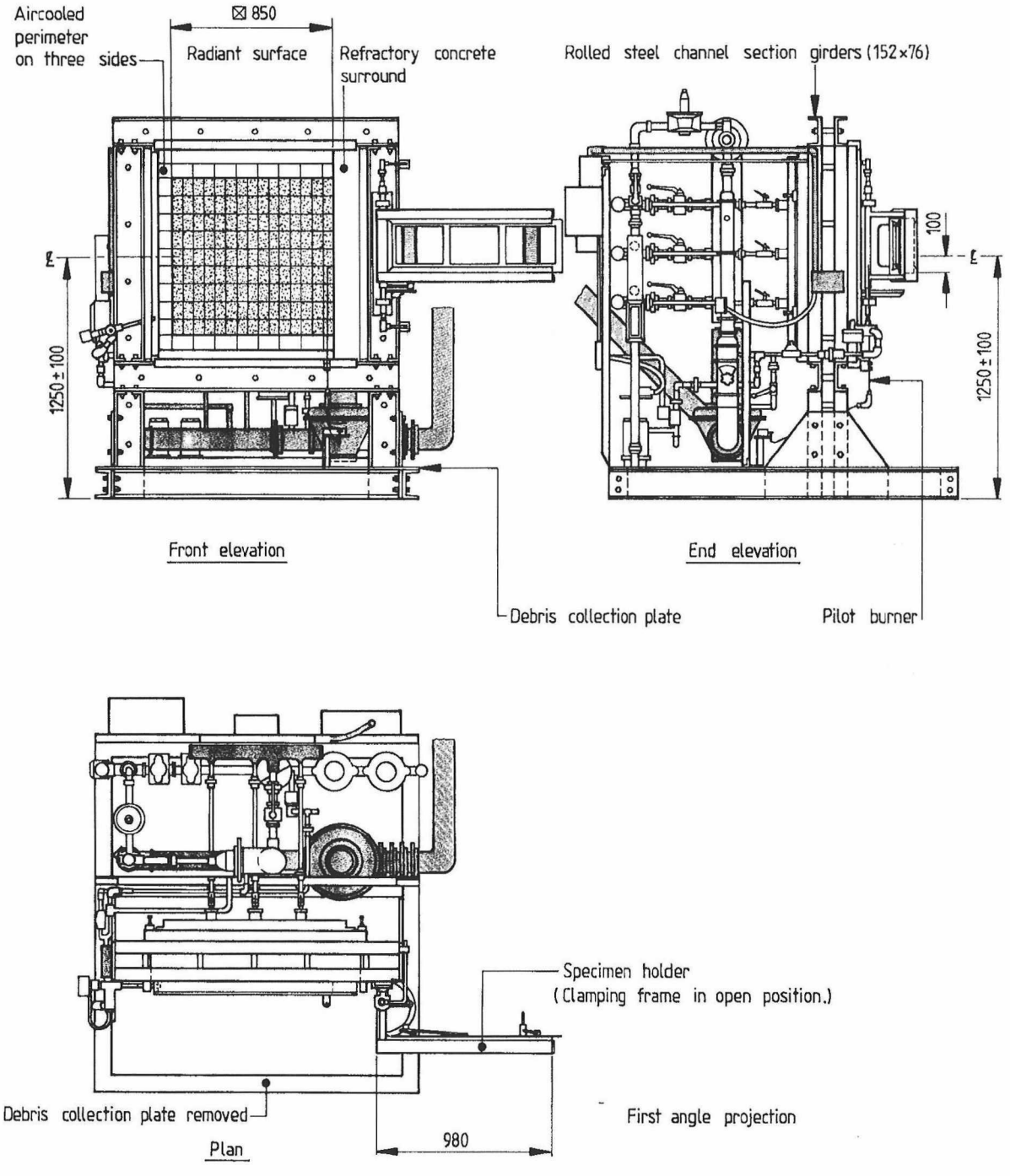
b) 1 m behind;

c) 4 m floor to ceiling;

d) 2.5 m on either side, measured from the panel centre.

