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Grenfell Tower Inquiry

Module 2 – Presentation

by Dr Barbara Lane
with Mr Tom Parker

An explanation of the relevant Reaction to Fire tests and Classification methods to restrict the combustibility of external walls of high buildings

Structure of the Presentation

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Setting the context of the reaction to fire tests

- Understanding the typical stages of a fire in a compartment
- External fire events
- The eight reaction to fire tests referred to from the statutory guidance document ADB 2013

Section 1

- National reaction to fire tests
- National reaction to fire definitions (National Classes)
- The definition of the fire performance for external walls since 1965
- How the definition of Class 0 has changed since 1965
- Reference to the National Classes made during the Grenfell Refurbishment

Structure of the Presentation

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Section 2

- European reaction to fire tests
- European classification system (European Classes)
- The importance of the field of application
- Reference to the European Classes in Approved Document B
- Prior work on equivalency – European and National classes
- Reference to the European Classes made during the Grenfell Refurbishment

Section 3

- Cladding systems and full scale test data BS 8414 – Parts 1 & 2
- BR 135 - performance criteria and classification method for BS 8414 Parts 1 & 2
- Reference to BR135 and BS8414 during the Grenfell Refurbishment

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Understanding the typical stages of a fire in a compartment

What are reaction to fire tests?

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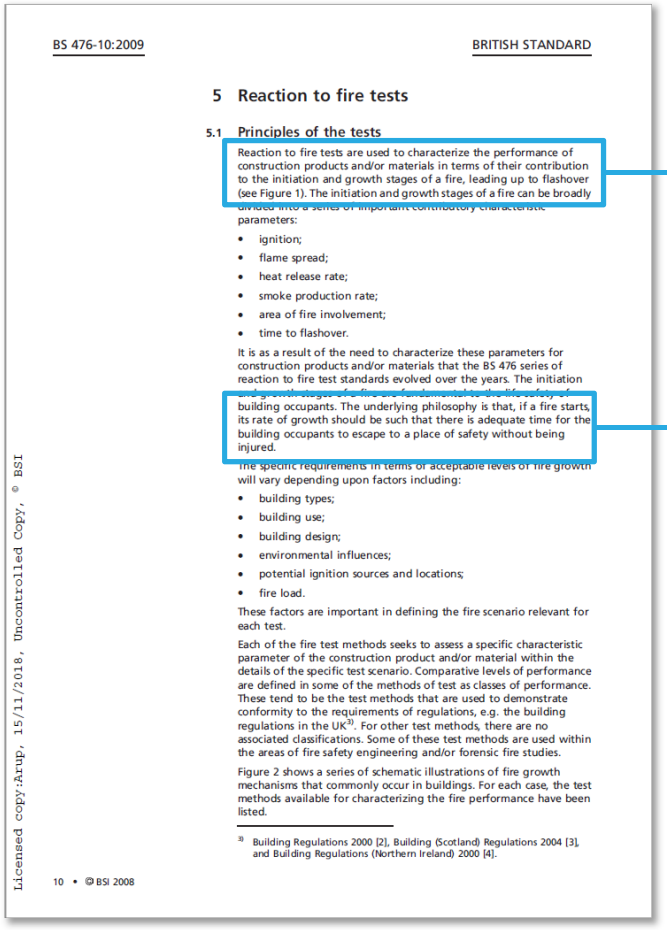

BS 476-10:2009 BRITISH STANDARD

5 Reaction to fire tests

5.1 Principles of the tests

Reaction to fire tests are used to characterize the performance of construction products and/or materials in terms of their contribution to the initiation and growth stages of a fire, leading up to flashover (see Figure 1). The initiation and growth stages of a fire can be broadly divided into a series of important contributory characteristic parameters:

- ignition;
- flame spread;
- heat release rate;
- smoke production rate;
- area of fire involvement;
- time to flashover.

It is as a result of the need to characterize these parameters for construction products and/or materials that the BS 476 series of reaction to fire test standards evolved over the years. The initiation and growth stages of a fire are fundamental to the safety of building occupants. The underlying philosophy is that, if a fire starts, its rate of growth should be such that there is adequate time for the building occupants to escape to a place of safety without being injured.

The specific requirements in terms of acceptable levels of fire growth will vary depending upon factors including:

- building types;
- building use;
- building design;
- environmental influences;
- potential ignition sources and locations;
- fire load.

These factors are important in defining the fire scenario relevant for each test.

Each of the fire test methods seeks to assess a specific characteristic parameter of the construction product and/or material within the details of the specific test scenario. Comparative levels of performance are defined in some of the methods of test as classes of performance. These tend to be the test methods that are used to demonstrate conformity to the requirements of regulations, e.g. the building regulations in the UK[3]. For other test methods, there are no associated classifications. Some of these test methods are used within the areas of fire safety engineering and/or forensic fire studies.

Figure 2 shows a series of schematic illustrations of fire growth mechanisms that commonly occur in buildings. For each case, the test methods available for characterizing the fire performance have been listed.

[3] Building Regulations 2000 [2], Building (Scotland) Regulations 2004 [3], and Building Regulations (Northern Ireland) 2000 [4].

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"Reaction to fire tests are used to characterize the performance of construction products and/or materials in terms of their contribution to the initiation and growth stages of a fire, leading up to flashover"

"The underlying philosophy is that, if a fire starts, its rate of growth should be such that there is adequate time for the building occupants to escape to a place of safety without being injured"

Sequence of events in a room fire

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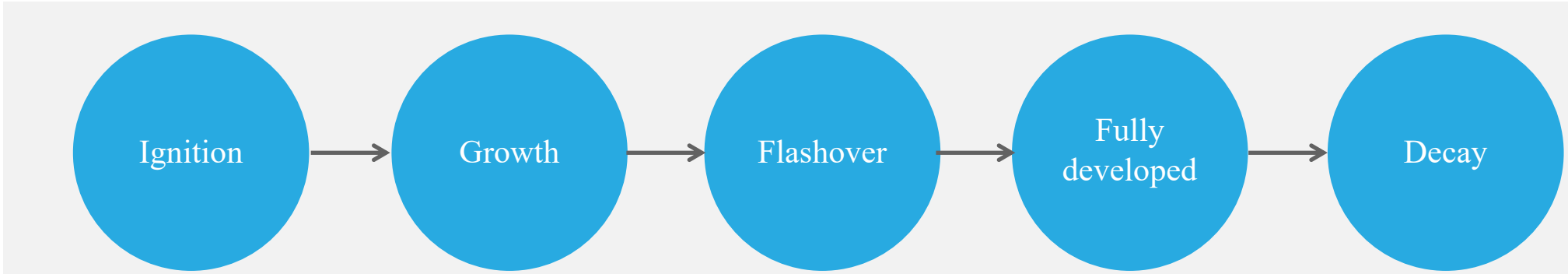

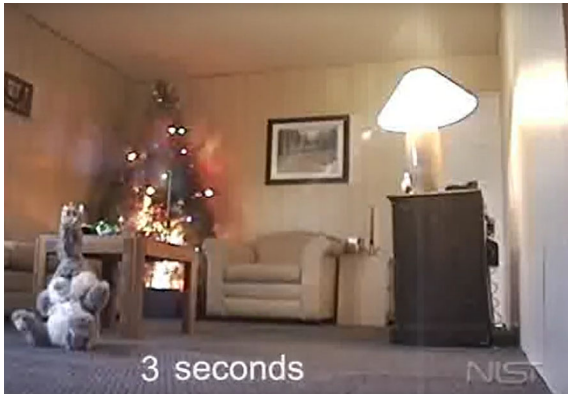

Small free burning fire

Spread to nearby objects

Room fills with hot smoke; remote items ignite

How is this power represented in fire safety science?

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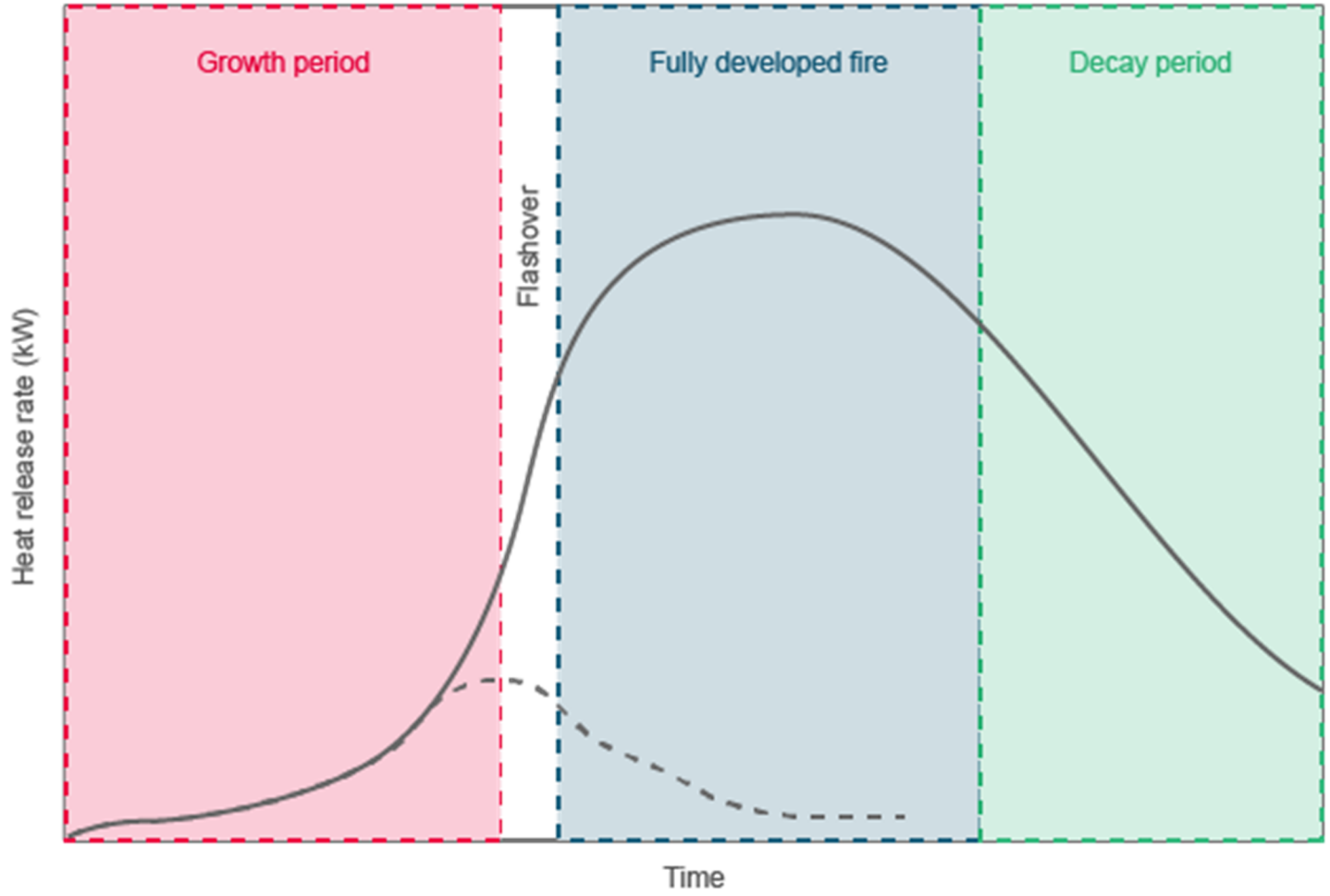

What is flashover and when does this occur?

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© Fire Hobbyist (2015). *Flashover Fire Caught on GoPro* Available at: https://youtu.be/k-3UCGGizgc; Accessed: 02/11/2020

Fire stages – the fire tests deemed to be relevant

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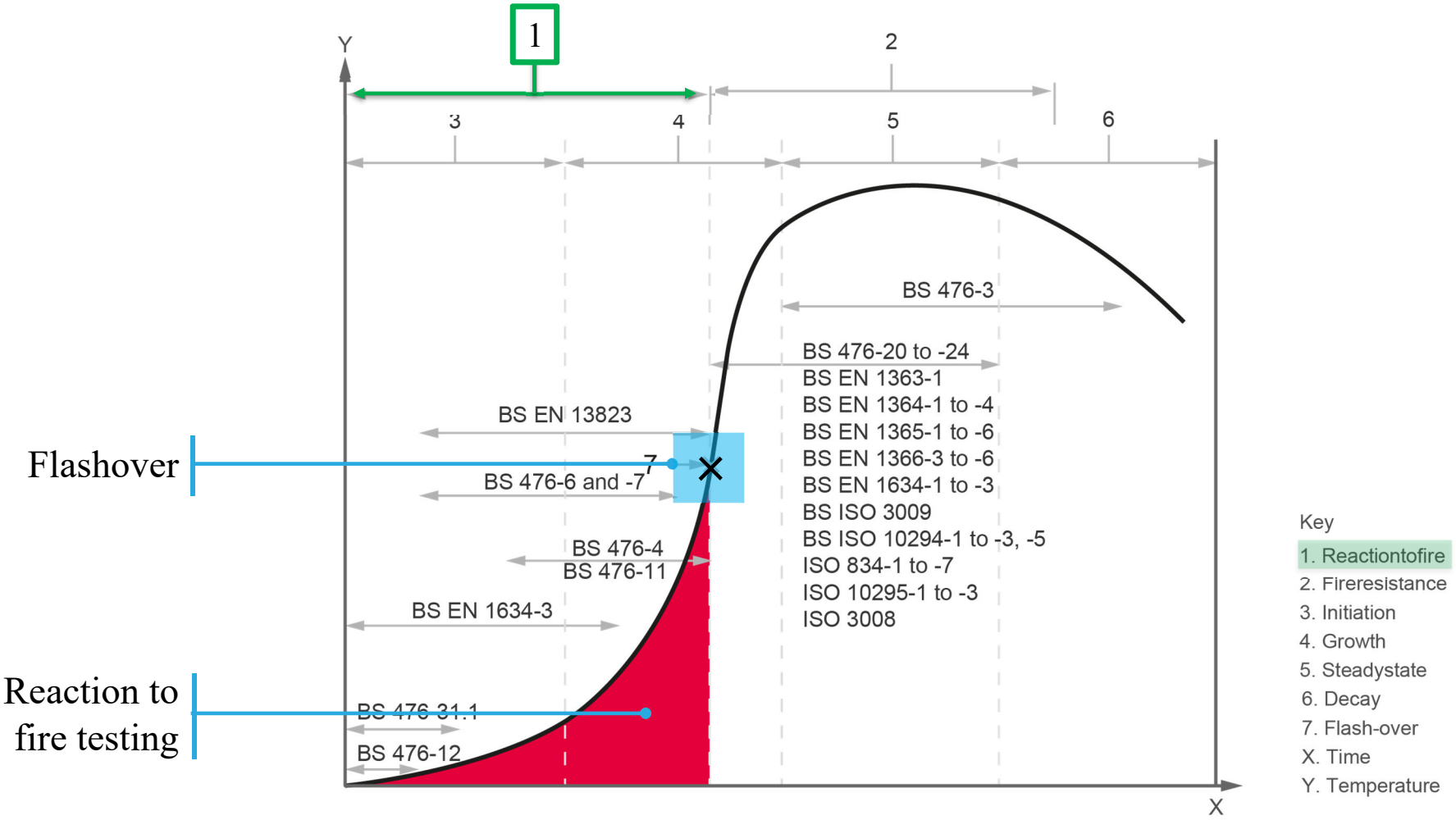

Diagram from Figure 1 of BS 476-10 overmarked by me

Fully developed fires and their aftermath

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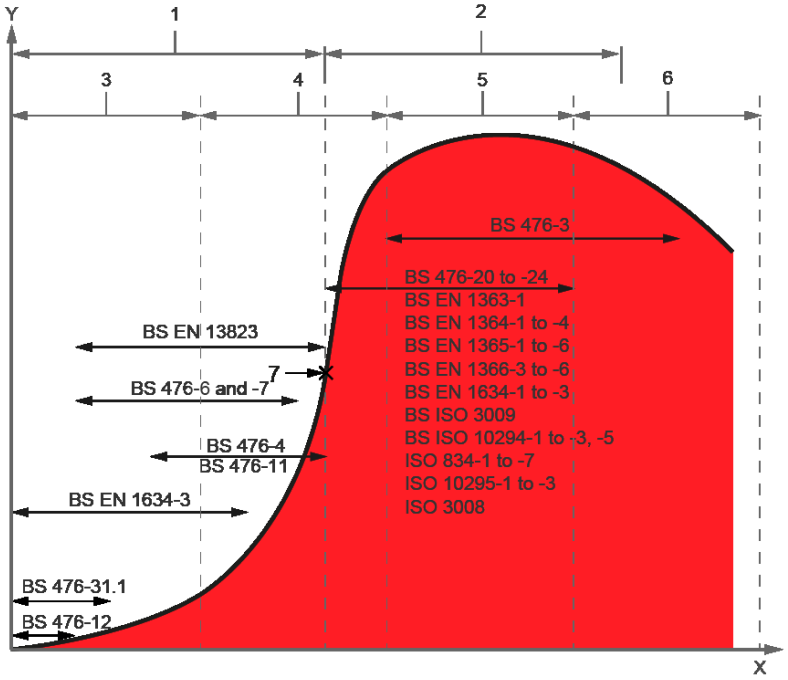

Key
1. Reaction to fire
2. Fire resistance
3. Initiation
4. Growth
5. Steady state
6. Decay
7. Flash-over
X. Time
Y. Temperature

Fully developed fires – their decay phase

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Decaying fires

Early fire growth phase – localised fires

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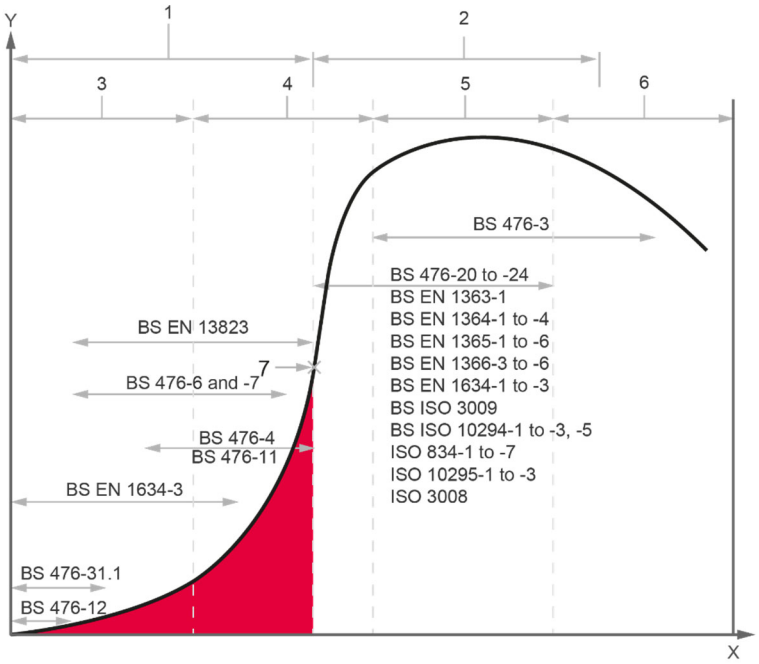

Fully developed fires

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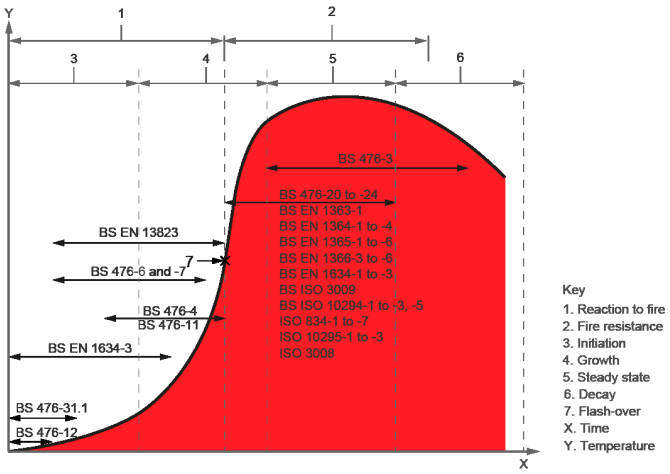
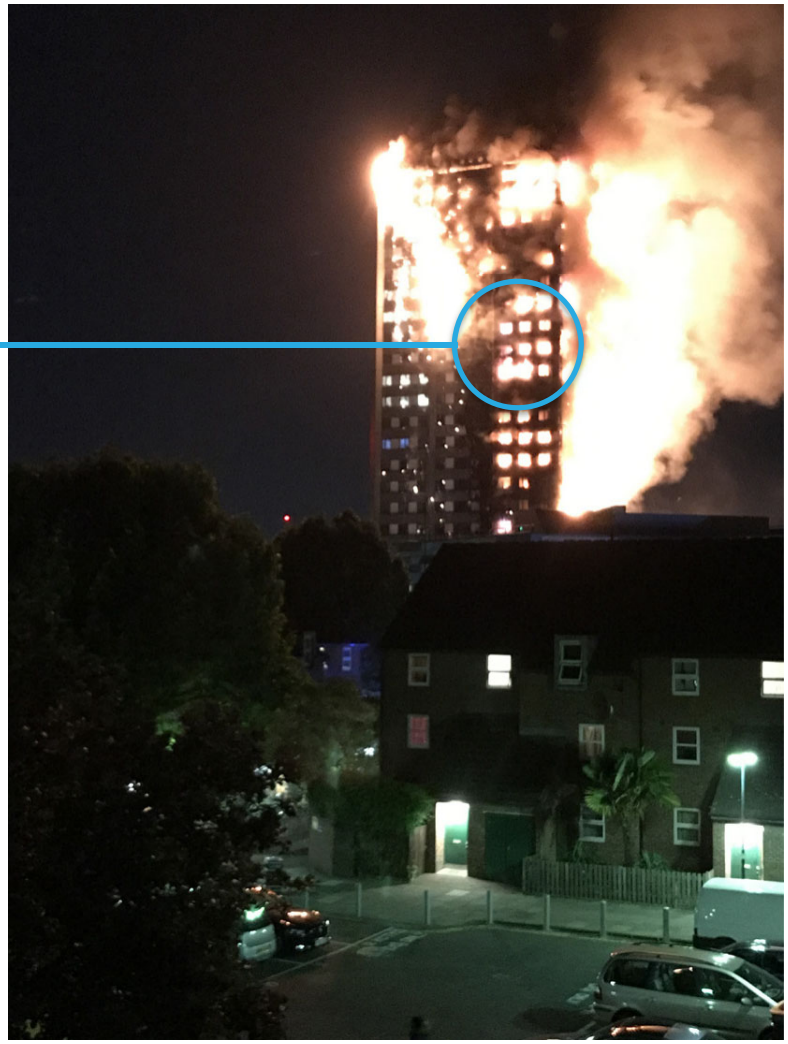
Transition via a flashover to a fully developed fire





East side of Grenfell Tower - taken at 02:22:00{MET00012593}

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But what about the external wall fire scenario?