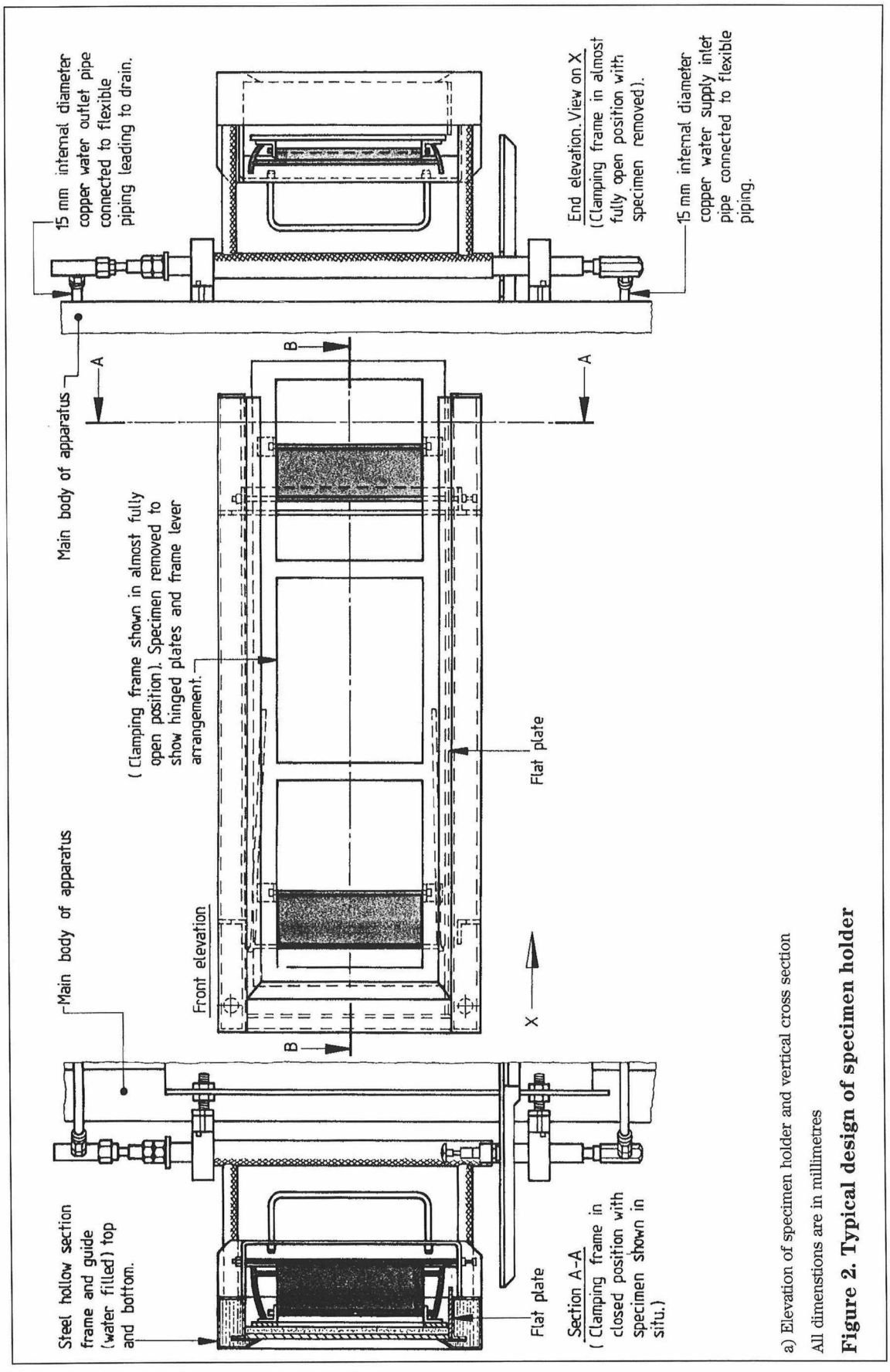
Effluent gases from the radiation panel and specimen shall be capable of being extracted without causing forced ventilation over the apparatus during the course of the test.

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 rest 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. A radiation screen should be installed alongside the radiation panel 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 of the radiation panel, nor extend further than 1.4 m in front of the radiation panel.



All dimensions are in millimetres

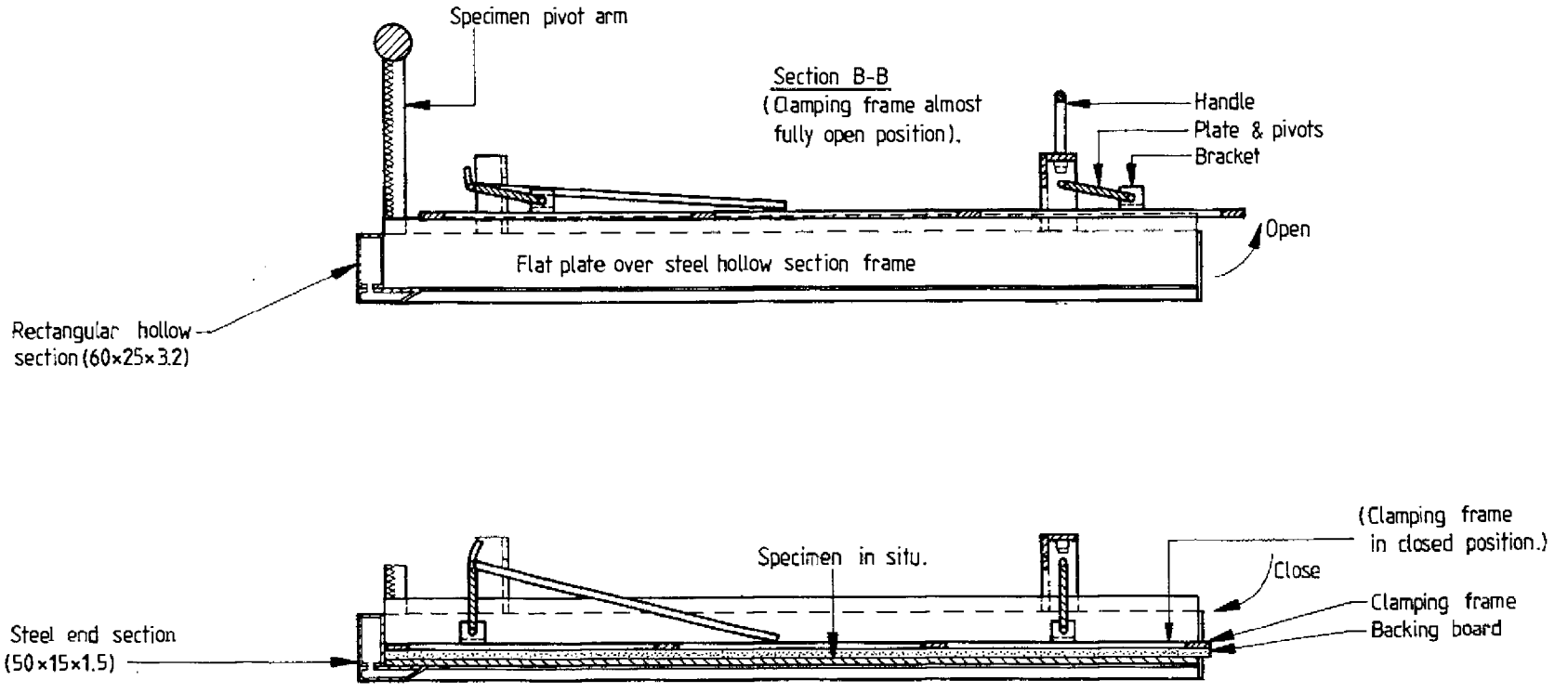
Figure 1. General arrangement of a typical apparatus



a) Elevation of specimen holder and vertical cross section

All dimenstions are in millimetres

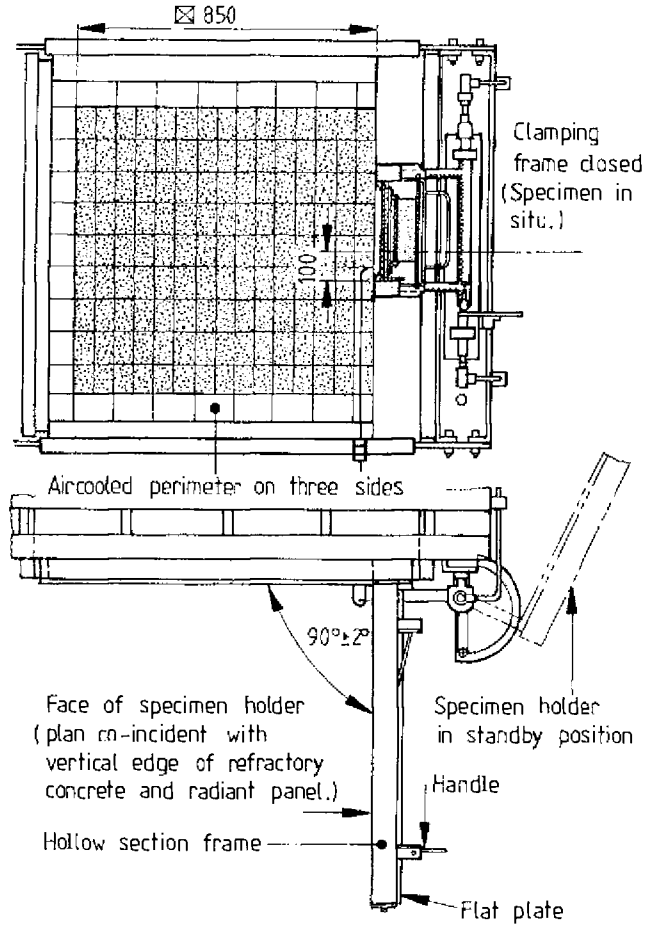
Figure 2. Typical design of specimen holder



b) Horizontal cross section through specimen holder and elevation at cool end

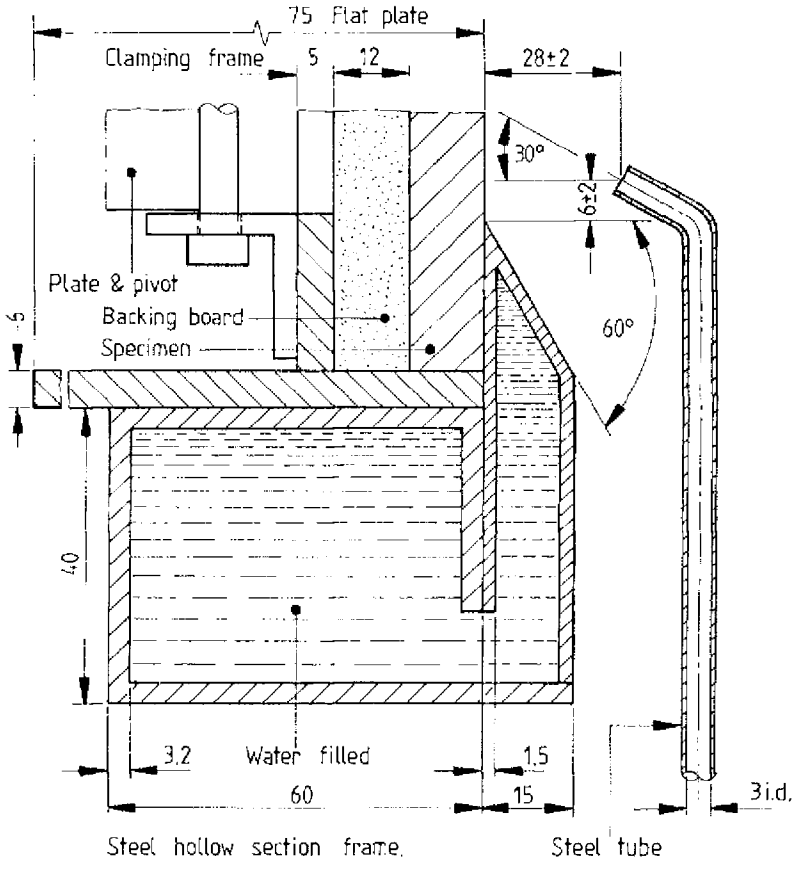
All dimensions are in millimetres

Figure 2. Typical design of specimen holder (*continued*)