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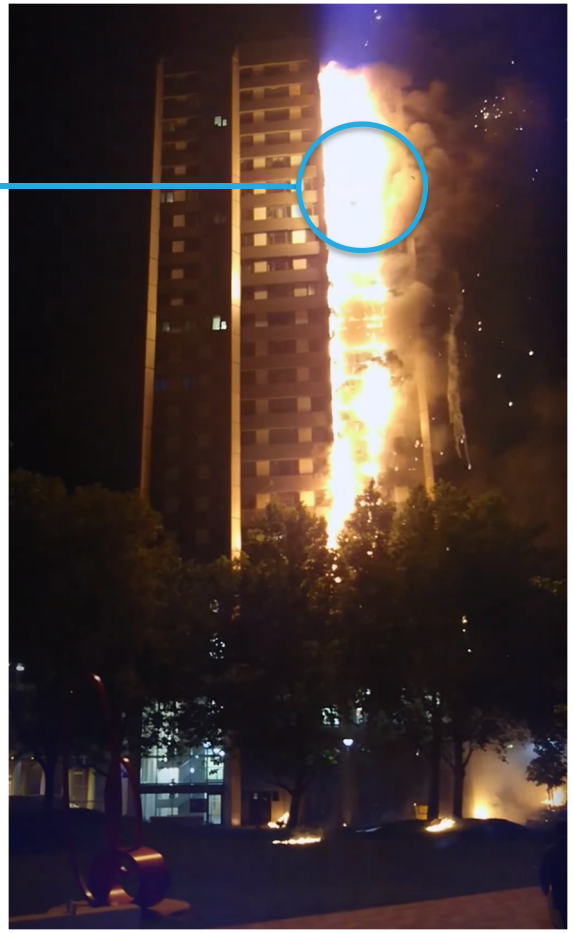
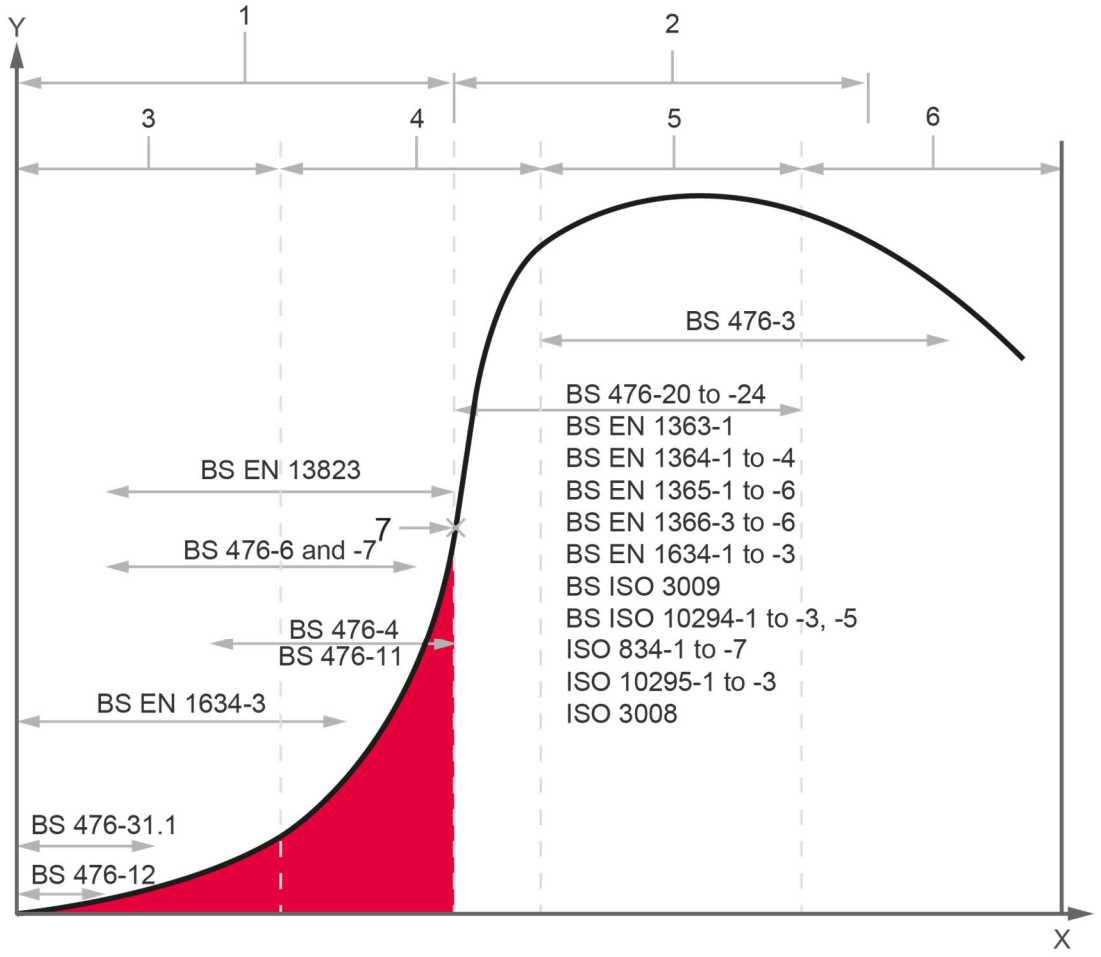
External Wall Fire



Available at: https://www.youtube.com/watch?v=6AYUZ5Snxzo



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The eight reaction to fire tests

National and European Reaction to Fire Tests

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BS 476-4
Non-combustibility test for materials

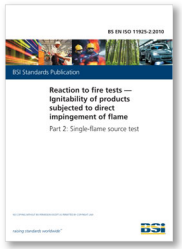
BS 476-6
Method of test for fire propagation for products

BS 476-7
Method of test to determine the classification of the surface spread of flame of products

BS 476-11
Method for assessing the heat emission from building materials

BS EN 13823
Building products excluding floorings exposed to the thermal attach by a single burning item

BS EN ISO 1716
Determination of the gross heat of combustion (calorific value)



BS EN ISO 11925-2
Ignitability of building products subjected to direct impingement of flame. Single-flame source test

BS EN ISO 1182
Non-combustibility test

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Section 1:
National reaction to fire tests

National test standards

What are reaction to fire tests?

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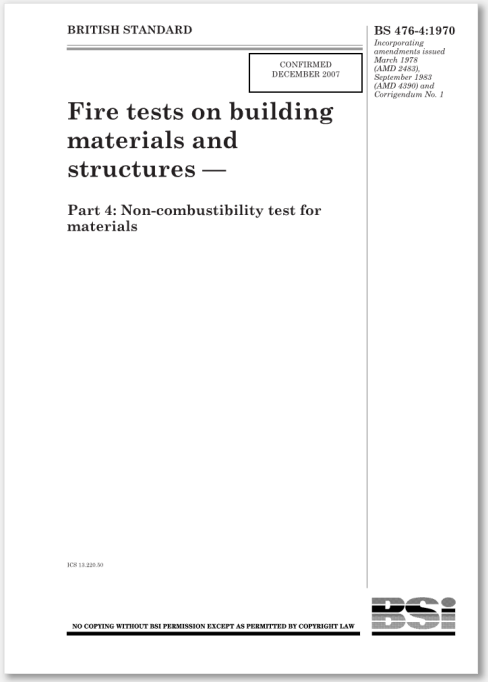
BRITISH STANDARD

BS 476-4:1970
Incorporating amendments issued March 1978 (AMD 2483), September 1983 (AMD 4296) and Corrigendum No. 1

CONFIRMED DECEMBER 2007

Fire tests on building materials and structures —

Part 4: Non-combustibility test for materials

ICS 13.220.50

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BSI

BS 476-4
Non-combustibility test for materials


BRITISH STANDARD

BS 476-6: 1989+A1:2009
Incorporating Corrigendum No. 1

Fire tests on building materials and structures –

Part 6: Method of test for fire propagation for products

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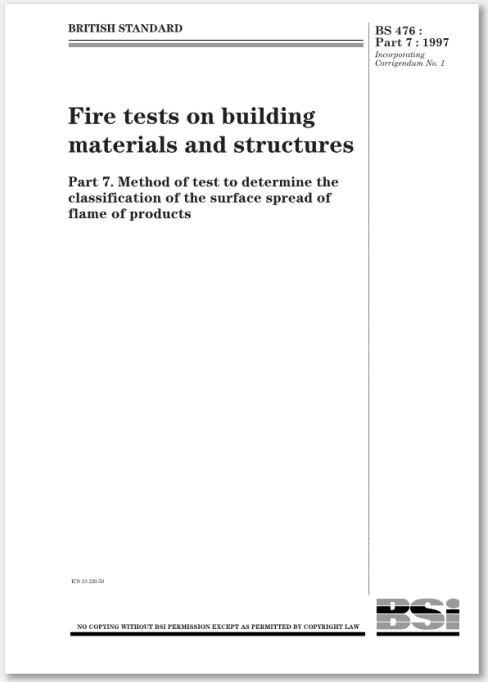
BS 476-6
Method of test for fire propagation for products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BS 476 : Part 7 : 1997
Incorporating Corrigendum No. 1

Fire tests on building materials and structures

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

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BS 476-7
Method of test to determine the classification of the surface spread of flame of products


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BS 476-11:1982
Incorporating Corrigendum No. 1

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Fire tests on building materials and structures —

Part 11: Method for assessing the heat emission from building materials

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BS 476-11
Method for assessing the heat emission from building materials

British Standards Committees- Reaction to fire tests

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BS 476-4:1970

Cooperating Organizations

The Fire Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Board of Trade*
County Councils Association
Department of Employment and Productivity*
Fire Extinguisher Trades Association
Chief Fire Officers' Association*
Fire Offices Committee*
Fire Protection Association*
Greater London Council*
Greater London Council (London Fire Brigade)
Home Office*
Industrial Fire Protection Association of Great Britain
Institution of Civil Engineers
Institution of Fire Engineers*
Institution of Municipal Engineers*
Ministry of Housing and Local Government*
Ministry of Public Building and Works* Ministry of Technology
Ministry of Technology—Joint Fire Research* Organization and Fire Offices Committee
National Council of Building Material Producers
Royal Institute of British Architects*

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

Association of British Roofing Felt Manufacturers
British Constructional Steelwork Association
British Fire Services Association
British Plastics Federation
British Rubber Manufacturers Association Ltd.
British Steel Industry
Building Board Manufacturers Association of Great Britain
Confederation of British Industry
Department of Education and Science
Felt Roofing Contractors Advisory Board
Fibre Building Board Development Organisation Ltd.
Gypsum Plasterboard Development Association
Imported Fibre Building Board Federation
Leathercloth and Coated Fabrics Manufacturers
Mastic Asphalt Employers Federation
Ministry of Technology—Forest Products Research Laboratory
National Coal Board
National Federation of Building Trades Employers
Rubber and Plastics Research Association of Great Britain
Timber Research and Development Association
United Kingdom Atomic Energy Authority
Wood Wool Building Slab Manufacturers Association
Individual manufacturers

This British Standard, having been approved by the Fire Standards Committee and endorsed by the Chairman of the Building Divisional Council, was published under the authority of the Executive Board on 26 January, 1970.

BS 476-6:1989+A1:2009

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Fire Standards Policy Committee (FSM/-) to Technical Committee FSM/1, upon which the following bodies were represented:

Association of British Roofing Felt Manufacturers
Association of Building Component Manufacturers Ltd.
Association of Structural Fire Protection Contractors and Manufacturers
British Cement Association
British Fire Services Association
British Floor Covering Manufacturers' Association
British Plastics Federation
British Railways Board
British Rigid Urethane Foam Manufacturers' Association
British Wood Preserving Association
Chemical Industries Association
Chief and Assistant Chief Fire Officers Association
Concrete Society
Department of Education and Science
Department of the Environment (Building Research Establishment)
Department of the Environment (Construction Industries Directorate)
Department of the Environment (Property Services Agency)
Department of the Environment for Northern Ireland
Department of Transport (Marine Directorate)
Electricity Supply Industry in England and Wales
Engineering Equipment and Materials Users' Association
Eurisol (UK) Association of Manufacturers of Mineral Insulation Fibres
Fibre Building Board Organisation (FIDOR)
Fibre Cement Manufacturers' Association Limited
Fire Protection Association
Flat Glass Manufacturers' Association
Flat Roofing Contractors Advisory Board
Gypsum Products Development Association
Home Office
Institution of Fire Engineers
Loss Prevention Council
Mastic Asphalt Council and Employers' Federation
National Council of Building Materials Producers
RAPRA Technology Ltd.
Royal Institute of British Architects
Steel Construction Institute
Timber Research and Development Association
United Kingdom Atomic Energy Authority
Warrington Fire Research Centre
Wood Wool Slab Manufacturers' Association
Yarsley Technical Centre Ltd.

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

Autoclaved Aerated Concrete Products Association
London Scientific Services
National GRP Construction Federation
Phenolic Foam Manufacturers' Association
Queen Mary College Industrial Research
Thermal Insulation Manufacturers and Suppliers Association (TIMSA)

This British Standard, having been prepared under the direction of the Fire Standards Policy Committee, was published under the authority of the Board of BSI

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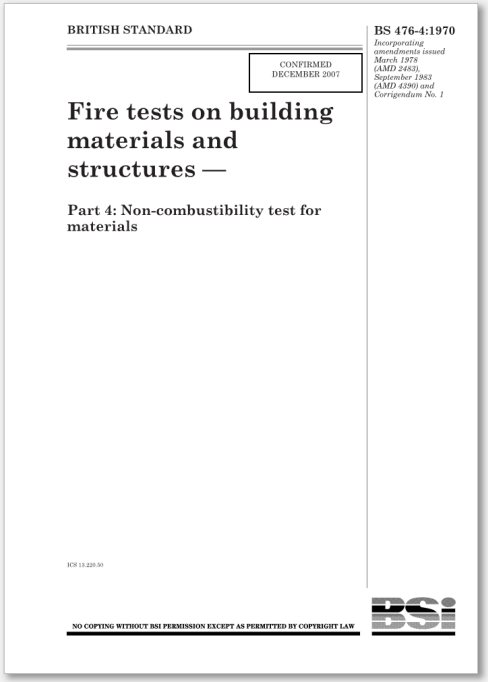
BRITISH STANDARD

BS 476-4:1970
Incorporating amendments issued March 1978 (AMD 2483), September 1983 (AMD 4296) and Corrigendum No. 1

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Fire tests on building materials and structures —

Part 4: Non-combustibility test for materials

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BS 476-4
Non-combustibility test for materials


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BS 476-6: 1989+A1:2009
Incorporating Corrigendum No. 1

Fire tests on building materials and structures –

Part 6: Method of test for fire propagation for products

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BS 476-6
Method of test for fire propagation for products


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

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BS 476-7
Method of test to determine the classification of the surface spread of flame of products


BRITISH STANDARD

BS 476-11:1982
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Fire tests on building materials and structures —

Part 11: Method for assessing the heat emission from building materials

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BS 476-11
Method for assessing the heat emission from building materials

BS 476-4 – apparatus

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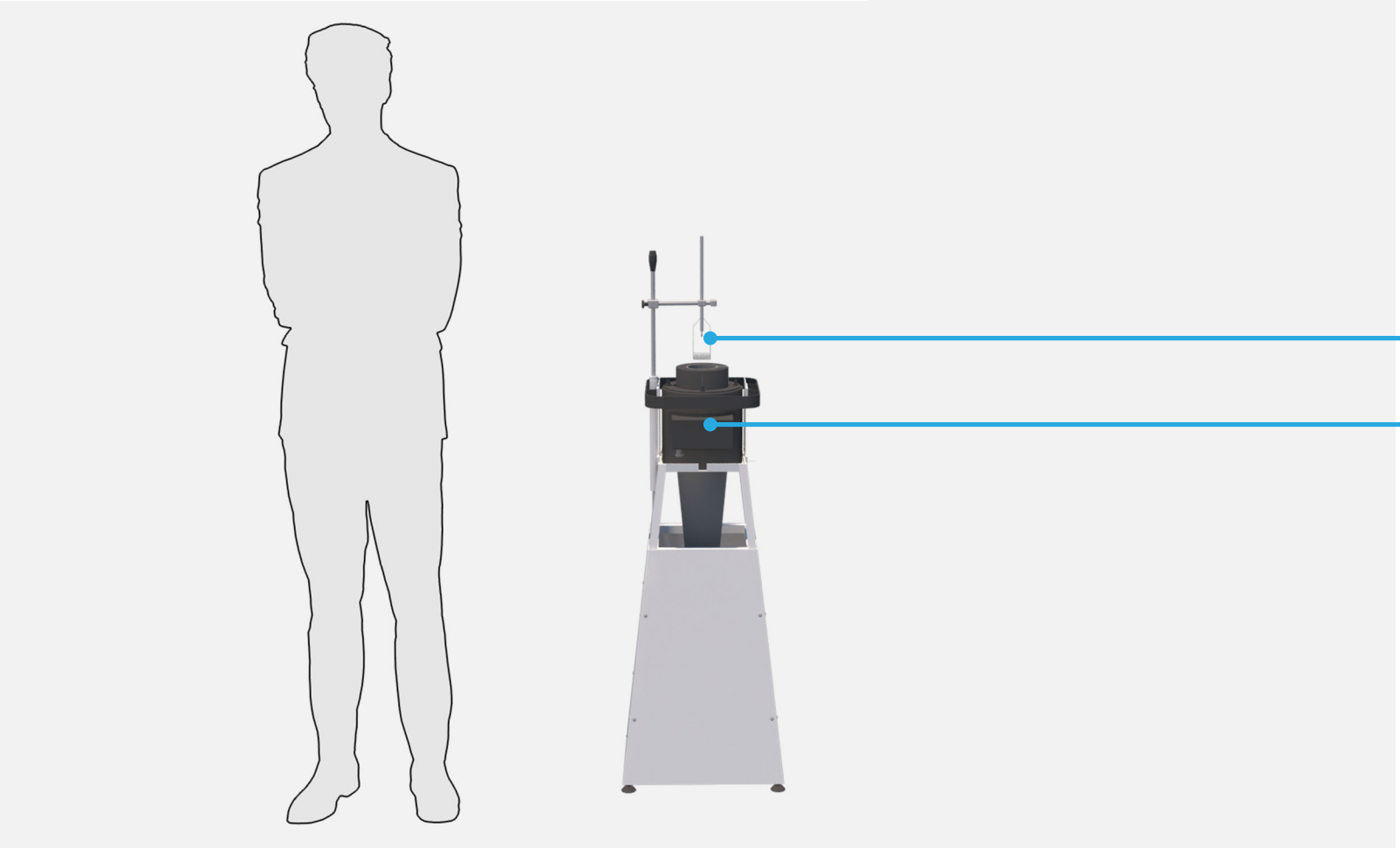