All linear dimensions are in millimetres

Figure 3. Position of specimen holder in relation to radiation panel



All dimensions are in millimetres

Figure 4. Position of pilot burner in relation to surface of specimen

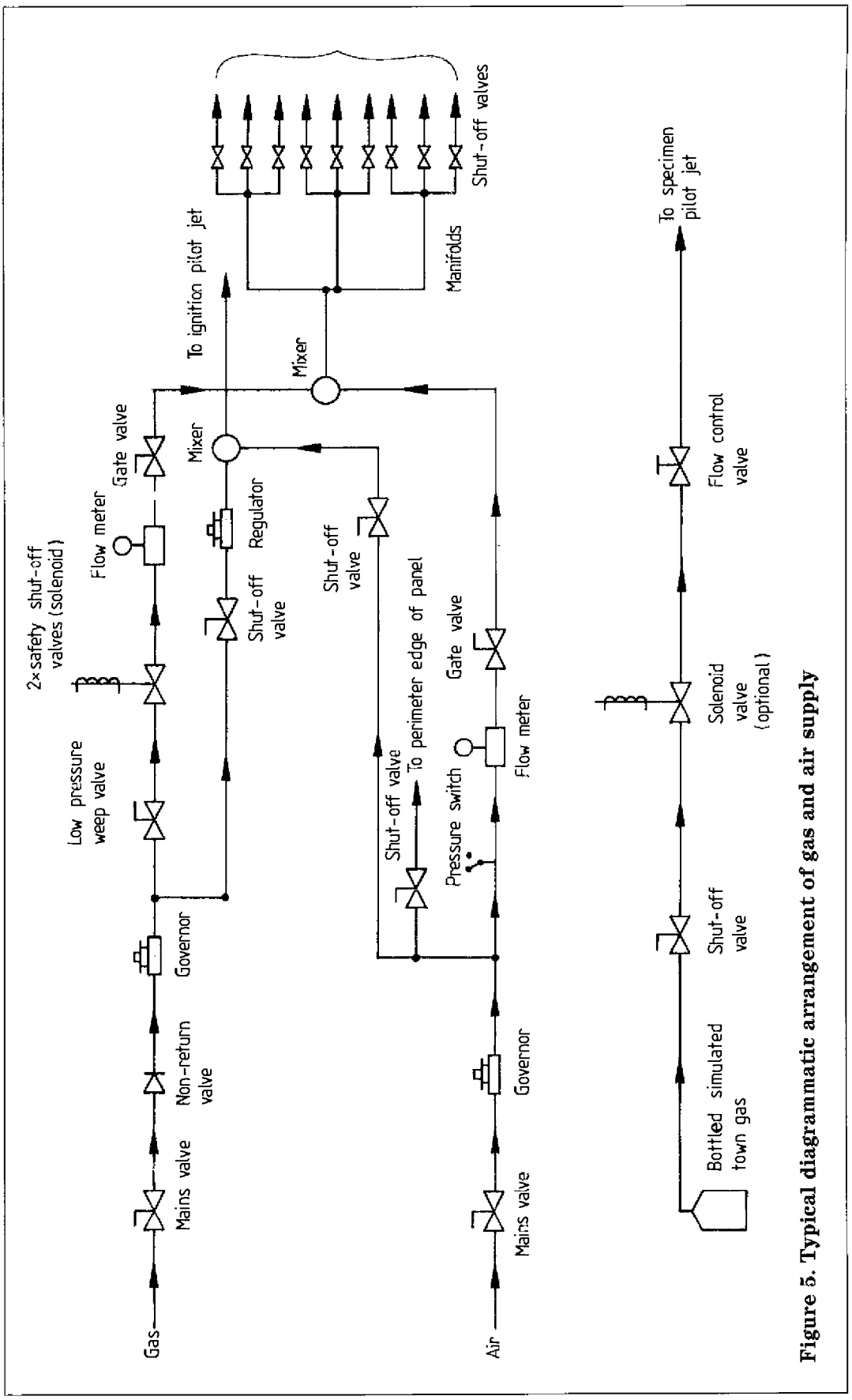


Figure 5. Typical diagrammatic arrangement of gas and air supply

7 Ancillary equipment

7.1 Radiometer (heat fluxmeter)

The radiometer of a Schmidt-Boelter (thermopile) type shall be capable of measuring irradiance within the range 4 kW/m^2 to 50 kW/m^2. The target in the radiometer that receives 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 target shall be contained within a water-cooled body, the front face of which shall be of highly polished metal, flat, coincident with the plane of the target and circular, with a diameter of about 25 mm.

Radiation shall not pass through any window on the radiometer before reaching the target. The instrument shall be robust, simple to set up and use, insensitive to draughts and stable in calibration. The instrument shall have an accuracy of within 5 % and a repeatability within 0.5 %. In order to ensure that the instrument is adequately calibrated, one of the following measures shall be taken.

a) The radiometer shall be calibrated by the laboratory at three-monthly intervals in accordance with BS 6809 : 1987; or

b) The laboratory shall hold two radiometers for cross-checking against each other by substitution during the regular calibration procedure specified in **8.3.1**, taking into account the following:

1) During the regular calibration procedure a daily use radiometer shall be used. Except where the furnace is used less often than monthly cross-checking with a reference radiometer[2)] shall be carried out on a monthly basis. Where the furnace is used less often than monthly the daily use radiometer shall be cross-checked every time it is used. A record of the cross-check shall be maintained by the laboratory.

2) The daily use radiometer shall be calibrated at least once a year in accordance with BS 6809 : 1987.

3) When the daily use radiometer is returned to the laboratory from its annual calibration, it shall be used to directly calibrate the reference radiometer by substitution during the regular calibration procedure. A record of the calibration of the reference radiometer directly against the daily use radiometer shall be maintained by the laboratory.

7.2 Millivolt measuring device

The millivolt measuring device shall be compatible with the output from the radiometer specified in **7.1**. It shall have a full scale deflection, sensitivity and accuracy which enables the irradiance measured by the radiometer to be resolved to 0.05 kW/m^2.

7.3 Timing device (timer)

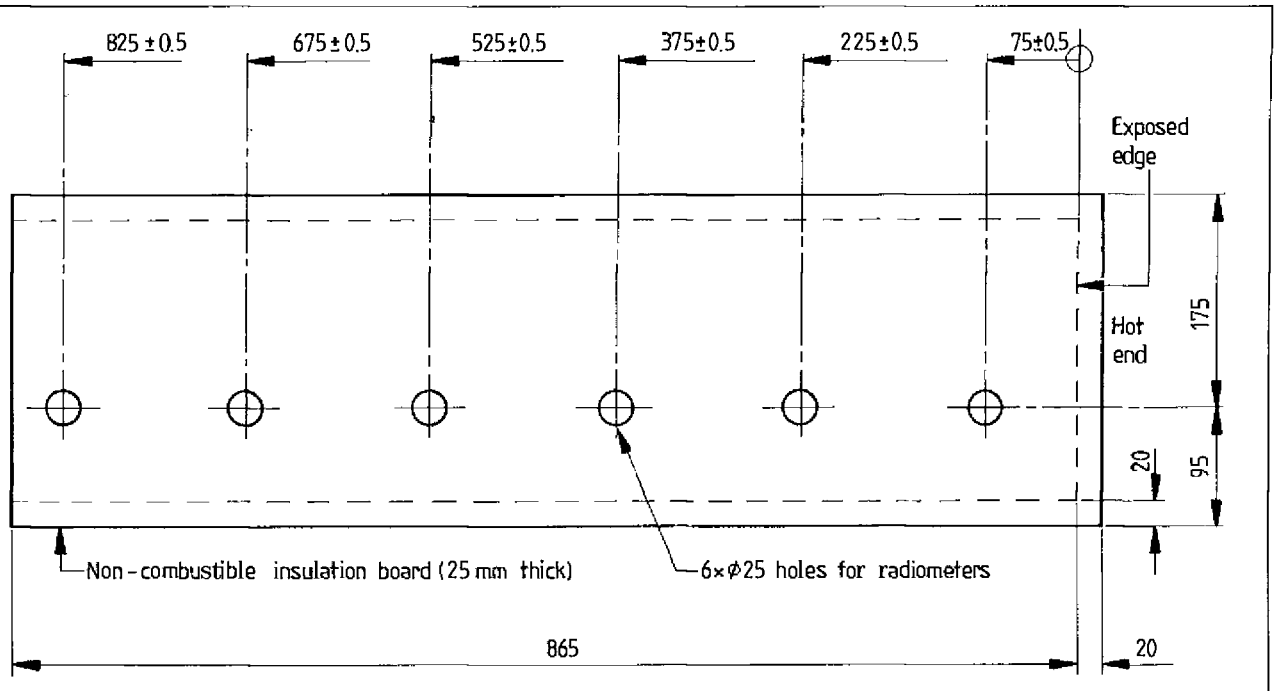
The timing device shall be capable of recording elapsed time to the nearest second, and shall be accurate to within 1 s in 1 h.

7.4 Calibration board

7.4.1 The calibration board shall be 885^{+0}_{-5} mm × 270^{+0}_{-5} mm. It shall be constructed, as shown in figure 6, from 25 mm non-combustible insulation board of density 950 ± 100 kg/m^3. It shall be capable of accommodating the radiometer specified in **7.1** at six positions along its length. The target of the radiometer shall be centred at the height specified in **5.6.1** for the reference line on the specimens, and at the distances along the reference line from the inside edge of the specimen holder specified in table I. The plane of the target shall coincide with the exposed face of the calibration board.

7.4.2 If only one radiometer is used during calibration then the holes cut in the board to accommodate the radiometer face (i.e. the target with water or air jacket surround) shall be provided with infill discs of the board material. The irradiances at each point shall then be measured consecutively with the one instrument.

[2)] The reference radiometer should be used only as a reference instrument.



NOTE. Distances from inside edge of specimen holder to centre line of apertures = 0.5 tolerance.