BS 476-4 – apparatus

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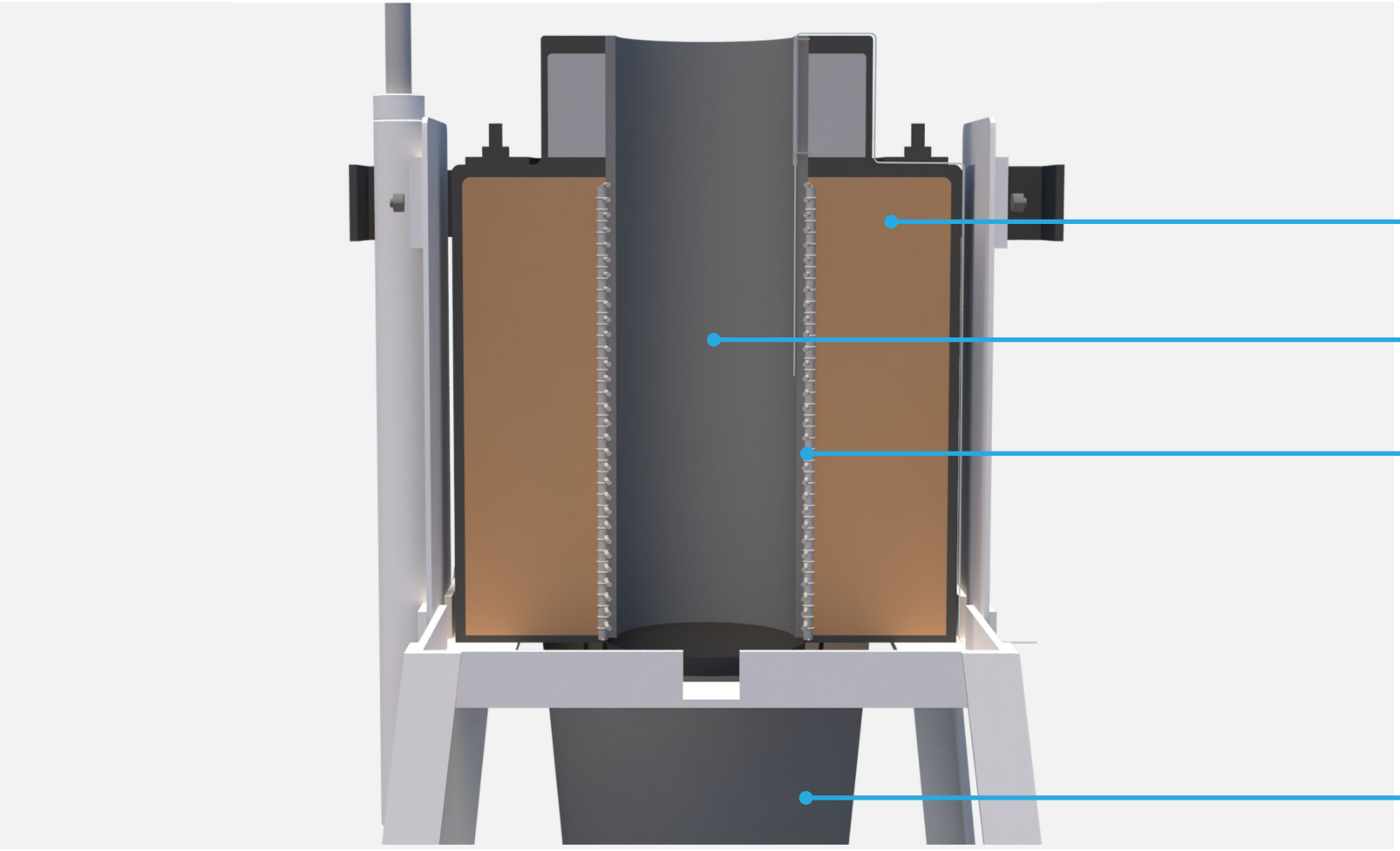

BS 476-4 – Specimen

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BS 476-4 – under/oversized specimens

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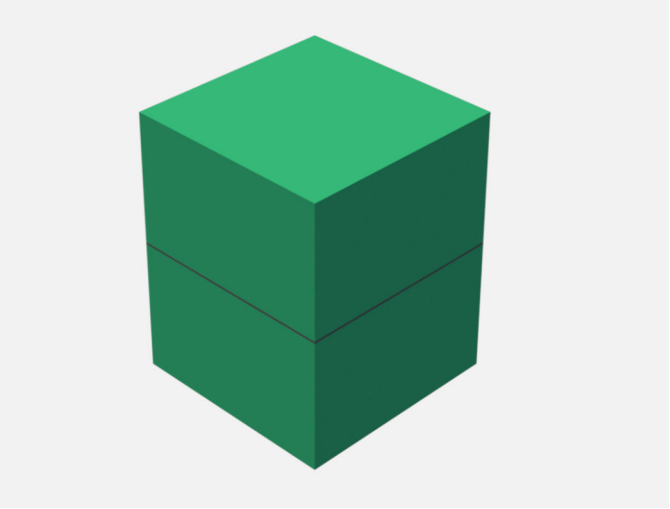
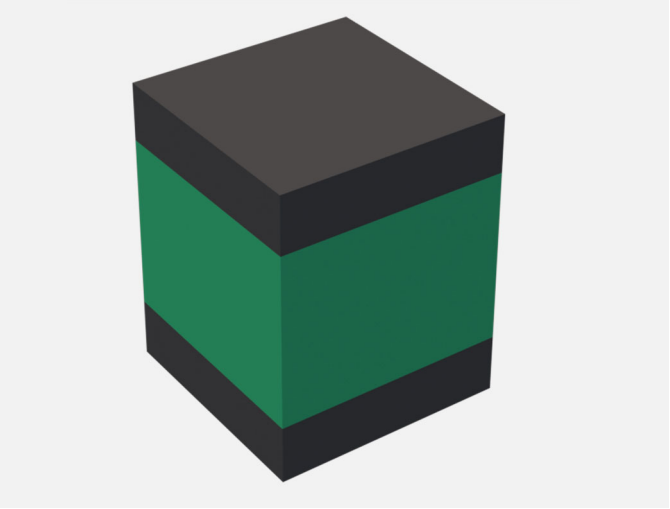
Option 1

Specimen is layered to achieve 50mm



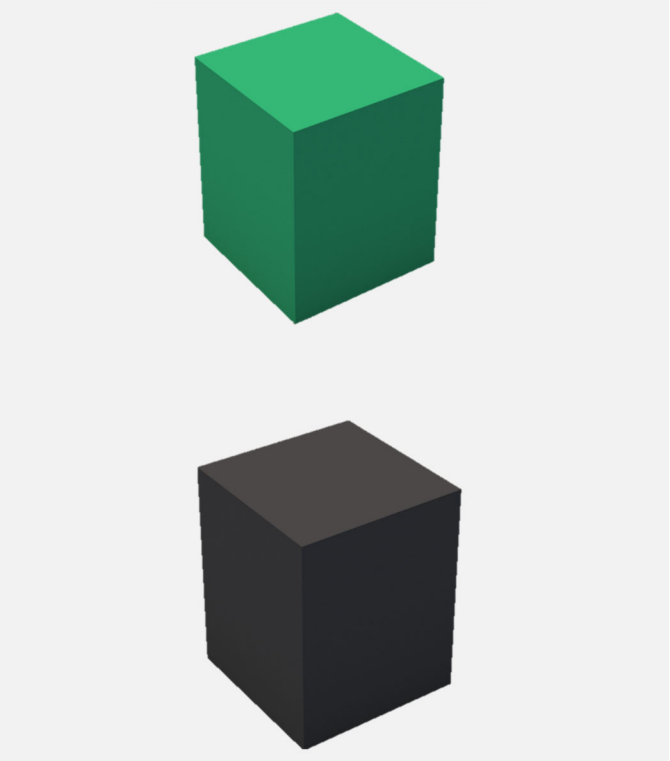
Option 2

Specimen has been scaled up in proportion

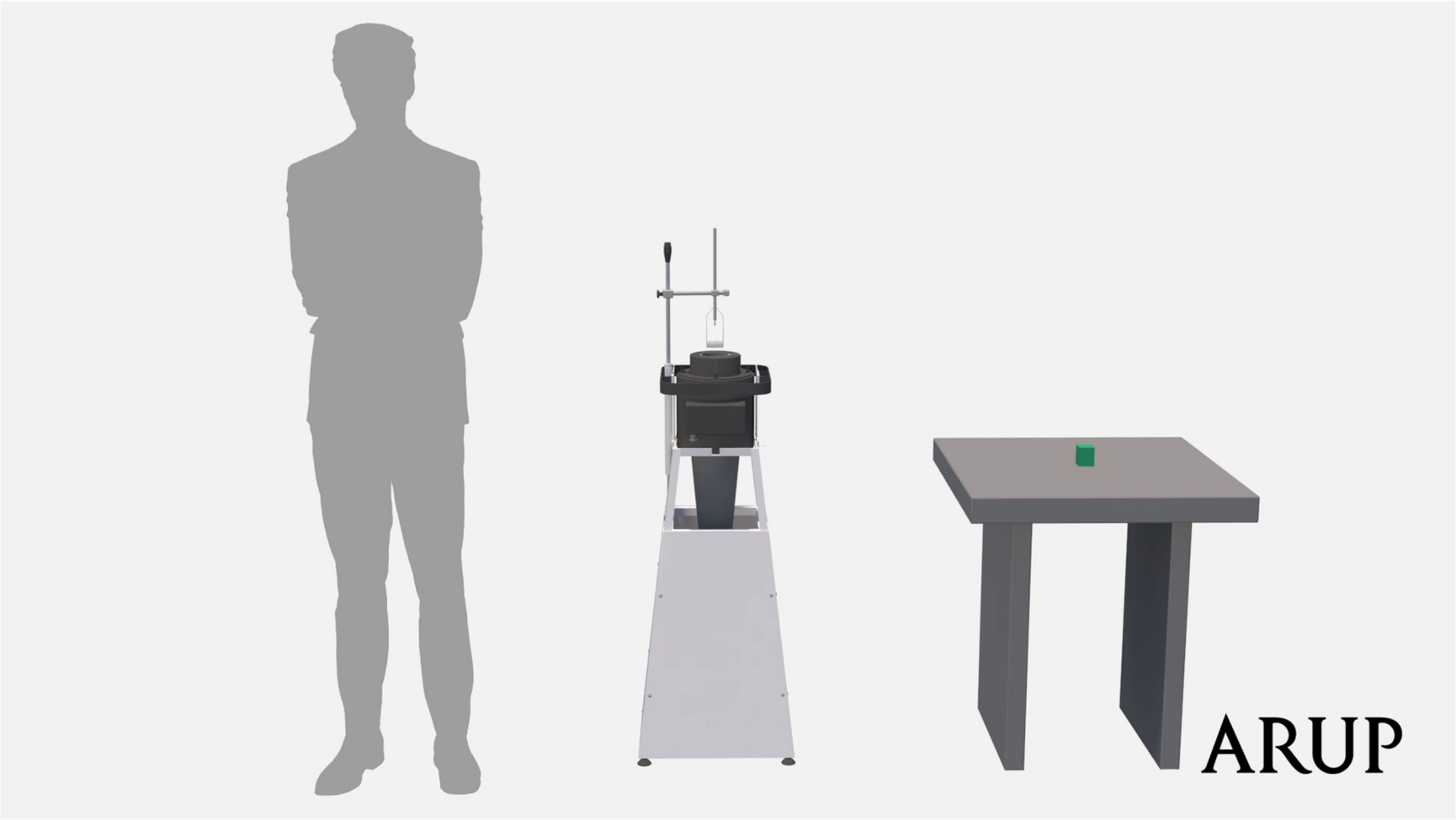


Option 3

Two composites are tested separately



BS 476-4 – apparatus



BS 476-4 – measurements taken

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- “A record shall be made for a further 20 min of the temperature of the two thermocouples by means of a continuous recorder; the occurrence and duration of any flaming in the furnace shall be noted.”

BS 476-4 – how results are interpreted

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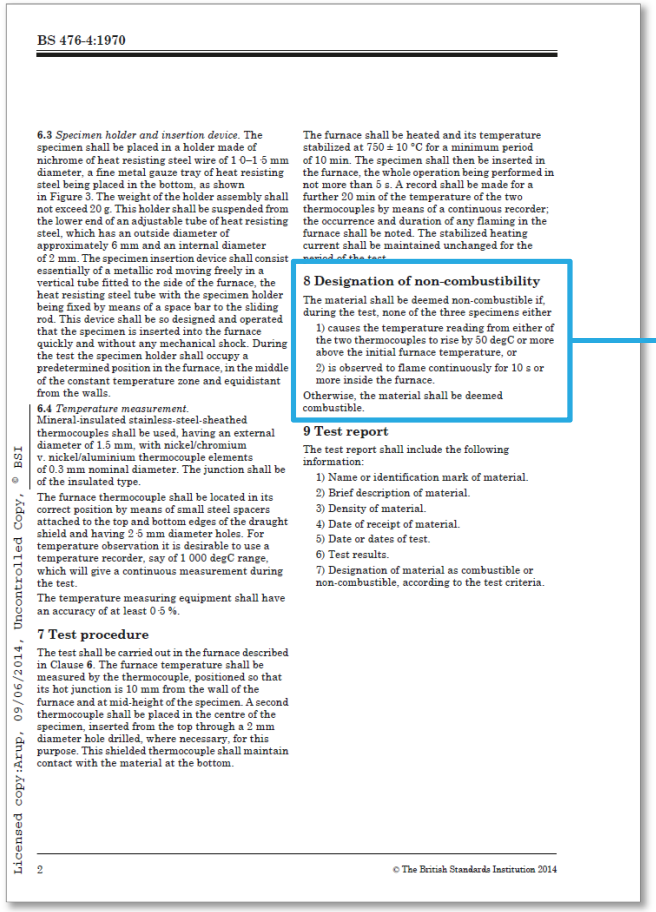

BS 476-4:1970

6.3 *Specimen holder and insertion device.* The specimen shall be placed in a holder made of nichrome of heat resisting steel wire of 1·0–1·5 mm diameter, a fine metal gauze tray of heat resisting steel being placed in the bottom, as shown in Figure 3. The weight of the holder assembly shall not exceed 20 g. This holder shall be suspended from the lower end of an adjustable tube of heat resisting steel, which has an outside diameter of approximately 6 mm and an internal diameter of 2 mm. The specimen insertion device shall consist essentially of a metallic rod moving freely in a vertical tube fitted to the side of the furnace, the heat resisting steel tube with the specimen holder being fixed by means of a space bar to the sliding rod. This device shall be so designed and operated that the specimen is inserted into the furnace quickly and without any mechanical shock. During the test the specimen holder shall occupy a predetermined position in the furnace, in the middle of the constant temperature zone and equidistant from the walls.

6.4 *Temperature measurement.* Mineral-insulated stainless-steel-sheathed thermocouples shall be used, having an external diameter of 1·5 mm, with nickel/chromium v. nickel/aluminium thermocouple elements of 0·3 mm nominal diameter. The junction shall be of the insulated type.

The furnace thermocouple shall be located in its correct position by means of small steel spacers attached to the top and bottom edges of the draught shield and having 2·5 mm diameter holes. For temperature observation it is desirable to use a temperature recorder, say of 1 000 degC range, which will give a continuous measurement during the test.

The temperature measuring equipment shall have an accuracy of at least 0·5 %.

7 Test procedure

The test shall be carried out in the furnace described in Clause **6**. The furnace temperature shall be measured by the thermocouple, positioned so that its hot junction is 10 mm from the wall of the furnace and at mid-height of the specimen. A second thermocouple shall be placed in the centre of the specimen, inserted from the top through a 2 mm diameter hole drilled, where necessary, for this purpose. This shielded thermocouple shall maintain contact with the material at the bottom.

The furnace shall be heated and its temperature stabilized at 750 ± 10 °C for a minimum period of 10 min. The specimen shall then be inserted in the furnace, the whole operation being performed in not more than 5 s. A record shall be made for a further 20 min of the temperature of the two thermocouples by means of a continuous recorder; the occurrence and duration of any flaming in the furnace shall be noted. The stabilized heating current shall be maintained unchanged for the period of the test.

8 Designation of non-combustibility

The material shall be deemed non-combustible if, during the test, none of the three specimens either

1) causes the temperature reading from either of the two thermocouples to rise by 50 degC or more above the initial furnace temperature, or

2) is observed to flame continuously for 10 s or more inside the furnace.

Otherwise, the material shall be deemed combustible.

9 Test report

The test report shall include the following information:

1) Name or identification mark of material.
2) Brief description of material.
3) Density of material.
4) Date of receipt of material.
5) Date or dates of test.
6) Test results.
7) Designation of material as combustible or non-combustible, according to the test criteria.

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BS 476-4 – test report

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The test shall be carried out in the furnace described in Clause **6**. The furnace temperature shall be measured by the thermocouple, positioned so that its hot junction is 10 mm from the wall of the furnace and at mid-height of the specimen. A second thermocouple shall be placed in the centre of the specimen, inserted from the top through a 2 mm diameter hole drilled, where necessary, for this purpose. This shielded thermocouple shall maintain contact with the material at the bottom.

The furnace shall be heated and its temperature stabilized at 750 ± 10 °C for a minimum period of 10 min. The specimen shall then be inserted in the furnace, the whole operation being performed in not more than 5 s. A record shall be made for a further 20 min of the temperature of the two thermocouples by means of a continuous recorder; the occurrence and duration of any flaming in the furnace shall be noted. The stabilized heating current shall be maintained unchanged for the period of the test.

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1) Name or identification mark of material.
2) Brief description of material.
3) Density of material.
4) Date of receipt of material.
5) Date or dates of test.
6) Test results.
7) Designation of material as combustible or non-combustible, according to the test criteria.

ARUP


BRITISH STANDARD

BS 476-4:1970
Incorporating amendments issued March 1978 (AMD 2483), September 1983 (AMD 4096) and Corrigendum No. 1

CONFIRMED DECEMBER 2007

Fire tests on building materials and structures —

Part 4: Non-combustibility test for materials

ICS 13.220.50

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BS 476-4
Non-combustibility test for materials


BRITISH STANDARD

BS 476-6: 1989+A1:2009
Incorporating Corrigendum No. 1

Fire tests on building materials and structures –

Part 6: Method of test for fire propagation for products

ICS 13.220.50

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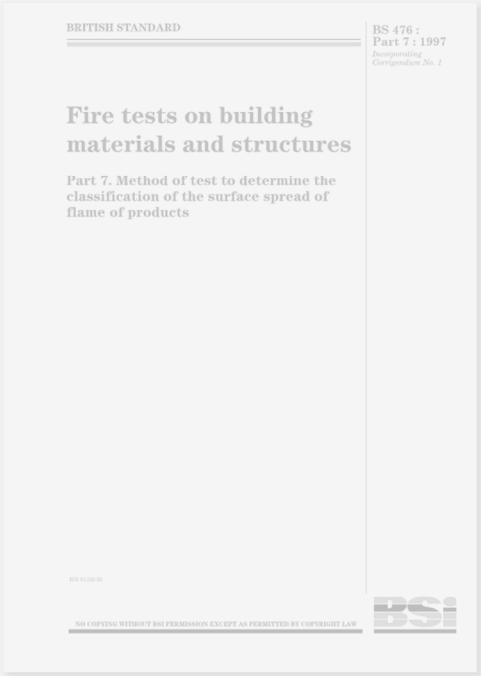
BS 476-6
Method of test for fire propagation for products


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

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BS 476-7
Method of test to determine the classification of the surface spread of flame of products


BRITISH STANDARD

BS 476-11:1982
Incorporating Corrigendum No. 1

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Fire tests on building materials and structures —

Part 11: Method for assessing the heat emission from building materials

ICS 13.220.50

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BS 476-11
Method for assessing the heat emission from building materials