All dimensions are in millimetres

Figure 6. Calibration board

8 Calibration

8.1 General

8.1.1 The apparatus shall be calibrated in accordance with the requirements given in table **1**. The specified values of irradiance shall be achieved to within a tolerance of $\pm$ 0.5 kW/m^2.

8.1.2 When setting up the radiation panel for the first time, or when any modifications have been made, carry out the initial calibration procedure specified in **8.2** (see clause **7**, otherwise monitor the calibration daily using the regular cahbration procedure specified in **8.3**).

8.2 Initial calibration of radiation panel

8.2.1 Adjust the gas and air supplies to the individual burner elements so that there is a relatively uniform radiant exitance over the face of the panel (see **A.3**).

8.2.2 Make adjustments to the gas-air supply to the apparatus and/or minor adjustments, within a tolerance of $\pm 2°$, to the 90° angle formed between the specimen holder and the radiation panel surface (see **A.4**) to enable the irradiances specified in **8.1.1** to be achieved.

8.2.3 The calibration board shall be at thermal equilibrium before the irradiances are determined. This shall be achieved by inserting the calibration board into the specimen holder, which is placed in the test position, during the heating up period. Irradiance at a specific distance (e.g. 825 nun) from the radiation panel shall be recorded, a constant value denoting thermal equilibrium.

8.3 Regular calibration procedure

8.3.1 Monitor the calibration of the radiation panel during the heating up period by inserting the calibration board in the specimen holder when it is in the test position, and monitoring until steady state conditions are recorded on the output of the radiometer at the 75 mm and 825 mm distances from (lie hot end; i.e. until the mean value of irradiance recorded from the output of radiometer(s) on the board varies by less than 0.5 kW/m^2.

8.3.2 If one radiometer is to be used during initial cahbration, in accordance with **7.4.2**, then the irradiance at each point specified in table **1** shall be measured consecutively over a period not exceeding 20 min.

8.3.3 If the values for irradiance specified in table 1 are not achieved, repeat the procedure in **8.2**.

Table 1. Irradiance along horizontal reference line on the calibration board

Distance along reference line from inside edge of specimen holder (see figure 6)	Irradiance kW/m^2		
mm	specified	min.	max.
75	32.5	32.0	33.0
225	21.0	20.5	21.5
375	14.5	14.0	15.0
525	10.0	9.5	10.5
675	7.0	6.5	7.5
825	5.0	4.5	5.5

9 Test procedure

9.1 Procedure

Carry out the following procedure.

a) Ignite the pilot flame.

b) Remove a specimen construction, including any backing boards, spacers and filler pieces, from the conditioning atmosphere, and within 5 min insert it into the specimen holder in its standby position at 90° or more from the test position. (See figure 3.)

c) Within 5 s swing the specimen holder and specimen into the test position, and immediately start the timing mechanism, i.e. start the test.

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

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

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

g) Repeat the procedures given in a) to f) above for each of the remaining specimen constructions.

9.2 Observations during test

9.2.1 Record the time at which the front of sustained flaming, spreading along material present at the position of the horizontal reference line, crosses each vertical reference line (see **5.6.1**). Also record the extent of the spread of flame along material present at the position of the horizontal reference line after 1.5 min and 10 min, disregarding any flaming which occurs from material that has slumped, melted or fallen below the position of horizontal reference line.

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

a) flashing;

b) transitory flaming.

Observe and note other phenomena such as debris falling away from the specimen and whether it is flaming or not, intumescence and/or deformation of the specimen.

NOTE. These observations do not influence the classification of surface spread of flame.

9.2.3 During the first minute of the test any softening, melting or disintegration of material resulting from 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 spread of flame, shall render the test on that specimen invalid.

However, when the surface of the product incorporates a thin film, (see **3.15** and **5.4.1**) which shrinks from the pilot flame during the first ten seconds of the test without ignition such that it is no longer available for spread of flame, the test result shall be regarded as valid. Where this occurs, a suffix 'Y' shall be added to the classification in accordance with **11.5**, and the reason for the suffix shall be clearly explained in the test report. Where ignition of the exposed face occurs during the application of the pdot flame, with a resultant flame front ahead of any such behaviour for the remaining period of application of the pilot flame, or where a spread of flame in excess of 265 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, no more than nine specimens shall 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, a suffix 'R' shall be added to the classification in accordance with **11.2**, 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 spread of flame performance of any of the test specimens, occurs after extinction of the pilot flame, a suffix ' Y' shall be added to the classification in accordance with **11.5**, and the reason for the suffix shall be clearly explained in the test report.

10 Recording of results

10.1 For each of the specimens tested in accordance with **9.1**, the following shall be recorded:

a) the time at which the flame front crosses each vertical reference line;

b) the maximum extent of spread of flame during the first 1.5 min from the start of the test;

c) the maximum extent of spread of flame during the whole test, i.e. 10 min or less (see **9.1**);

d) the time and distance at which maximum spread of flame is reached;

e) any spread of flame that extends for less than 50 mm whilst the pilot flame is still on as 'less than 50 mm'.

10.2 If the results reported in accordance with **10.1** include invalid tests, the reason for the testing being invalid shall be reported (see **9.2.3**) and such results shall be clearly indicated in accordance with clause **11**.

11 Classification of results

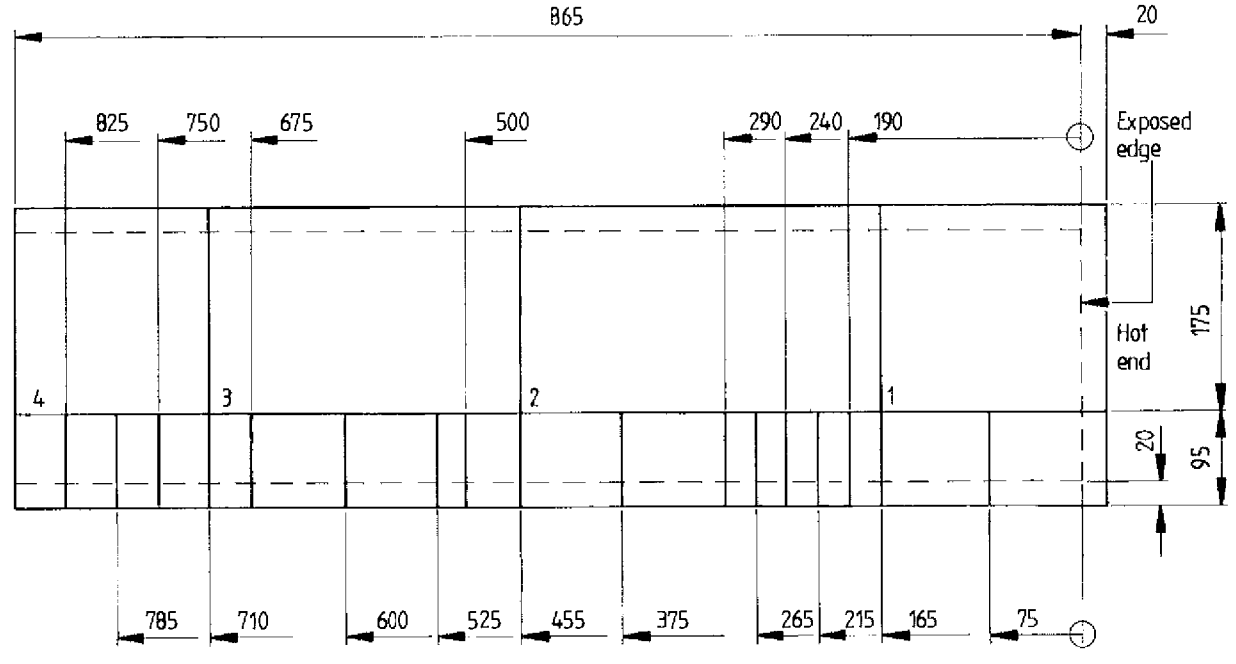
11.1 The results recorded in **10.1** shall be used to obtain a classification for the product according to the criteria specified in table 2. At least five of the six test specimens for which valid test results have been obtained shall have a spread of flame which does not exceed the 1.5 min limit and the final limit specified for the designated class.

The remaining specimen shall not exceed this limit by more than the tolerances given in table 2. (See also figure 7.)

11.2 A suffix 'R' shall be added to the classification if more than six specimens are required in order to obtain six valid test results, e.g. class 2R. (See **9.2.3**.)

11.3 If four or more invalid test results are achieved from one sample, then the product shall be classified as 'not suitable for assessment by this test method'.

11.4 A prefix 'D' shall be added to the classification of any product which does not conform to the surface characteristics given in **4.1.1** and which has therefore been tested in a modified form e.g. class D3. (See **4.1.3**.)



Distances from inside edge of specimen holder

All dimensions are in millimetres

Figure 7. Reference lines to assist surface spread of flame classification

11.5 A suffix 'Y' shall be added to the classification if any of the following occur:

a) the product distorts during testing, e.g. curls away at the hot end, so that areas of the test specimen are shielded from the irradiance from the radiation panel such that the test classification may be affected;

b) the test specimen does not remain in position for the duration of the test (see **9.2.3**);

c) the test specimen delaminates, with the flaming portion of the specimen falling away, thus preventing further spread of flame;

d) there is delamination from the substrate over a substantial area of the specimen;

e) a thin product that softens or melts and coalesces so that areas of the substrate become exposed but without the product falling away;

NOTE 1. Movement of the test specimen should not lead to the addition of a 'Y' suffix if this results in the specimen being subjected to increased irradiance from the radiation panel.

NOTE 2. A material could have a classification of D3RY indicating:

a) a modified surface has been used;

b) a class 3 result has been obtained;

c) additional specimens have been used to obtain six valid results; and

d) softening and/or other behaviour has occurred which is considered to have affected the test result.

Table 2. Classification of spread of flame

Classification	Spread of flame at 1.5 min		Final spread of flame	
	Limit	Limit for one specimen in sample	Limit	Limit for one specimen in sample
	mm	mm	mm	mm
Class 1	165	165 + 25	165	165 + 25
Class 2	215	215 + 25	455	455 + 45
Class 3	265	265 + 25	710	710 + 75
Class 4	Exceeding the limits for class 3			

12 Report

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 its component parts and method of construction, name and/or reference number if available, nominal thickness(s), colour(s) and, where appropriate, density(ies);

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

f) the individual test results in accordance with clause **10**;

g) observations made during the test and comments on any difficulties encountered during the test (see **9.2.2** and **9.2.3**);

h) details of the form in which the specimens were tested (material, composite or assembly), together with details of any modification to the product (**4.1.3**), the specimen thickness and, where appropriate, air gap; orientation; substrate; whether the product incorporates a thin film; the face or faces subjected to the test; use of reduced size specimens (**5.3.1**) and the use of short pieces to make up a specimen (**5.3.2**);

i) the derived classification according to clause **11**, including any prefix and/or suffix as appropriate;

j) where necessary, the statement that the prefix 'D' or suffix 'R' or 'Y' to the classification indicates that the results should be treated with caution, together with the reasons why this prefix or suffix has been applied;

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'.