BS 476-11 – apparatus

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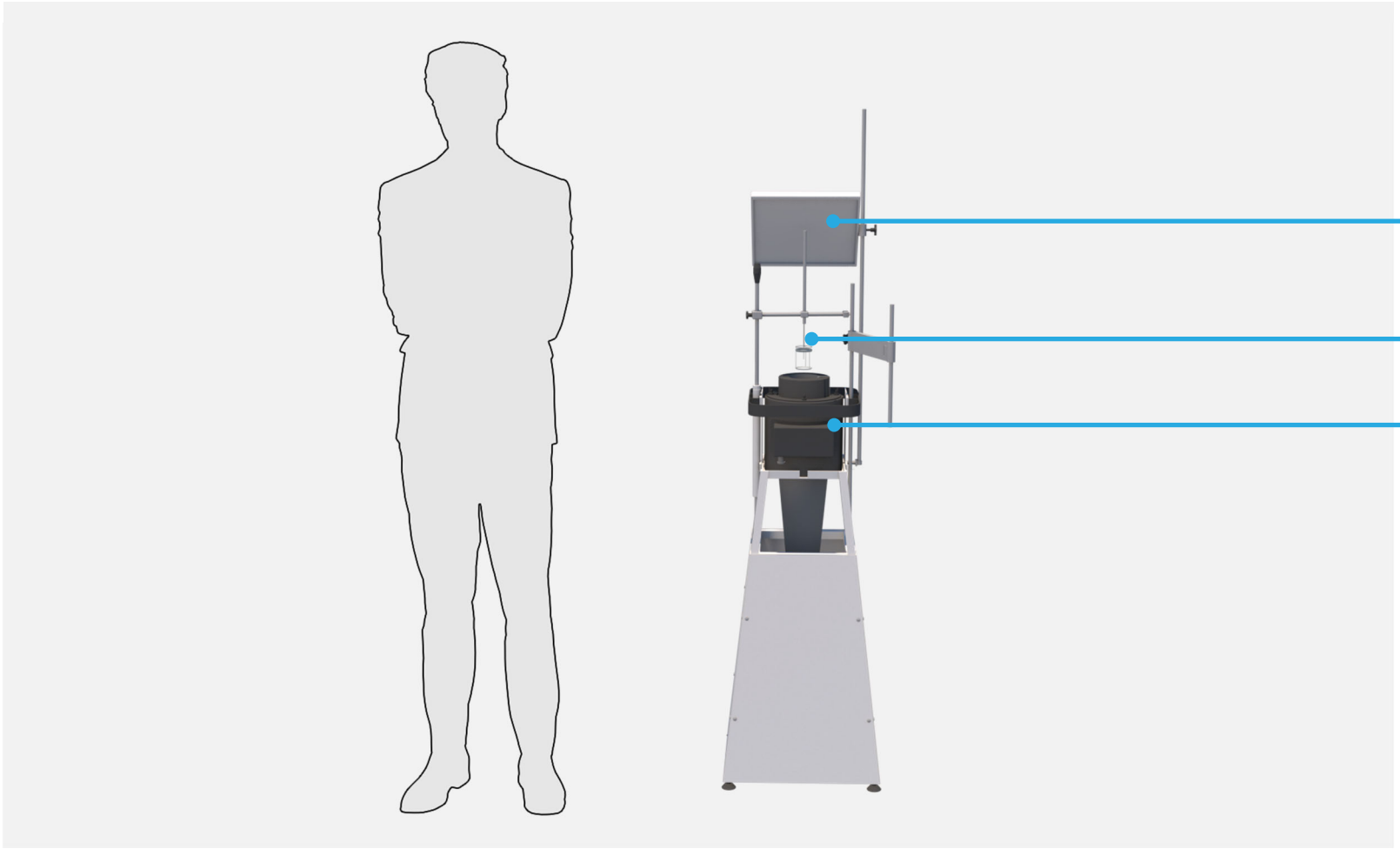
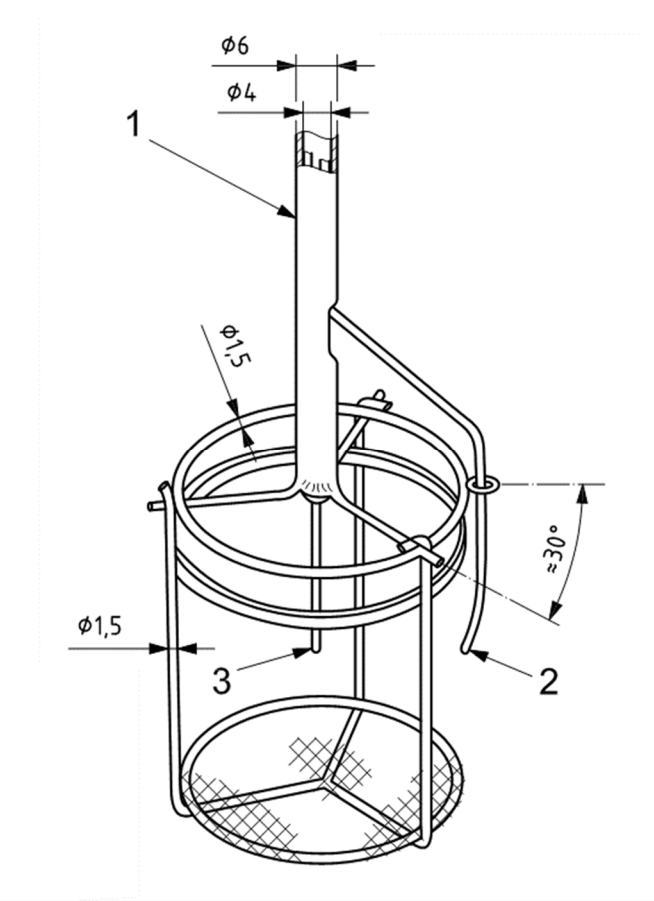
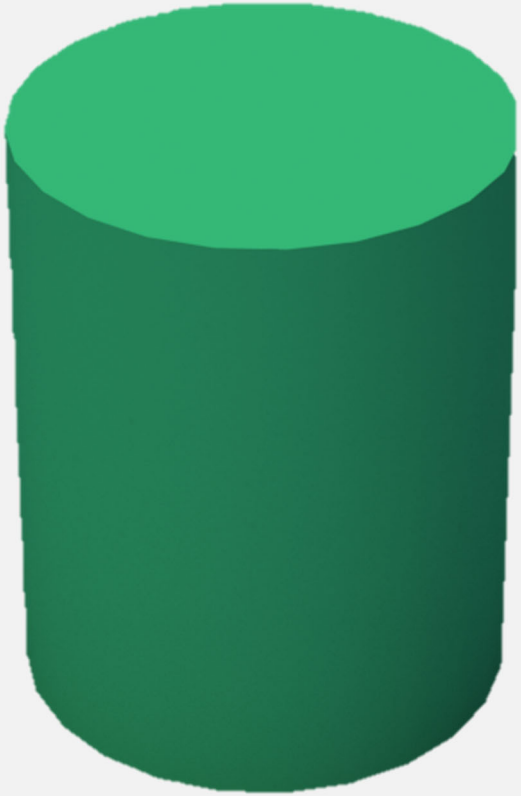


BS 476-11 – specimen

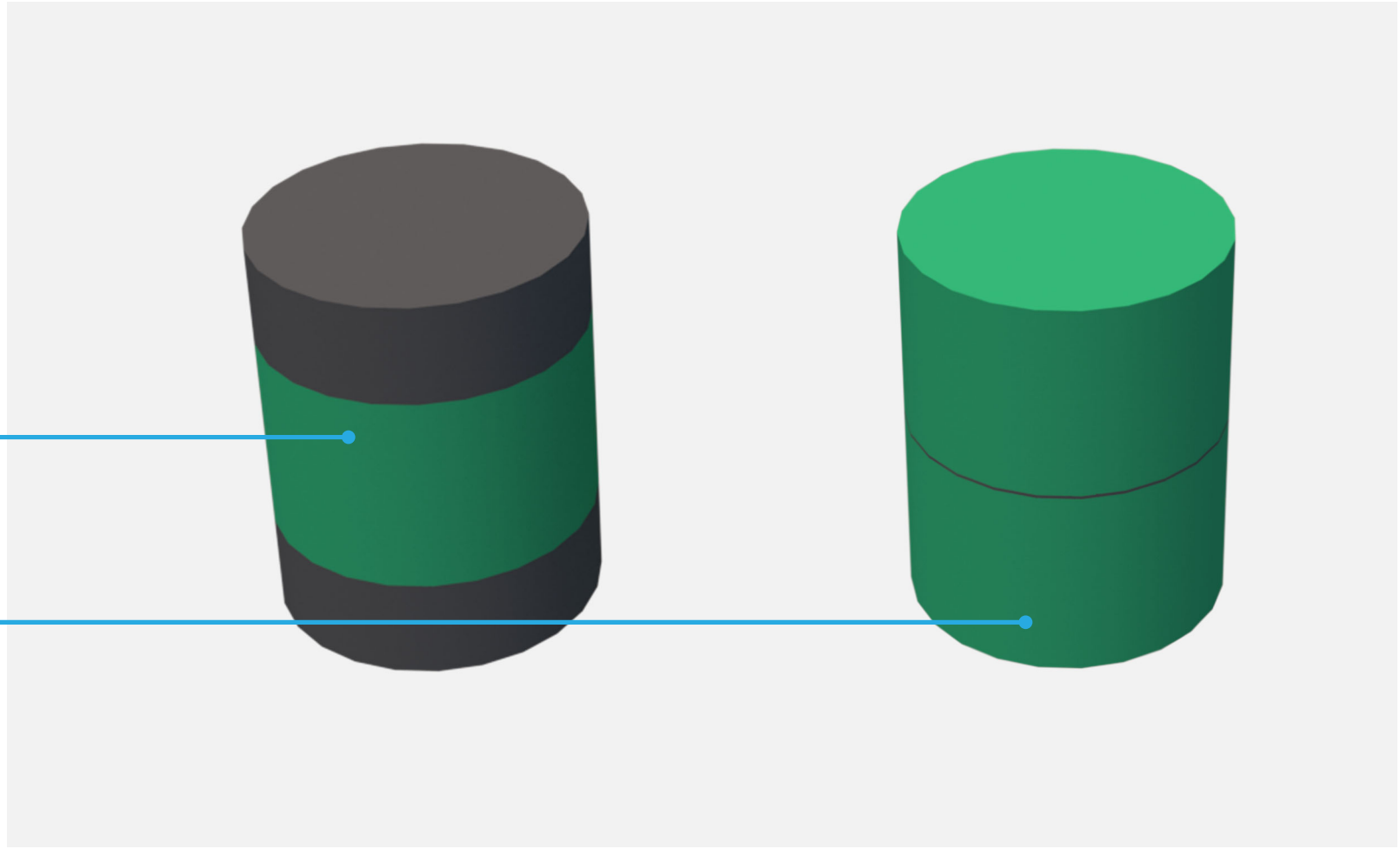
ARUP



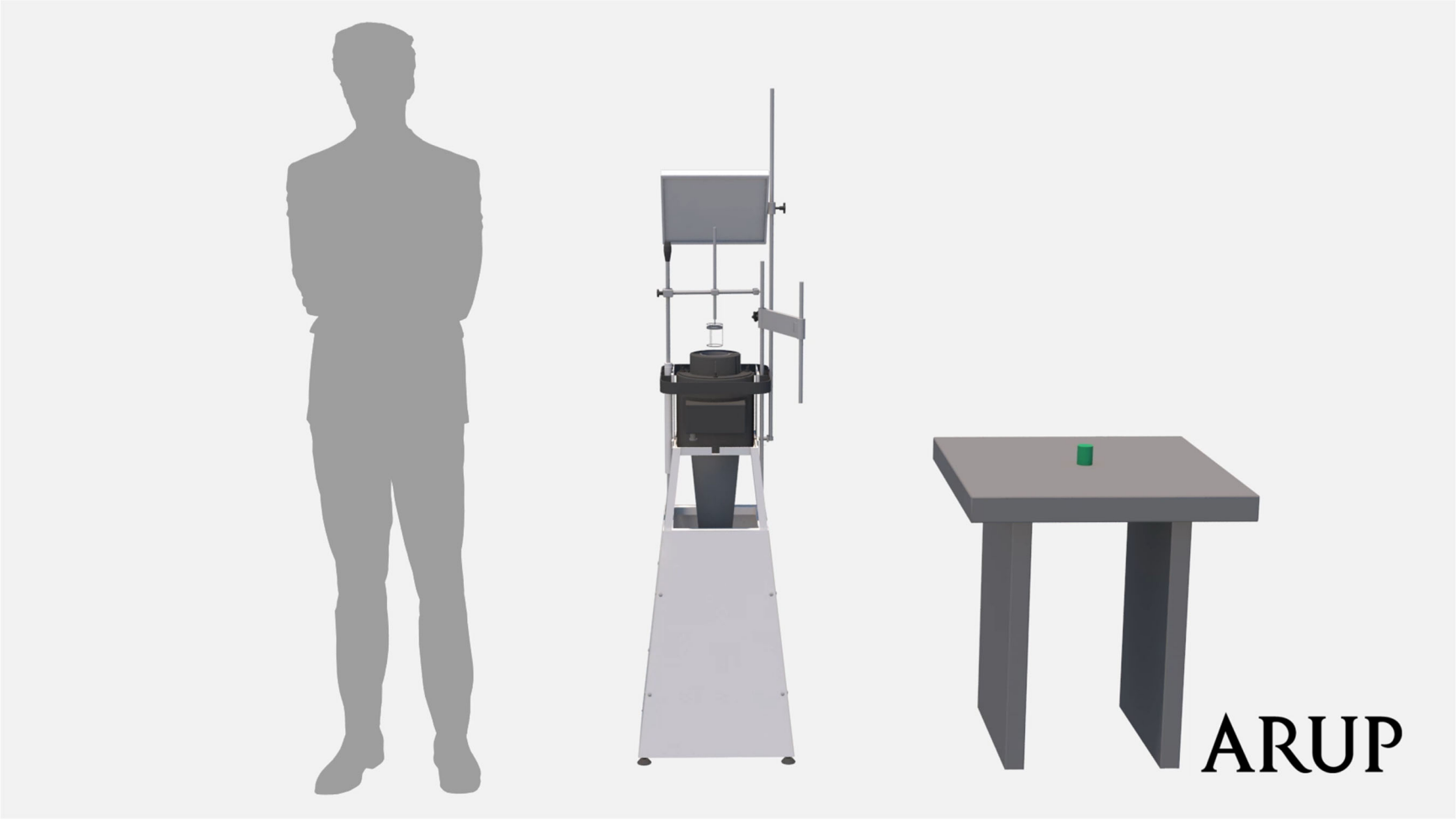


BS 476-11 – under/oversized specimens

ARUP



BS 476-11 – procedure



BS 476-11 – measurements taken

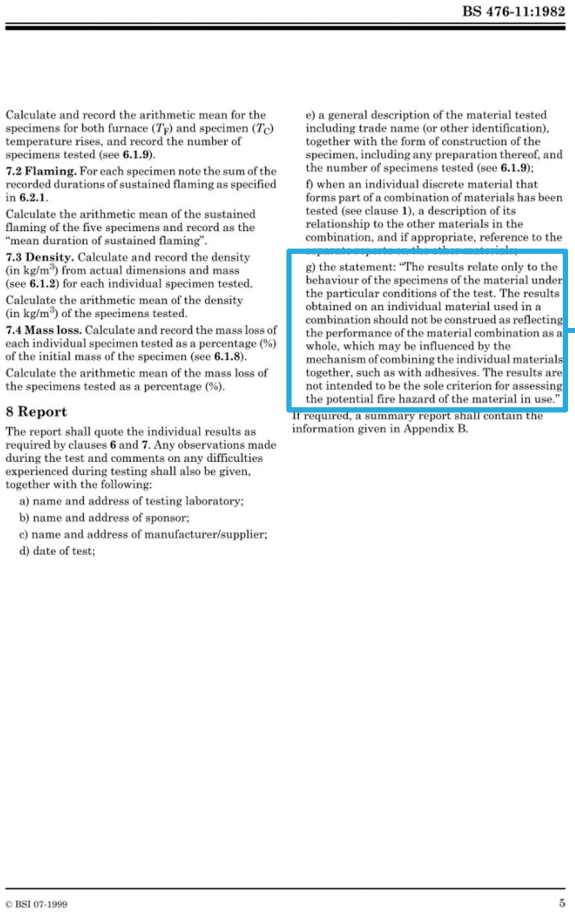
ARUP

- Temperature in the furnace throughout the test, including maximum **furnace temperature**
- The final **furnace** temperature
- Temperature in the specimen throughout the test, including maximum **specimen temperature**
- The final **specimen** temperature
- The average duration of sustained flaming is also calculated for the five samples and recorded in the report.

- Calculate and record the density (in kg/m3) from actual dimensions and mass for each individual specimen tested.
- Calculate the arithmetic mean of the density (in kg/m3) of the specimens tested.
- Calculate and record the mass loss of each individual specimen tested as a percentage (%) of the initial mass of the specimen.
- Calculate the arithmetic mean of the mass loss of the specimens tested as a percentage (%).

BS 476-11 – measurements taken

ARUP



BS 476-11:1982

Calculate and record the arithmetic mean for the specimens for both furnace (T_F) and specimen (T_C) temperature rises, and record the number of specimens tested (see **6.1.9**).

7.2 Flaming. For each specimen note the sum of the recorded durations of sustained flaming as specified in **6.2.1**.

Calculate the arithmetic mean of the sustained flaming of the five specimens and record as the "mean duration of sustained flaming".

7.3 Density. Calculate and record the density (in kg/m^3) from actual dimensions and mass (see **6.1.2**) for each individual specimen tested.

Calculate the arithmetic mean of the density (in kg/m^3) of the specimens tested.

7.4 Mass loss. Calculate and record the mass loss of each individual specimen tested as a percentage (%) of the initial mass of the specimen (see **6.1.8**).

Calculate the arithmetic mean of the mass loss of the specimens tested as a percentage (%).

8 Report

The report shall quote the individual results as required by clauses **6** and **7**. Any observations made during the test and comments on any difficulties experienced during testing shall also be given, together with the following:

a) name and address of testing laboratory;

b) name and address of sponsor;

c) name and address of manufacturer/supplier;

d) date of test;

e) a general description of the material tested including trade name (or other identification), together with the form of construction of the specimen, including any preparation thereof, and the number of specimens tested (see **6.1.9**);

f) when an individual discrete material that forms part of a combination of materials has been tested (see clause **1**), a description of its relationship to the other materials in the combination, and if appropriate, reference to the

g) the statement: "The results relate only to the behaviour of the specimens of the material under the particular conditions of the test. The results obtained on an individual material used in a combination should not be construed as reflecting the performance of the material combination as a whole, which may be influenced by the mechanism of combining the individual materials together, such as with adhesives. The results are not intended to be the sole criterion for assessing the potential fire hazard of the material in use."

If required, a summary report shall contain the information given in Appendix B.

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"The results relate only to the behaviour of the specimens of the material under the particular conditions of the test. The results obtained on an individual material used in a combination should not be construed as reflecting the performance of the material combination as a whole, which may be influenced by the mechanism of combining the individual materials together, such as with adhesives. The results are not intended to be the sole criterion for assessing the potential fire hazard of the material in use."

ARUP


BRITISH STANDARD

BS 476-4:1970

Incorporating amendments issued March 1978 (AMD 2483), September 1982 (AMD 4200) and Corrigendum No. 1

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Fire tests on building materials and structures —

Part 4: Non-combustibility test for materials

ICS 13.220.50

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BS 476-4
Non-combustibility test for materials


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BS 476-6: 1989+A1:2009

Incorporating Corrigendum No. 1

Fire tests on building materials and structures –

Part 6: Method of test for fire propagation for products

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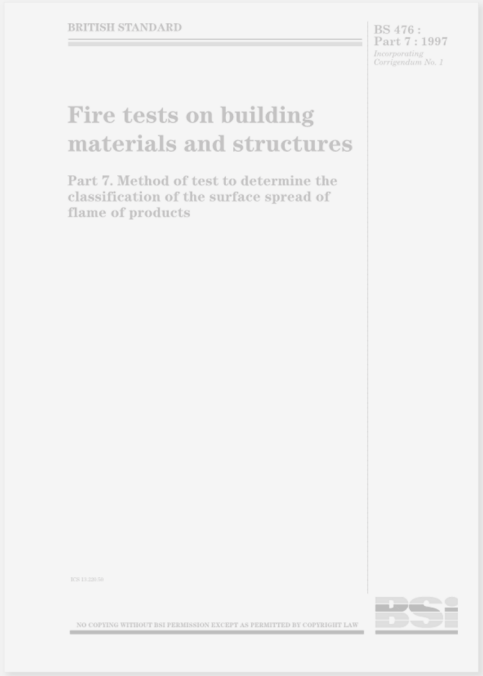
BS 476-6
Method of test for fire propagation for products


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

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BS 476-7
Method of test to determine the classification of the surface spread of flame of products


BRITISH STANDARD

BS 476-11:1982

Incorporating Corrigendum No. 1

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Fire tests on building materials and structures —

Part 11: Method for assessing the heat emission from building materials

ICS 13.220.50

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BS 476-11
Method for assessing the heat emission from building materials

BS 476-6 – scope

ARUP

1 Scope

This Part of BS 476 specifies a method of test, the result being expressed as a fire propagation index, that provides a comparative measure of the contribution to the growth of fire made by an essentially flat material, composite or assembly. It is primarily intended for the assessment of the performance of internal wall and ceiling linings.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 476, the definitions given in BS 4422-1, BS 4422-2 and BS 4422-5 and BS 476-10 apply, together with the following.

2.1
assembly

a fabrication of materials and/or composites that can contain air gaps

2.2
composite

a combination of materials which are generally recognized in building construction as discrete entities, e.g. coated or laminated materials

2.3
exposed surface(s)

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

2.4
essentially flat surface

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

3 Suitability of a product for testing

3.1 Surface characteristics

3.1.1 A product having one of the following is 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:

1) at least 50 % of the surface of a representative square area of 225 mm × 225 mm lies within a depth of 6 mm from a plane taken across the highest points on the exposed surface;

2) any cracks, fissures or holes do not exceed 6.5 mm in width nor 10 mm in depth, and the total area of such cracks fissures or holes at the surface does not exceed 30 % of a representative square area of 225 mm × 225 mm of the exposed surface.

3.1.2 When an exposed surface does not comply with the requirements of either **3.1.1** a) or **3.1.1** b) it is permissible for the product to be tested in a modified form with a flat exposed surface; this shall be stated in the test report.

3.2 Asymmetrical products

A product submitted for this test could have faces that differ or could contain laminations of different materials arranged in a different order in relation to the two faces. If either of these faces can be exposed in use within a room, cavity or void, then both faces shall be tested.

3.3 Products with particular burning characteristics

This method of test could be inadequate for assessing products that react in particular ways under exposure to the specified heating conditions (see **9.2**). In this case provision is either made to apply a suffix to the result [see **10.4.2** and clause **11** g)], or prohibit an assessment being made because the product is unsuitable for testing by this method (see **10.4.3**).

NOTE Products showing these characteristics should be assessed by other test methods.

4 Test specimens

4.1 Number of specimens

The test sample shall comprise a minimum of three and a maximum of five specimens for each face to be tested.

4.2 Size of specimens

NOTE Specific advice on the testing of assemblies is given in **A.2** and appendix B.

4.2.1 The specimens shall be square, with sides 225 ± 1.5 mm long.

4.2.2 Products of normal thickness 50 mm or less shall be used to full thickness.

4.2.3 For products of normal thickness greater than 50 mm, the specimens shall be obtained by cutting away the unexposed face of the product to reduce the thickness to 50^{+0}_{-3} mm.