Annexes

Annex A (informative)
Guidance for operators

A.1 Surface irregularities

Where assessment of the area of surface irregularity is required (see **4.1.1**), this can be carried out by machining the surface to a depth of 6 mm below the highest point, and estimating the machined area.

A.2 Asymmetric specimens

Because of the wide range of products which are available on the market, operators should take particular care to ascertain in detail the form of construction used in composites or assemblies that are to be tested. These products may contain variations in the core, facing materials, or bonding materials which could affect the surface spread of flame properties[3]. Consequently, several tests may be required for a particular product in order to predict accurately its overall performance in use. Account should also be taken of the effects of these variations on the performance of the product (see annex B).

A.3 Radiation panel temperature

When calibrating a radiation panel for the first time, the fuel flow to the individual rows/segments of the panel should be adjusted so that a reasonably constant temperature, as assessed by the colour over the panel, is achieved. This will usually require the fuel flow to the lower rows of burners to be higher than to the upper rows.

A.4 Fine adjustments to achieve calibration

Minor modifications may be made, as necessary, to enable the calibration values to be achieved, e.g. increase or decrease of fuel supply to individual rows or columns of burners and/or adjustments to the gas-air ratio to individual burners. If necessary, a minor adjustment as specified in **8.2.2**, may be made to the 90° angle between the specimen holder and the panel face to change the irradiance at the cool end of the calibration board.

A.5 Pilot flame positioning

The positional relationship between the pilot burner and the surface of the test specimen specified in **6.4** may necessitate the burner being moved slightly during the movement of the specimen from the standby position to the test position, or vice-versa

Annex B (informative)
Effect of thermal characteristics on the performance of assemblies

With thin materials or composites, particularly those with a high thermal conductivity, the presence of an air gap and the nature of any underlying construction may significantly affect the ignition performance of the exposed surface. Increasing the thermal capacity of the underlying construction increases the 'heat sink' effect and may delay ignition of the exposed surface. Any backing provided to the test specimen and in intimate contact with it such as the non-combustible spacers, may alter this 'heat sink' effect and may be fundamental to the test result itself. The influence of the underlying layers on the performance of the assembly should be understood and care should be taken to ensure that the result obtained on any assembly is relevant to its use in practice.

The following advice is offered on the construction and preparation of test specimens.

a) Where the thermal properties of the product are such that no significant heat loss to the underlying layers can occur, e.g. a material or composite greater than approximately 6 mm thick of high thermal capacity and/or low thermal conductivity, then the product should be tested backed only by the backing board.

b) Where the product is normally used as a free-standing sheet and the characteristics noted in a) do not apply, then an air space should be provided at the back of the product by testing over spacers of non-combustible insulation board 20 mm wide and (25 ± 1) mm thick.

c) Where the product is to be used over a low density non-combustible substrate and the characteristics noted in a) do not apply, then the product should be tested in conjunction with that substrate.

d) Where the product is to be used over a combustible substrate and the characteristics noted in a) do not apply, then the product should be tested in conjunction with that substrate.

NOTE. Discussions are taking place in ISO/TC92/SC1 concerning the possible use of a restricted range of reference substrates (mainly non-combustible) where it is not apparent or possible to test materials or products in the representative end-use substrate.

[3] Such variations can include different surface finishes or surfacing materials and asymmetry in core materials (including air gaps), both in terms of the thicknesses of laminations and also the way that they are combined.

Annex C (informative)
Validation of test method

Inter-laboratory tests were carried out in 1994 in accordance with the 1987 edition of this Part of this standard. Six UK laboratories participated, and each carried out tests on the following seven materials: plasterboard, polycarbonate, GRP (cast), GRP (extruded), PMMA (cast), chipboard, and pinewood.

Out of a total of 42 classifications, there was agreement in all but five cases. A detailed analysis of the test results showed that one was explained as material variation by the manufacturer and a further two as mis-interpretation by the laboratory. Videos of these tests were reviewed by a coordinator and would have resulted in the expected classifications being achieved under normal circumstances. The remaining two classifications that did not agree are still unexplained. Accordingly, the results of the inter-laboratory tests show that the appropriate classification would be achieved in 40 out of 42 cases, a success rate of 95 %.

blank

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 476 :	*Fire tests on building materials and structures*
BS 476 : Part 10 : 1983	*Guide to the principles and application of fire testing*
BS 4422 :	*Glossary of terms associated with fire*
BS 4422 : Part 1 : 1987	*General terms and phenomena of fire*
BS 4422 : Part 2 : 1990	*Structural fire protection*
BS 4422 : Part 5 : 1989	*Smoke control*
BS 6809 : 1987	*Method for calibration of radiometers for use in fire testing*

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