4.3 Edge effects

Where the specimen is backed by an air gap (see appendix B), ensure that the perimeter of the specimen will not permit flame to penetrate into the cavity. Similarly, where a flame-retardant coating is applied to a surface, the edge detail shall be such as to prevent ignition of the underlying layers.

"This Part of BS 476 specifies a method of test, the result being expressed as a fire propagation index, that provides a comparative measure of the contribution to the growth of fire made by an essentially flat material, composite or assembly. It is primarily intended for the assessment of the performance of internal wall and ceiling linings."

BS 476-6

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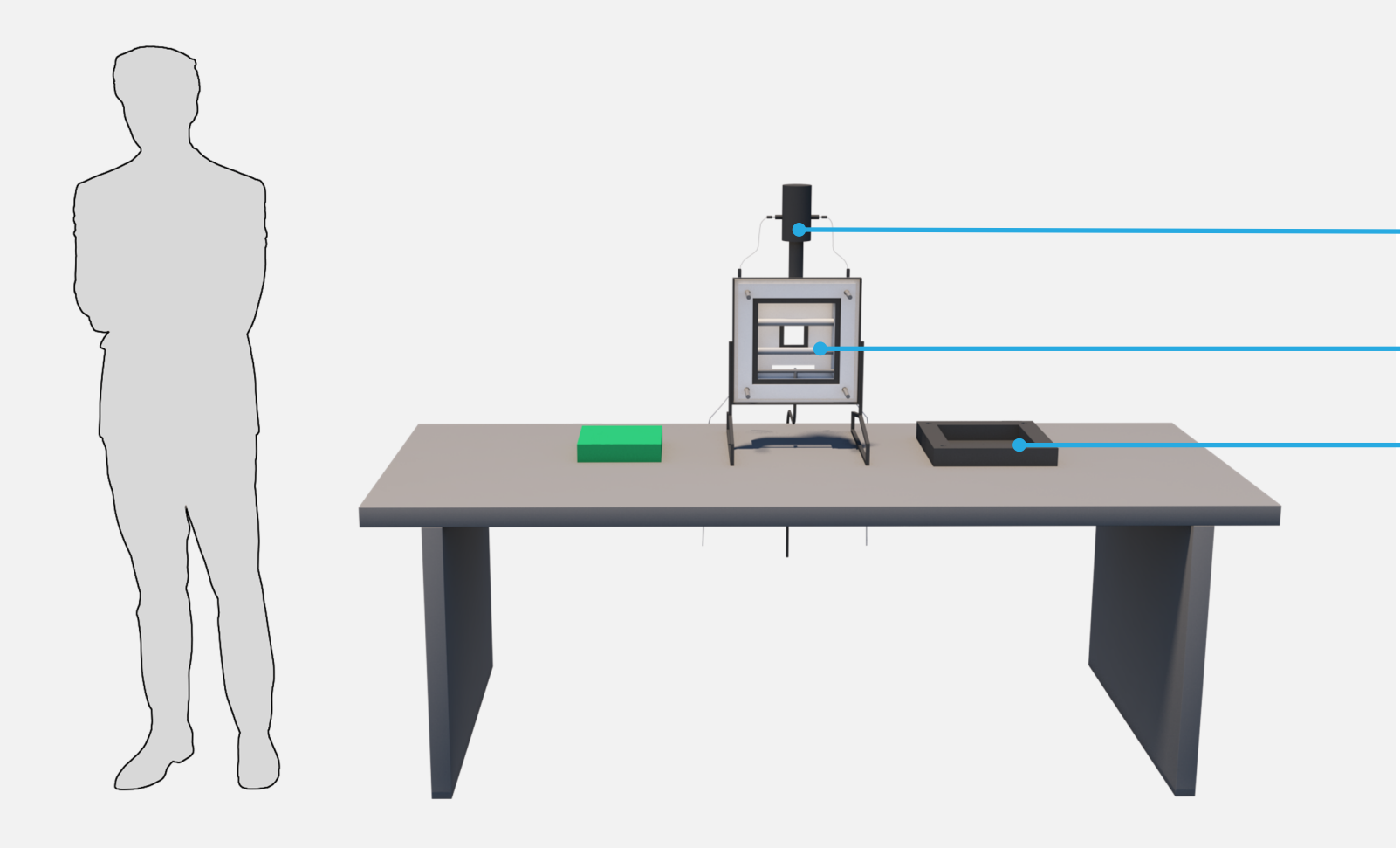
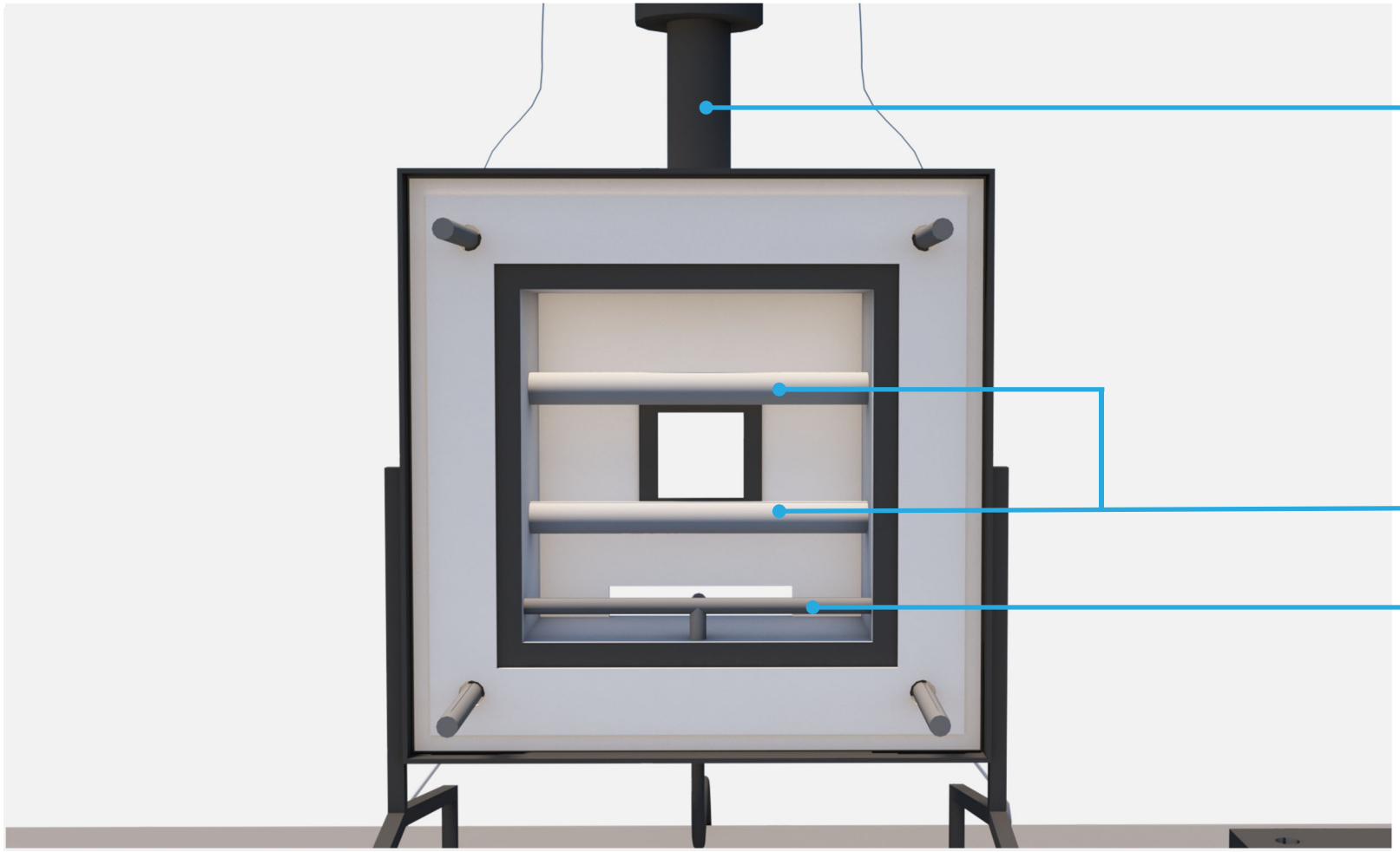


BS 476-6- combustion chamber design

ARUP



BS 476-6- combustion chamber design

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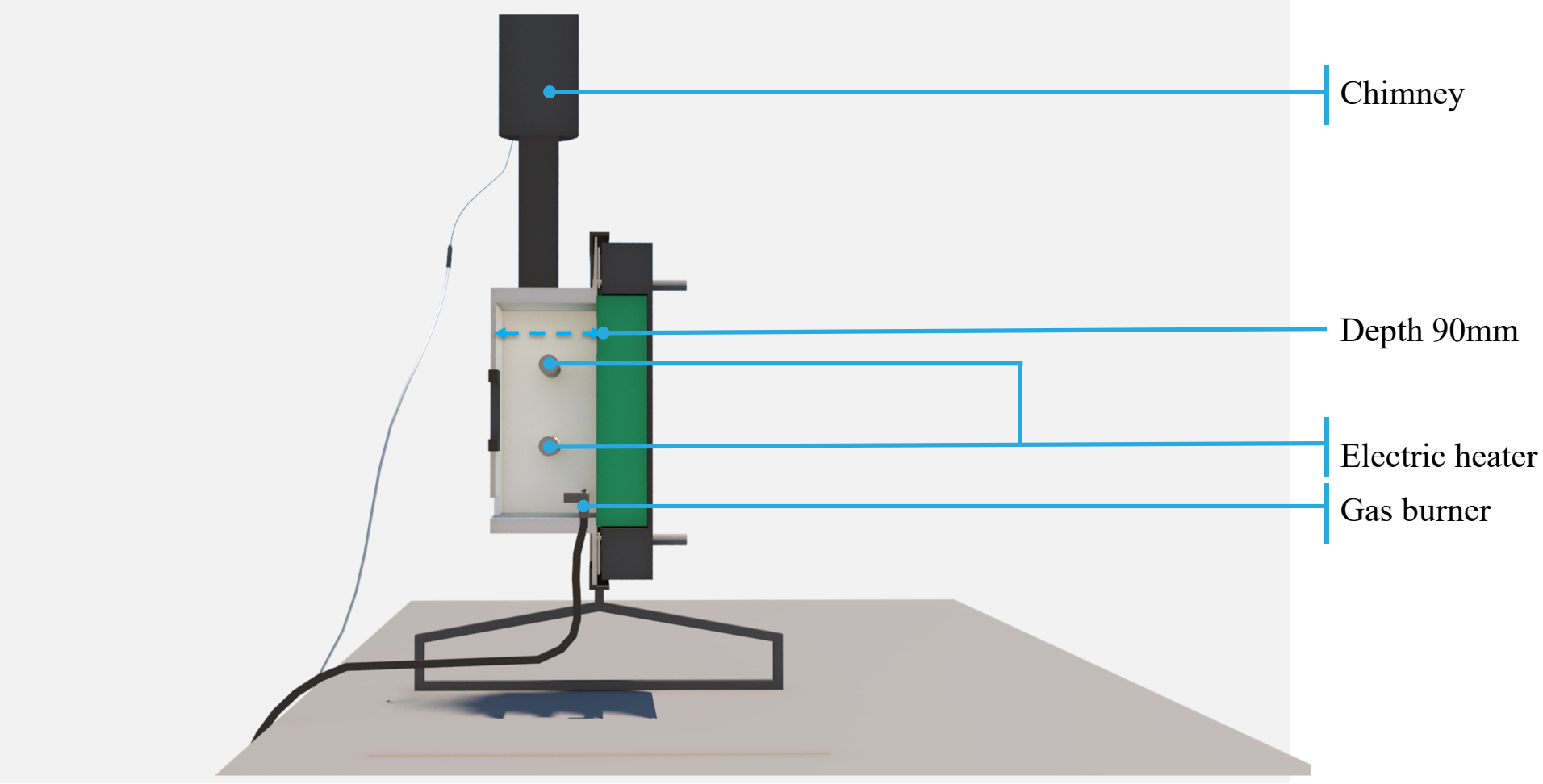

BS 476-6 combustion chamber design

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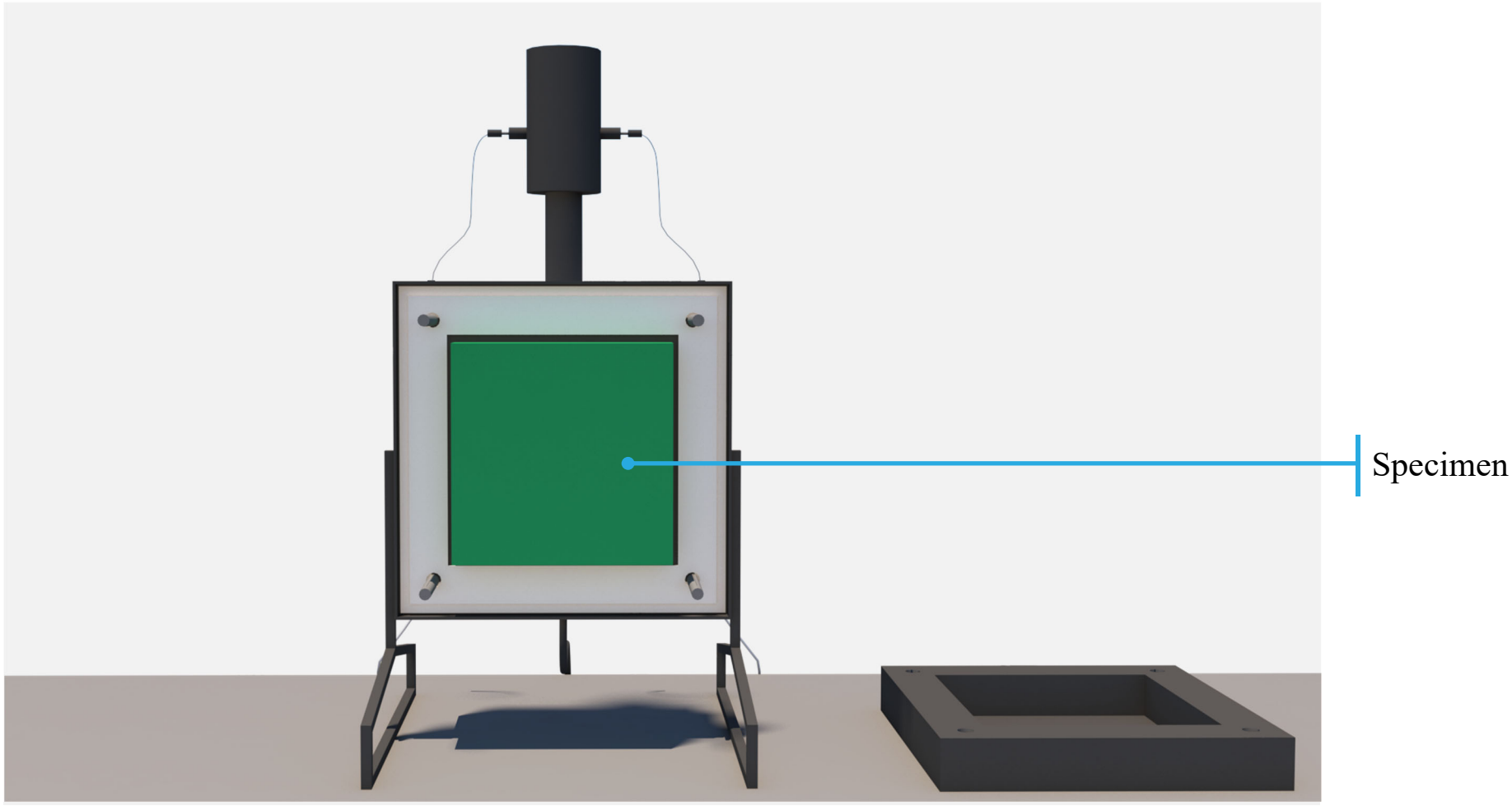


BS 476-6 – Substrate and other specimens requirements

ARUP

"Annex B 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."

BS 476-6 – Substrate and other specimens requirements

ARUP

"The following 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/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 specimen holder.

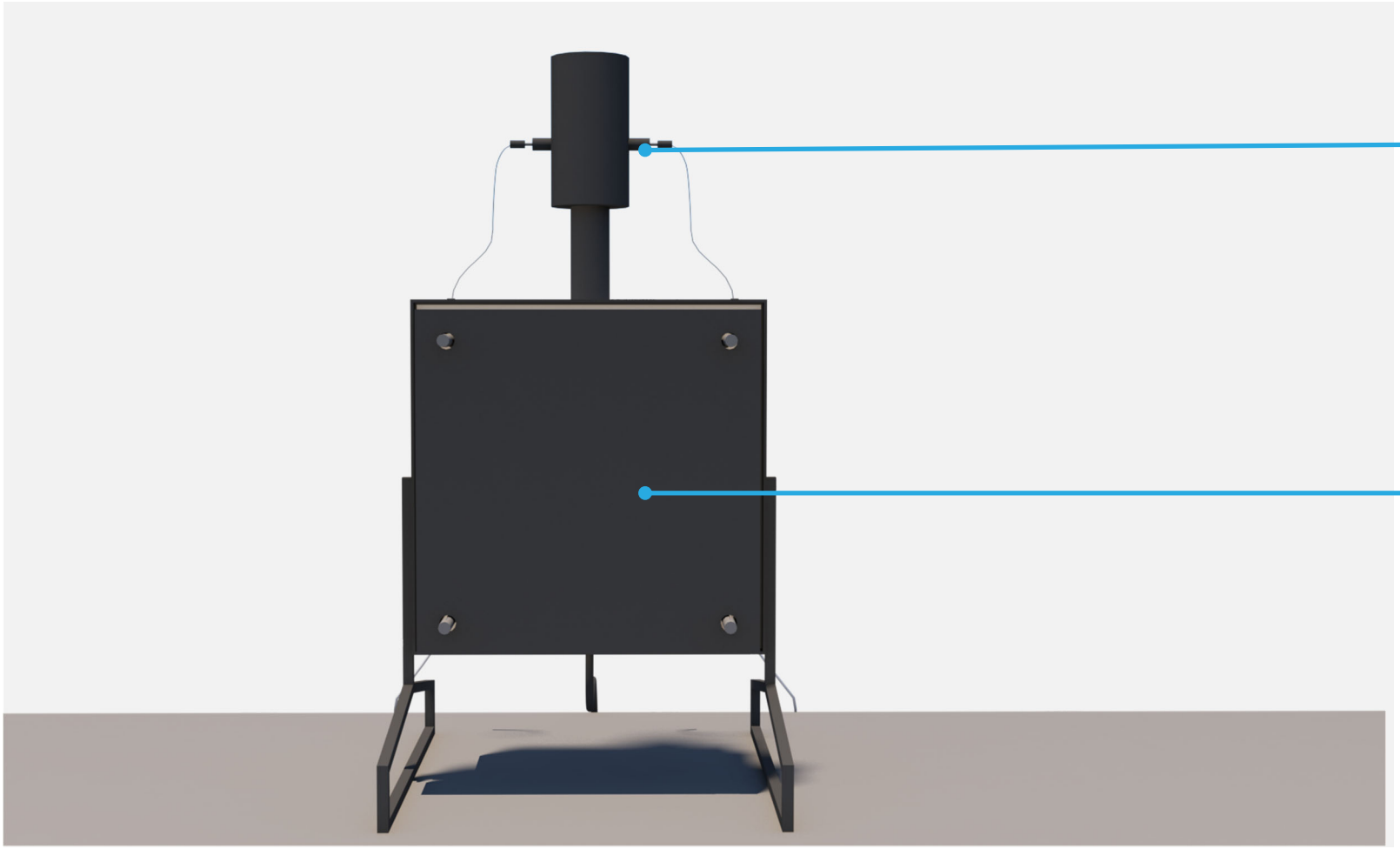
b. where the product is normally used as a free-standing sheet and the characteristics noted in a) do not apply, then an air space should be provided at the back of the product by testing over non-combustible perimeter battens 20 mm wide and 12.5 mm thick.

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."

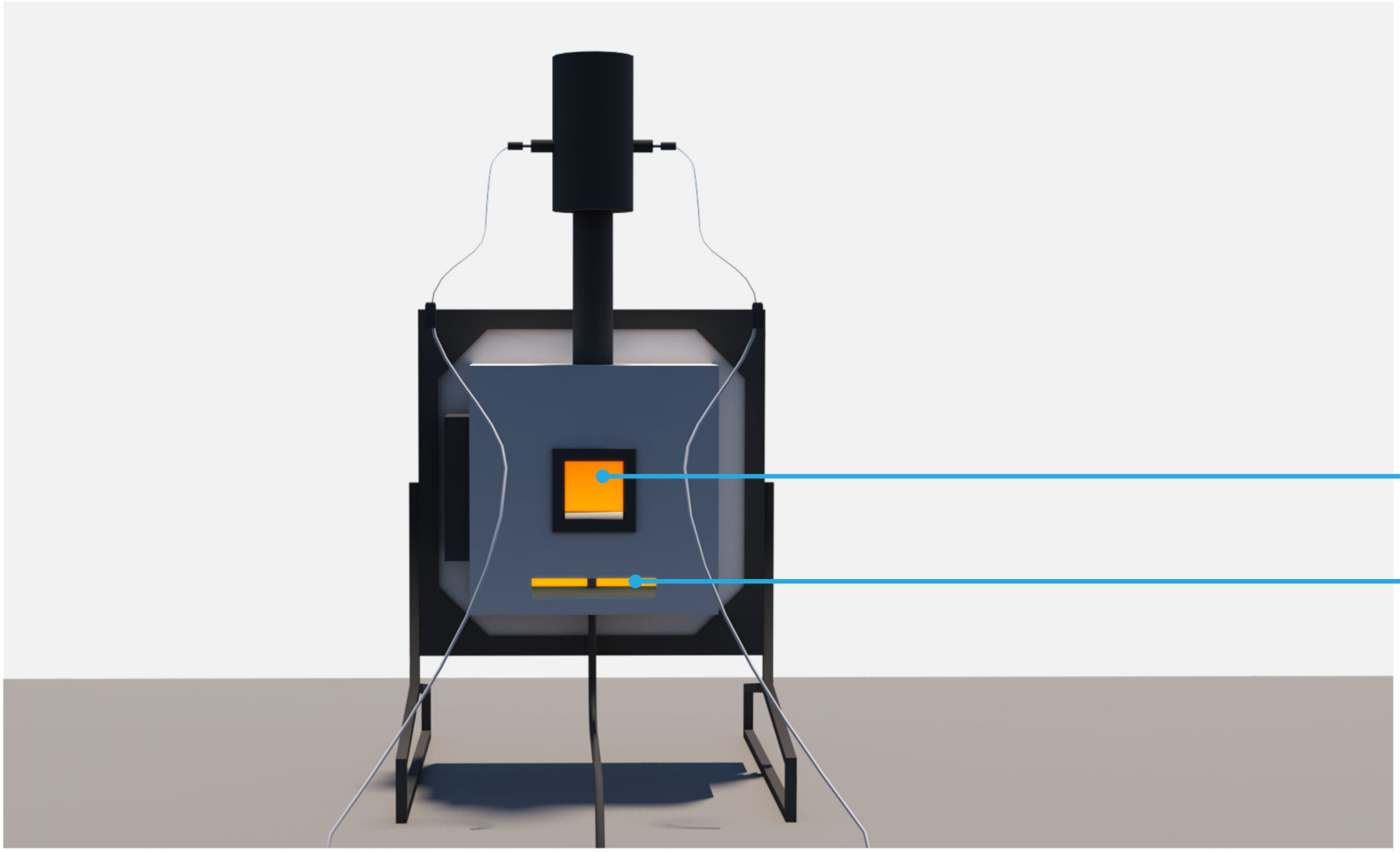
BS 476-6 combustion chamber design

ARUP



BS 476-6- combustion chamber design

ARUP



BS 476-6 – specimen

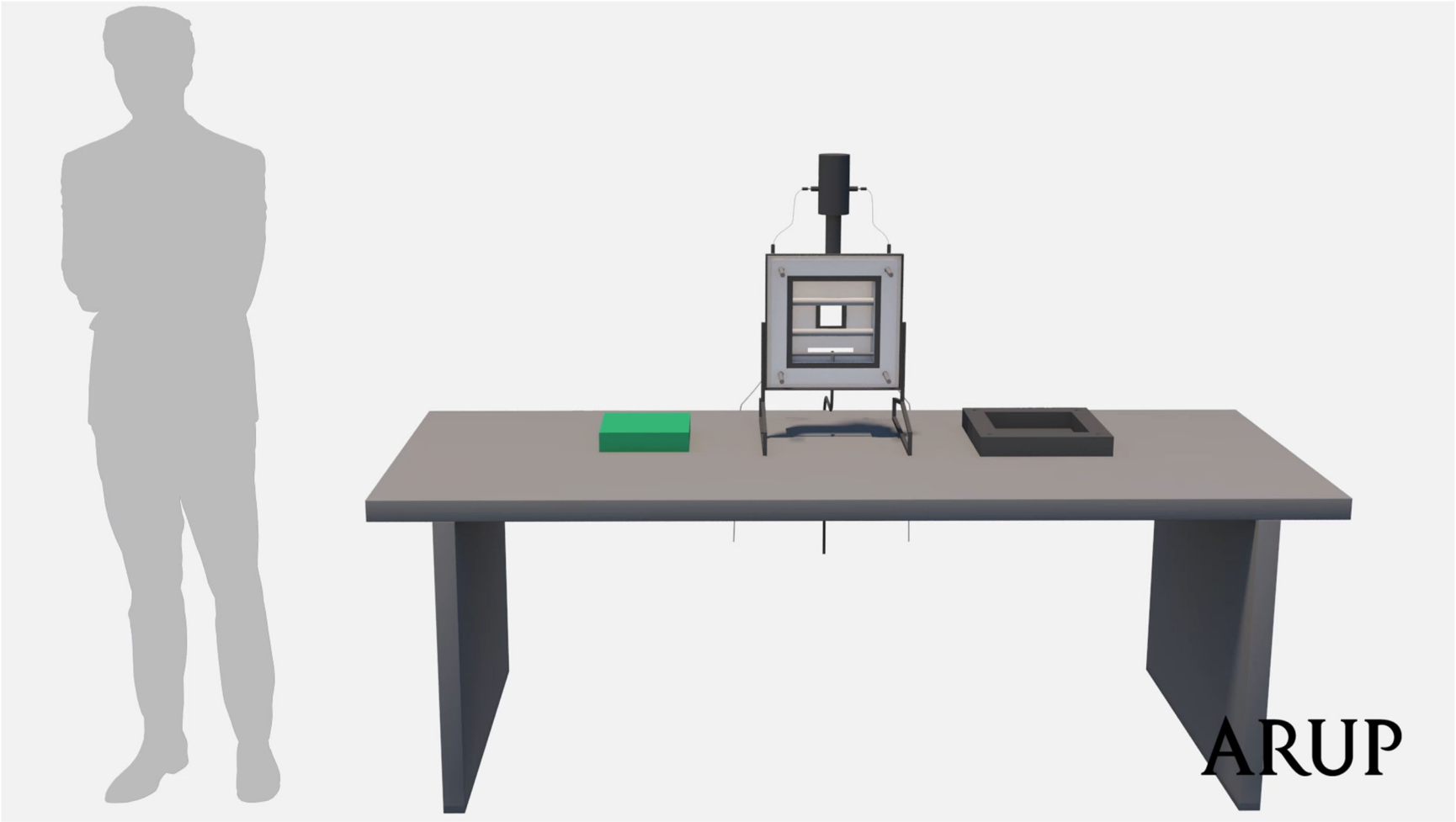
ARUP

Calcium Silicate Board

Specimen to be tested

BS 476-6 – test methodology

ARUP



BS 476-6 – temperature measurements taken

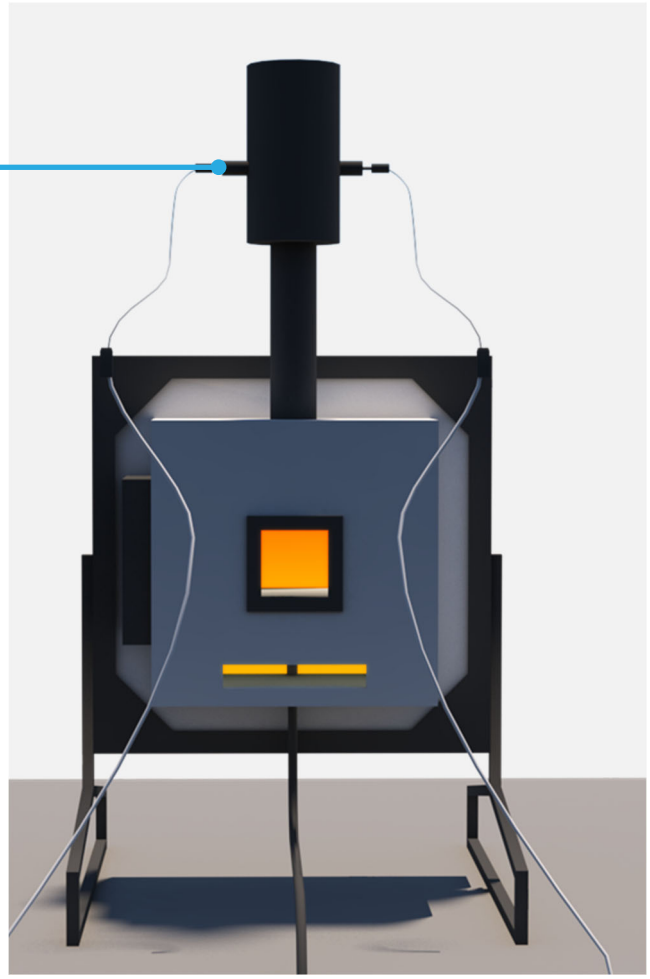
ARUP

The output from the two thermocouples located in the chimney is recorded at:

a) 0.5 min intervals, up to and including 3 min form the time at which the gas was ignited

b) 1 min intervals, up to and including 10 min from the time at which the gas was ignited

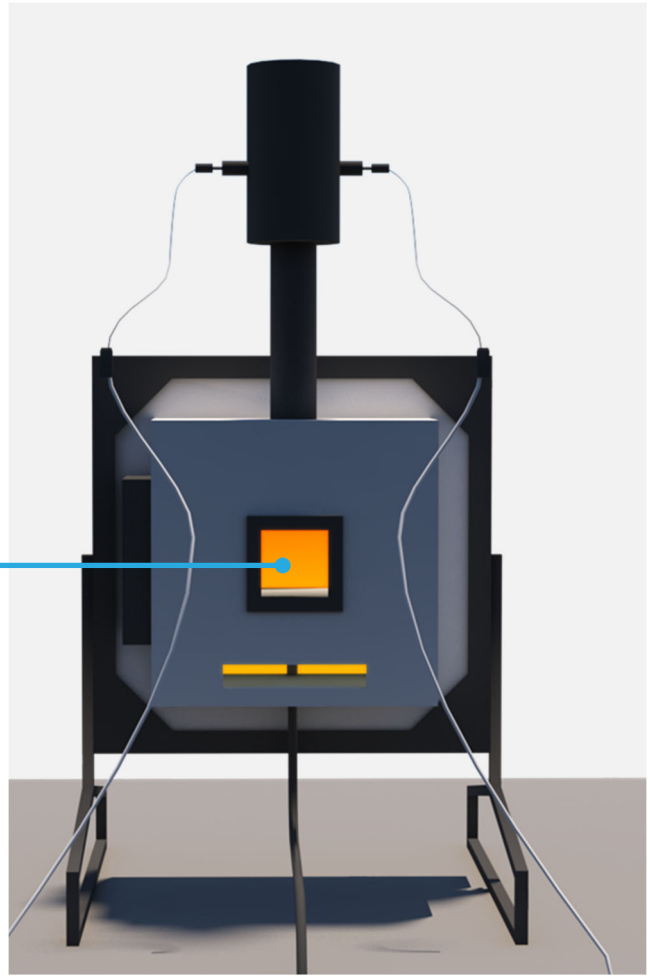
c) 2 min intervals, up to and including 20 min from the time at which the gas was ignited



BS 476-6 – visual observation made

ARUP

- Visual observation of intumescence or deformation or spalling of the specimen that tends to block the burner ports so that the required gas input cannot be maintained;
- Visual observation of melting or slumping of the specimen that results in material escaping from the air inlet or being confined to the recess of the specimen holder, where it is not exposed to the heating conditions;
- Visual observation of air flow through the apparatus being restricted owing to obstruction of the inlet port by fallen material or by soot accumulation in the chimney.



BS 476-6 – Output from test

ARUP

10.3 Fire propagation index

The index of overall performance, l (fire propagation index), of the product shall be calculated from the individual results of each test as follows:

$$l = i_1 + i_2 + i_3$$

where i_1, i_2 and i_3 are given by the expressions

$$i_1 = {}^1/_3 \left[(s_1)_A + (s_1)_B + (s_1)_C\right]$$

$$i_2 = {}^1/_3 \left[(s_2)_A + (s_2)_B + (s_2)_C\right]$$

$$i_3 = {}^1/_3 \left[(s_3)_A + (s_3)_B + (s_3)_C\right]$$

13 The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:

a. composed throughout of materials of limited combustibility; or

b. a Class 1 material which has a fire propagation index (I) of not more than 12 and sub-index (i1) of not more than 6.

Note: Class 0 is not a classification identified in any British Standard test.

BS 476-6 – Interpretation of results

ARUP

c) air flow through the apparatus being restricted owing to obstruction of the inlet port by fallen material or by soot accumulation in the chimney.

Occurrence of any of the above phenomena shall deem the test on that specimen to be invalid.

10 Calculation of results

10.1 Test results

The fire propagation index and the individual subindices for each specimen shall be calculated to the first decimal place from valid test results obtained on three specimens (see **9.1.6**).

10.2 Index of performance of specimens

The index of performance, S, for each of the specimens tested shall be calculated from the subindices, s_1, s_2 and s_3, according to the respective temperature ranges as follows:

$$S = s_1 + s_2 + s_3$$

where

s_1, s_2 and s_3 are given by the expressions

$$s_1 = \sum_{t\,=\,0.5}^{t\,=\,3} \frac{\theta_s - \theta_c}{10t}$$

$$s_2 = \sum_{t\,=\,4}^{t\,=\,10} \frac{\theta_s - \theta_c}{10t}$$

$$s_3 = \sum_{t\,=\,12}^{t\,=\,20} \frac{\theta_s - \theta_c}{10t}$$

where

θ_s is as defined in **9.1.5**;

θ_c is as defined in **8.3.9**;

t is as defined in **8.3.9**.

Only positive values of $(\theta_s - \theta_c)$ shall be used in the calculation.

10.3 Fire propagation index

The index of overall performance, I (fire propagation index), of the product shall be calculated from the individual results of each test as follows:

$$I = i_1 + i_2 + i_3$$

where i_1, i_2 and i_3 are given by the expressions

$$i_1 = {}^1/_3\,[(s_1)_A + (s_1)_B + (s_1)_C]$$

$$i_2 = {}^1/_3\,[(s_2)_A + (s_2)_B + (s_2)_C]$$

$$i_3 = {}^1/_3\,[(s_3)_A + (s_3)_B + (s_3)_C]$$

where

A, B and C represent individual specimens giving valid test results;

s_1, s_2 and s_3 are as defined in **10.2**.

NOTE The indices of performance are calculated to the first decimal point. Although they are therefore stated with this precision there is no suggestion that this degree of accuracy is achieved by the test.

10.4 Expression of results

10.4.1 The fire propagation index shall be stated without a suffix where the first three specimens tested give valid results.

10.4.2 The fire propagation index shall be stated with a suffix "R" where four or five specimens have to be tested to obtain three valid results.

10.4.3 Where less than three valid results are obtained from five specimens, no fire propagation index shall be stated and the product shall be designated "unsuitable for assessment by this method".

11 Test report

The test report shall quote the individual results obtained for each specimen tested. Any observations made during the test and comments on any difficulties experienced during testing as described in **9.2** shall also be given, together with the following.

a) name and address of testing laboratory;

b) name and address of sponsor;

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

d) date of test;

e) full description of the product tested sufficient to describe its construction and to allow its identification. Different materials will need to be described in different ways but the description shall always contain sufficient information to allow the product to be accurately identified and differentiated from other similar products.

All the components of the specimen shall be described and the description shall include as much information as possible, including the following where applicable:

1) trade name(s);

2) generic identification of material(s);

3) thickness(es);

4) density(ies) or mass(es) per unit area;

5) details that may be significant to the fire performance of the material, e.g. type and level of any flame retardant treatment;

10.2 Index of performance of specimens

The index of performance, S, for each of the specimens tested shall be calculated from the subindices, s_1, s_2 and s_3, according to the respective temperature ranges as follows:

$$S = s_1 + s_2 + s_3$$

where

s_1, s_2 and s_3 are given by the expressions

$$s_1 = \sum_{t\,=\,0.5}^{t\,=\,3} \frac{\theta_s - \theta_c}{10t}$$

$$s_2 = \sum_{t\,=\,4}^{t\,=\,10} \frac{\theta_s - \theta_c}{10t}$$

$$s_3 = \sum_{t\,=\,12}^{t\,=\,20} \frac{\theta_s - \theta_c}{10t}$$

where

θ_s is as defined in **9.1.5**;

θ_c is as defined in **8.3.9**;

t is as defined in **8.3.9**.

Only positive values of $(\theta_s - \theta_c)$ shall be used in the calculation.

10.3 Fire propagation index

The index of overall performance, I (fire propagation index), of the product shall be calculated from the individual results of each test as follows:

$$I = i_1 + i_2 + i_3$$

where i_1, i_2 and i_3 are given by the expressions

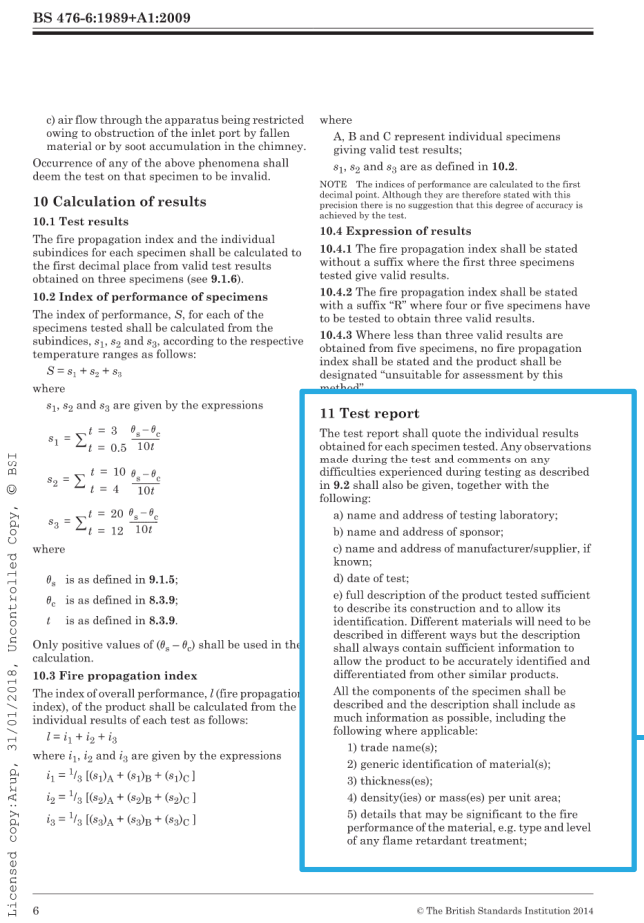
$$i_1 = {}^1/_3\,[(s_1)_A + (s_1)_B + (s_1)_C]$$

$$i_2 = {}^1/_3\,[(s_2)_A + (s_2)_B + (s_2)_C]$$

$$i_3 = {}^1/_3\,[(s_3)_A + (s_3)_B + (s_3)_C]$$

BS 476-6 – Test report requirements

ARUP



BS 476-6:1989+A1:2009

c) air flow through the apparatus being restricted owing to obstruction of the inlet port by fallen material or by soot accumulation in the chimney.

Occurrence of any of the above phenomena shall deem the test on that specimen to be invalid.

10 Calculation of results

10.1 Test results

The fire propagation index and the individual subindices for each specimen shall be calculated to the first decimal place from valid test results obtained on three specimens (see **9.1.6**).

10.2 Index of performance of specimens

The index of performance, S, for each of the specimens tested shall be calculated from the subindices, s_1, s_2 and s_3, according to the respective temperature ranges as follows:

$$S = s_1 + s_2 + s_3$$

where

s_1, s_2 and s_3 are given by the expressions

$$s_1 = \sum_{t=0.5}^{t=3} \frac{\theta_s - \theta_c}{10t}$$

$$s_2 = \sum_{t=4}^{t=10} \frac{\theta_s - \theta_c}{10t}$$

$$s_3 = \sum_{t=12}^{t=20} \frac{\theta_s - \theta_c}{10t}$$

where

θ_s is as defined in **9.1.5**;

θ_c is as defined in **8.3.9**;

t is as defined in **8.3.9**.

Only positive values of $(\theta_s - \theta_c)$ shall be used in the calculation.

10.3 Fire propagation index

The index of overall performance, I (fire propagation index), of the product shall be calculated from the individual results of each test as follows:

$$I = i_1 + i_2 + i_3$$

where i_1, i_2 and i_3 are given by the expressions

$$i_1 = {}^1/_3\,[(s_1)_A + (s_1)_B + (s_1)_C]$$

$$i_2 = {}^1/_3\,[(s_2)_A + (s_2)_B + (s_2)_C]$$

$$i_3 = {}^1/_3\,[(s_3)_A + (s_3)_B + (s_3)_C]$$

where

A, B and C represent individual specimens giving valid test results;

s_1, s_2 and s_3 are as defined in **10.2**.

NOTE The indices of performance are calculated to the first decimal point. Although they are therefore stated with this precision there is no suggestion that this degree of accuracy is achieved by the test.

10.4 Expression of results

10.4.1 The fire propagation index shall be stated without a suffix where the first three specimens tested give valid results.

10.4.2 The fire propagation index shall be stated with a suffix "R" where four or five specimens have to be tested to obtain three valid results.

10.4.3 Where less than three valid results are obtained from five specimens, no fire propagation index shall be stated and the product shall be designated "unsuitable for assessment by this method".

11 Test report

The test report shall quote the individual results obtained for each specimen tested. Any observations made during the test and comments on any difficulties experienced during testing as described in **9.2** shall also be given, together with the following:

a) name and address of testing laboratory;

b) name and address of sponsor;

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

d) date of test;

e) full description of the product tested sufficient to describe its construction and to allow its identification. Different materials will need to be described in different ways but the description shall always contain sufficient information to allow the product to be accurately identified and differentiated from other similar products.

All the components of the specimen shall be described and the description shall include as much information as possible, including the following where applicable:

1) trade name(s);

2) generic identification of material(s);

3) thickness(es);

4) density(ies) or mass(es) per unit area;

5) details that may be significant to the fire performance of the material, e.g. type and level of any flame retardant treatment;

6

11 Test report

The test report shall quote the individual results obtained for each specimen tested. Any observations made during the test and comments on any difficulties experienced during testing as described in **9.2** shall also be given, together with the following:

a) name and address of testing laboratory;

b) name and address of sponsor;

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

d) date of test;

e) full description of the product tested sufficient to describe its construction and to allow its identification. Different materials will need to be described in different ways but the description shall always contain sufficient information to allow the product to be accurately identified and differentiated from other similar products.

All the components of the specimen shall be described and the description shall include as much information as possible, including the following where applicable:

1) trade name(s);

2) generic identification of material(s);

3) thickness(es);

4) density(ies) or mass(es) per unit area;

5) details that may be significant to the fire performance of the material, e.g. type and level of any flame retardant treatment;

f) details of the form in which the specimens were tested (material, composite or assembly), together with specimen thickness and, where appropriate, orientation, backing material and the face or faces subjected to the test and whether the material was tested in a modified form;

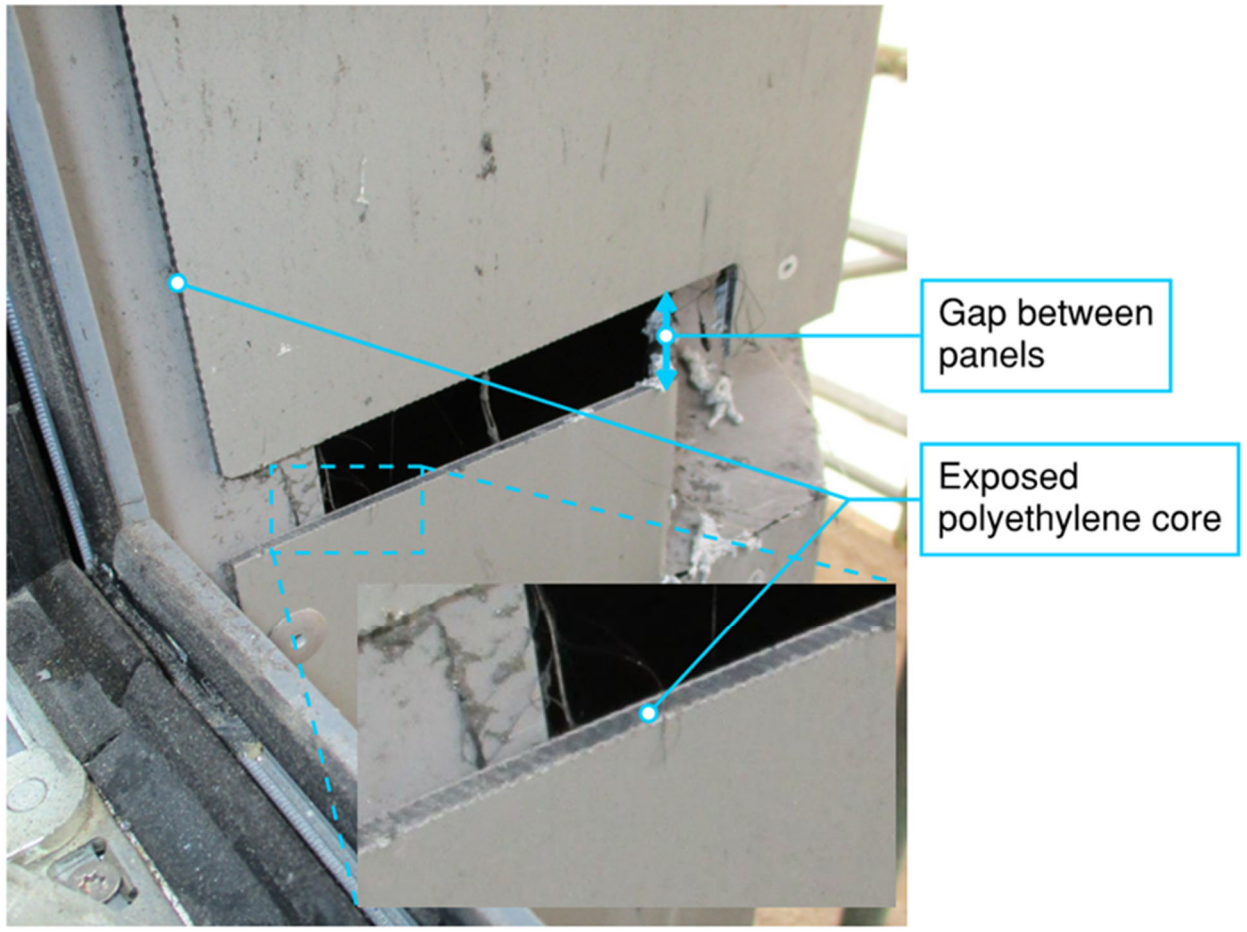
g) the fire propagation index, I, for the product, with the suffix "R" if appropriate, and the subindices i_1 and i_2;

h) the statement that the suffix "R" to the fire propagation index indicates that the results should be treated with caution;

i) 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".

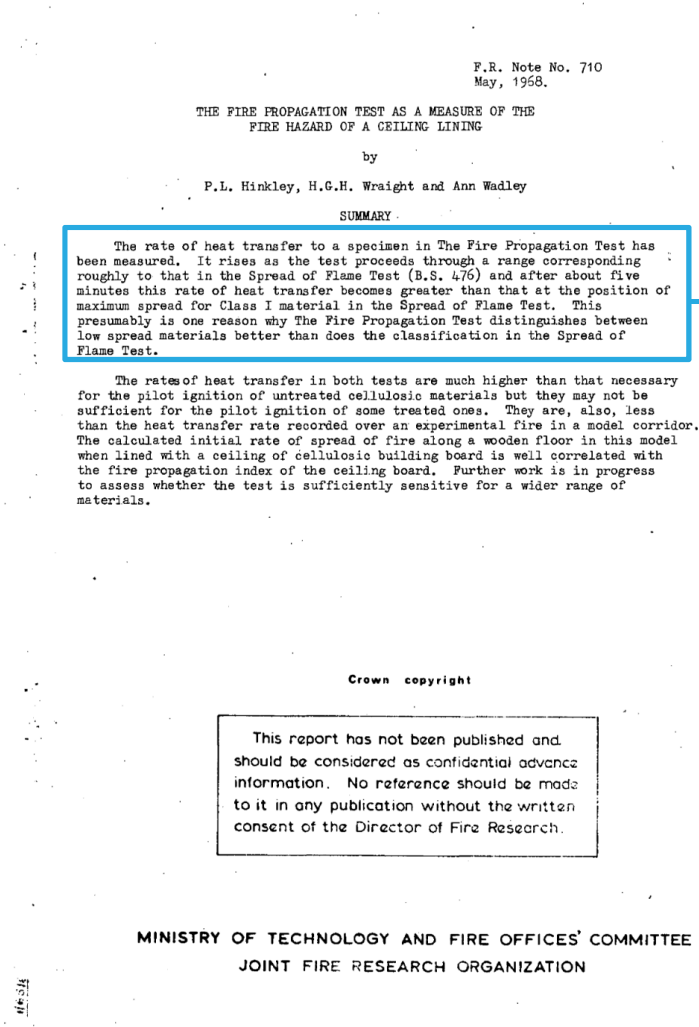
BS 476-6 – Relevance of no edge exposure and the overall heating dose

ARUP



Fire Note 710 – rate of heat transfer to a tested specimen

ARUP



F.R. Note No. 710
May, 1968.

THE FIRE PROPAGATION TEST AS A MEASURE OF THE FIRE HAZARD OF A CEILING LINING

by

P.L. Hinkley, H.G.H. Wraight and Ann Wadley

SUMMARY

The rate of heat transfer to a specimen in The Fire Propagation Test has been measured. It rises as the test proceeds through a range corresponding roughly to that in the Spread of Flame Test (B.S. 476) and after about five minutes this rate of heat transfer becomes greater than that at the position of maximum spread for Class I material in the Spread of Flame Test. This presumably is one reason why The Fire Propagation Test distinguishes between low spread materials better than does the classification in the Spread of Flame Test.

The rates of heat transfer in both tests are much higher than that necessary for the pilot ignition of untreated cellulosic materials but they may not be sufficient for the pilot ignition of some treated ones. They are, also, less than the heat transfer rate recorded over an experimental fire in a model corridor. The calculated initial rate of spread of fire along a wooden floor in this model when lined with a ceiling of cellulosic building board is well correlated with the fire propagation index of the ceiling board. Further work is in progress to assess whether the test is sufficiently sensitive for a wider range of materials.

MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

"The rate of heat transfer to a specimen in The Fire Propagation Test has been measured."

BS 476-6 – what heat is received by the specimen tested?

ARUP

This formula ensures that an increase in temperature (over that obtained during the calibrations) which occurs at the beginning of a test is very heavily weighted compared with one occurring later on. The weighting is justified in principle because the relative contribution of a combustible lining to the spread of fire in a compartment is greatest if the heat output from the lining occurs early in the spread when the heat output from the other combustible materials in the compartment is small.

The "gross" rate of heat transfer* to the centre of an asbestos wood specimen was measured by a method similar to that described by Christensen et al[4] and

* Defined as the algebraic sum of the rates of heat transfer(1) into the specimen by conduction (2) from the surface by radiation (3) from the surface by convection.

are shown in Fig. 1. Due to the gas jets alone it was about 0.5W/cm^2, however, the flames impinged on a line below the centre of the specimen and the rate of heating locally may have been much higher[5], possibly 2.0W/cm^2. When the electric heaters were turned on the rate of heat transfer rose to more than 2.5W/cm^2; falling slightly when the power was reduced from 1800 watts to 1500 watts, but it subsequently rose steadily to about 5.0W/cm^2 after 20 minutes. The rate of heat transfer at this time was still rising.

The gross heat transfer rates will be higher for good insulators (because the heat loss through the walls of the combustion chamber will be less) although they will still be of the same order and will vary with time in much the same way as with an asbestos wood specimen. After a combustible specimen has ignited there will probably be a large increase in the gross heat transfer rate.

The "gross" rate of heat transfer to the centre of an asbestos wood specimen was measured by a method similar to that described by Christensen et al and are shown in· Fig. 1. Due to the gas jets alone it was about 0.5W/cm^2, however, the flames impinged on a line below the centre of the specimen and the rate of heating locally may have been much higher, possibly 2.0W/cm^2.

When the electric heaters were turned on the rate of heat transfer rose to more than 2.5W/cm^2 ; falling slightly when the power was reduced from 1800 watts to 1500 watts, but it subsequently rose steadily to about 5.0w/cm^2 after 20 minutes. The rate of heat transfer at this time was still rising."

BS 476-6 – example of received heat flux

ARUP

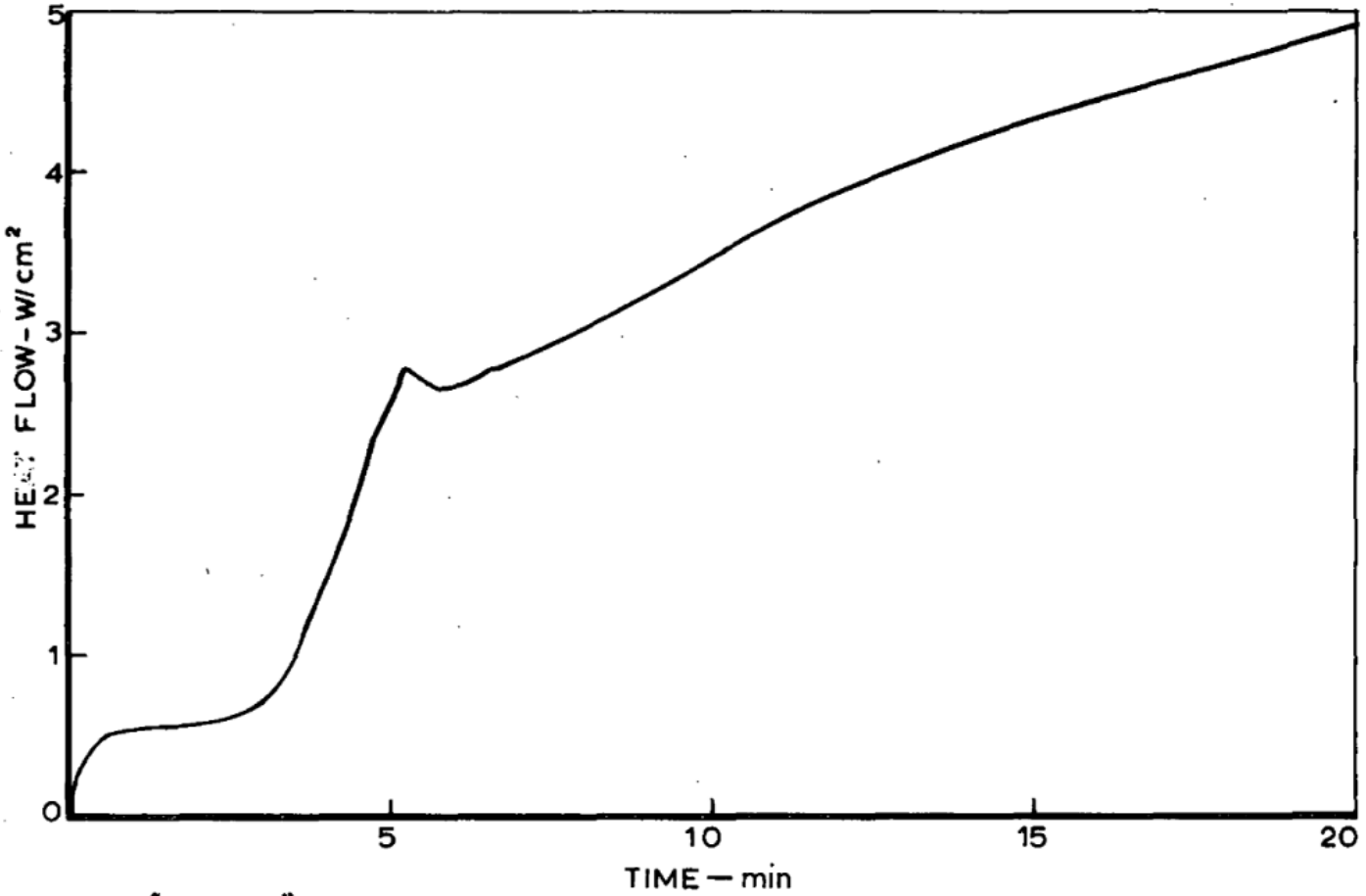
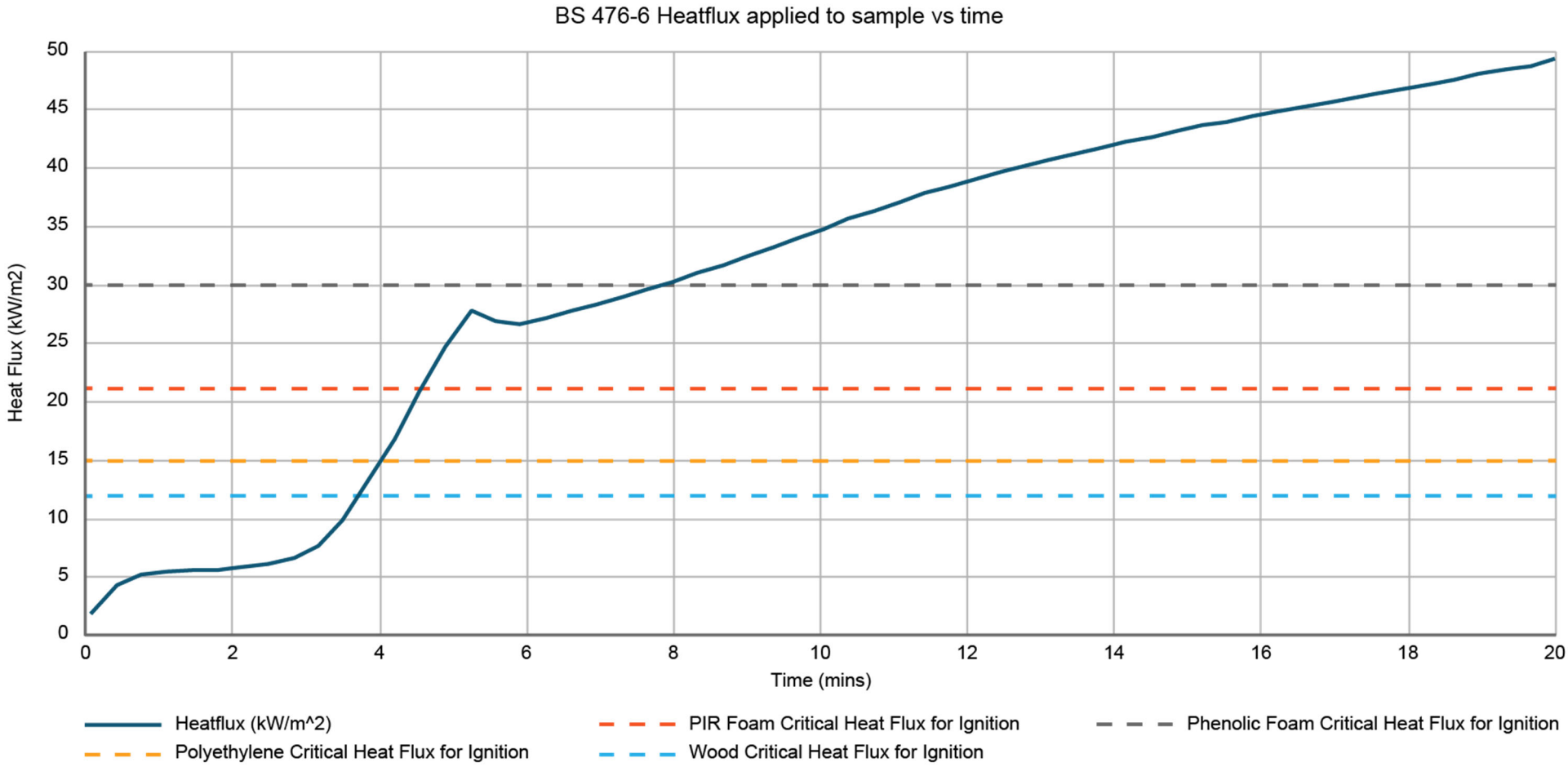


FIG.1. "GROSS" HEAT FLOW TO ASBESTOS WOOD IN FIRE PROPAGATION TEST

BS 476-6 – comparison with other materials

ARUP



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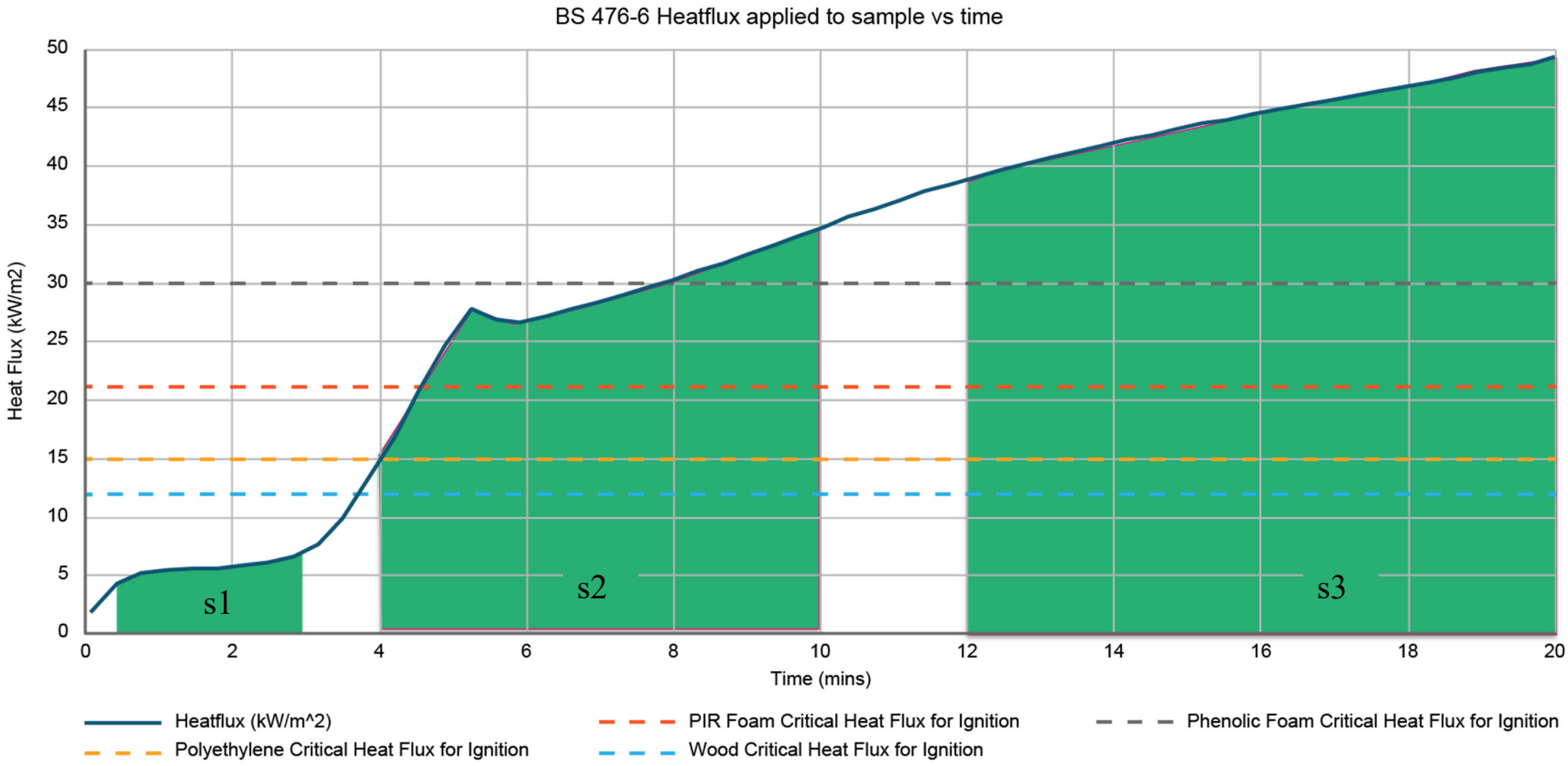
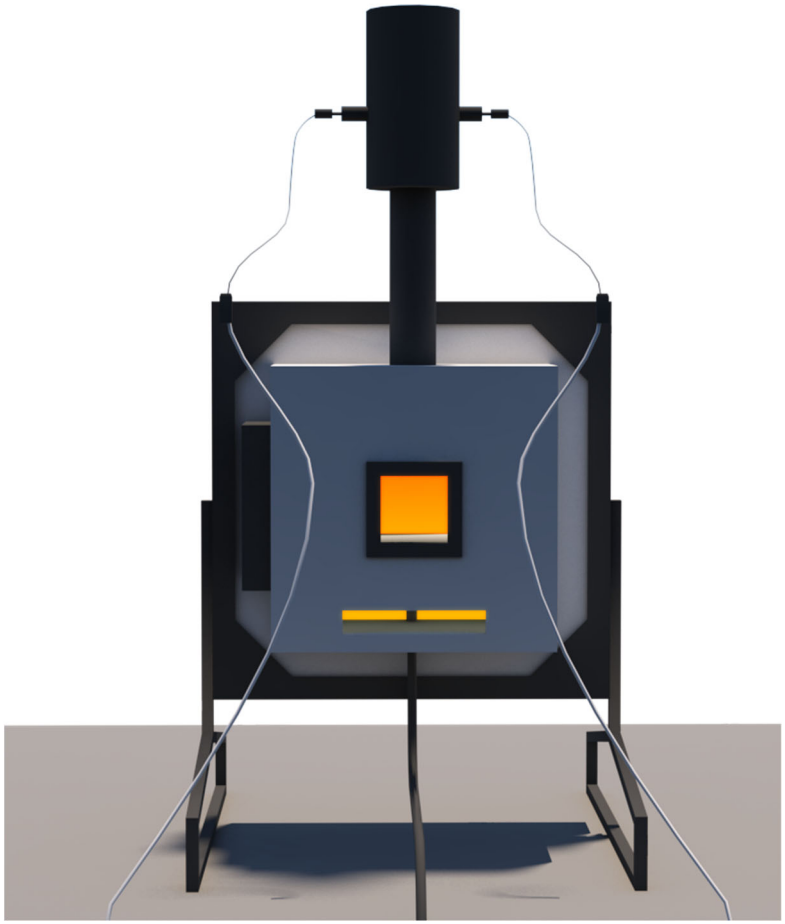
BS 476-6 – when are the sub indices measured?



BS 476-6 – Conclusions

ARUP



13 The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:

a. composed throughout of materials of limited combustibility; or

b. a Class 1 material which has a fire propagation index (I) of not more than 12 and sub-index (i1) of not more than 6.

Note: Class 0 is not a classification identified in any British Standard test.

ARUP


BRITISH STANDARD

BS 476-4:1970

Incorporating amendments issued March 1978 (AMD 2483), September 1983 (AMD 4390) and Corrigendum No. 1

CONFIRMED DECEMBER 2007

Fire tests on building materials and structures —

Part 4: Non-combustibility test for materials

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BS 476-4
Non-combustibility test for materials


BRITISH STANDARD

BS 476-6: 1989+A1:2009

Incorporating Corrigendum No. 1

Fire tests on building materials and structures –

Part 6: Method of test for fire propagation for products

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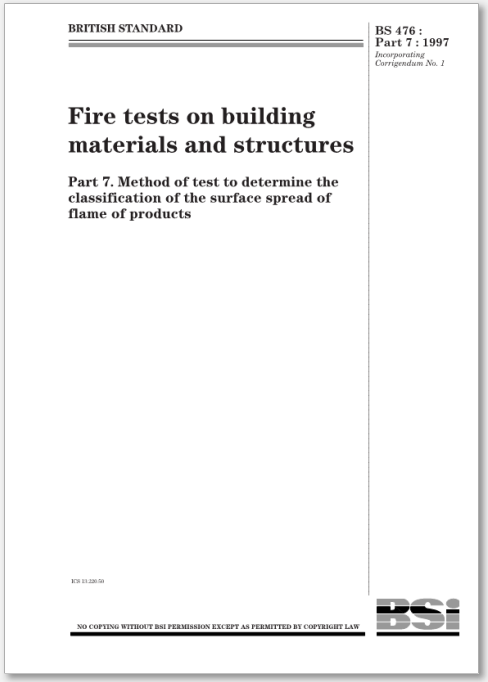
BS 476-6
Method of test for fire propagation for products


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

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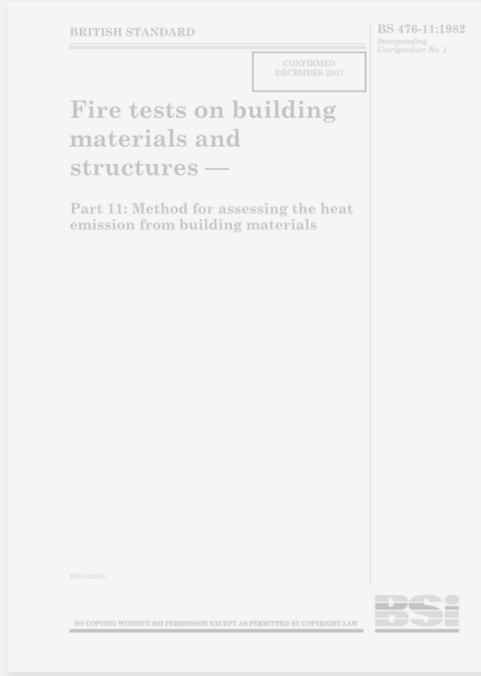
BS 476-7
Method of test to determine the classification of the surface spread of flame of products


BRITISH STANDARD

BS 476-11:1982

Incorporating Corrigendum No. 1

CONFIRMED DECEMBER 2007

Fire tests on building materials and structures —

Part 11: Method for assessing the heat emission from building materials

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BS 476-11
Method for assessing the heat emission from building materials

BS 476-7 – foreword

ARUP

Foreword

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.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

"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."

BS 476-7 – scope

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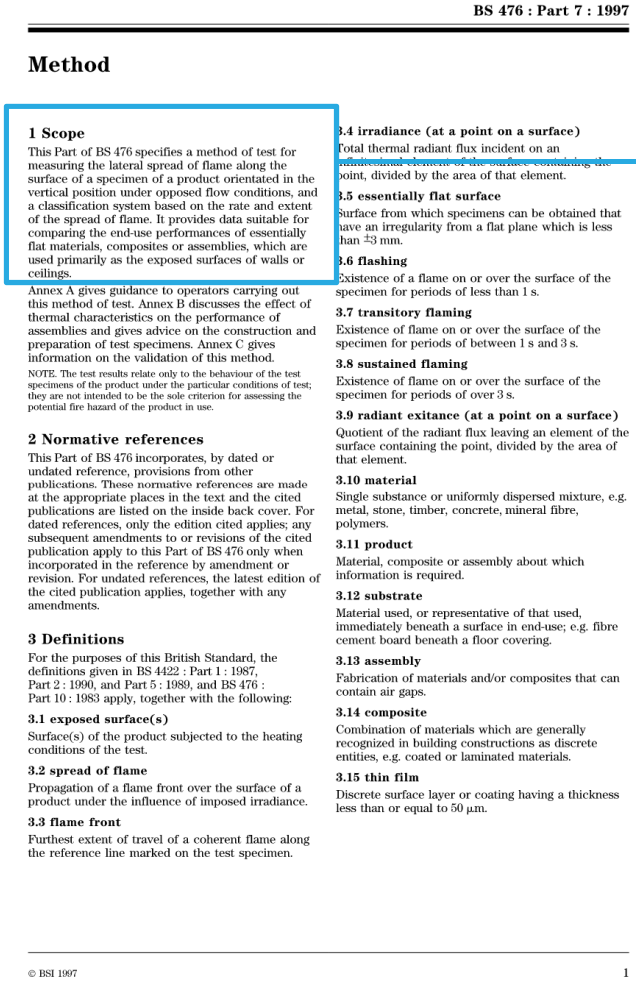


BS 476 : Part 7 : 1997

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 element 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.

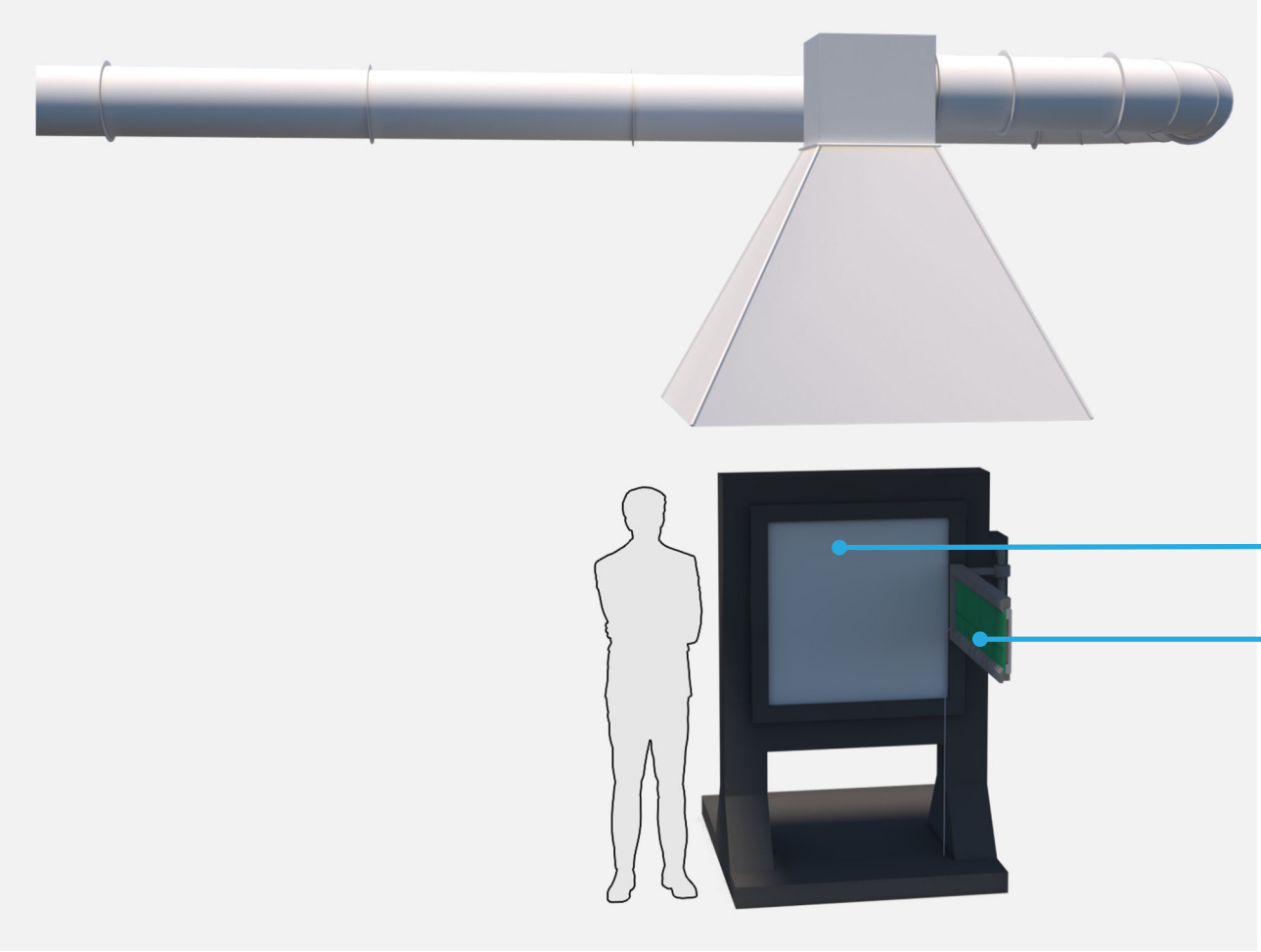
3.15 thin film

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

"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."

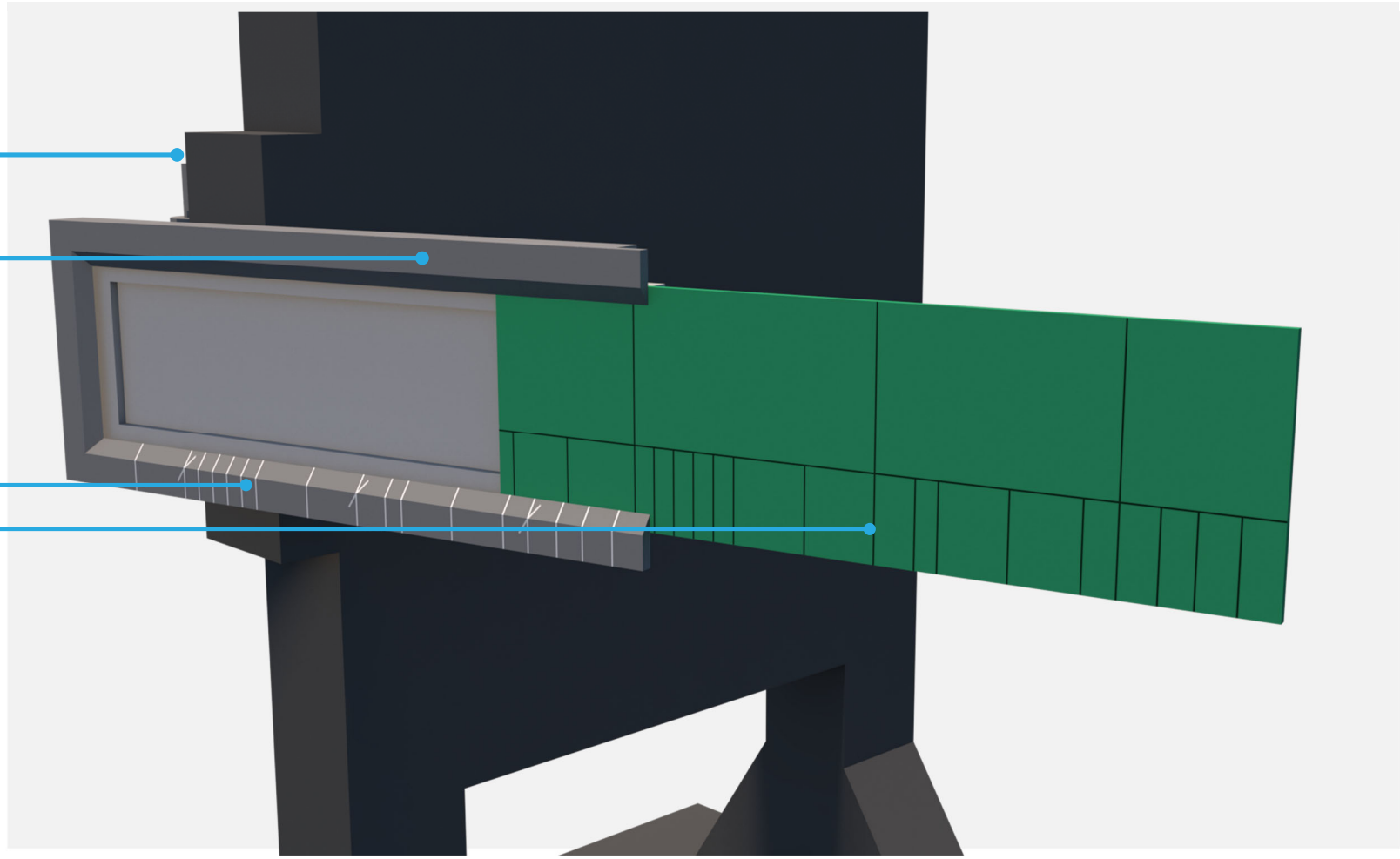
BS 476-7 – apparatus

ARUP



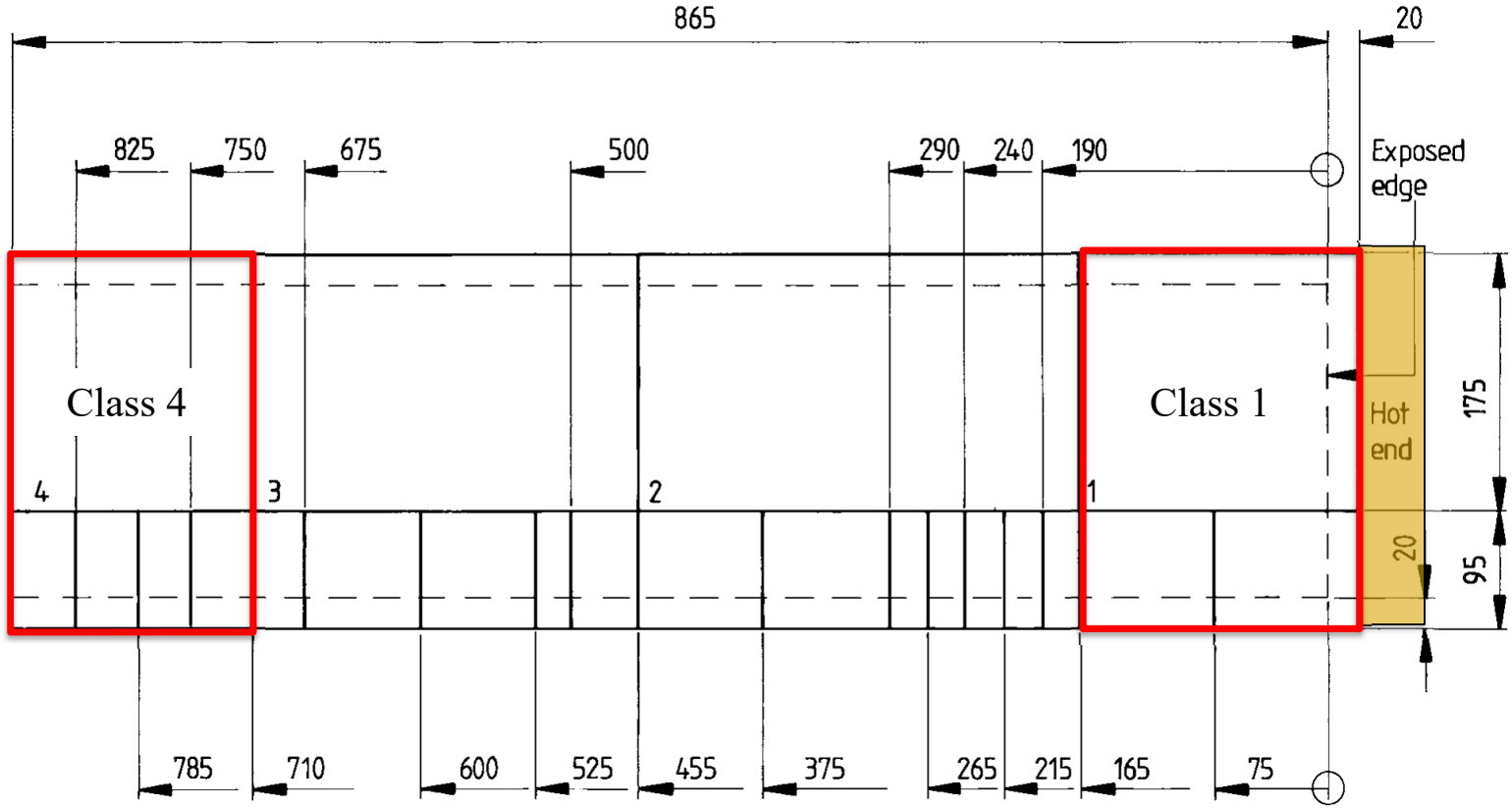
BS 476-7 – specimen

ARUP



BS 476-7 – reference lines

ARUP



Distances from inside edge of specimen holder

All dimensions are in millimetres

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

BS 476-7 –specimen requirements

ARUP

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.

BS 476-7 –specimen requirements continued

ARUP

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.

5.4.1 When the product is a thin film, it shall be applied 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.

BS 476-7 – Substrate and other specimens requirements

ARUP

Annex B 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.

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.

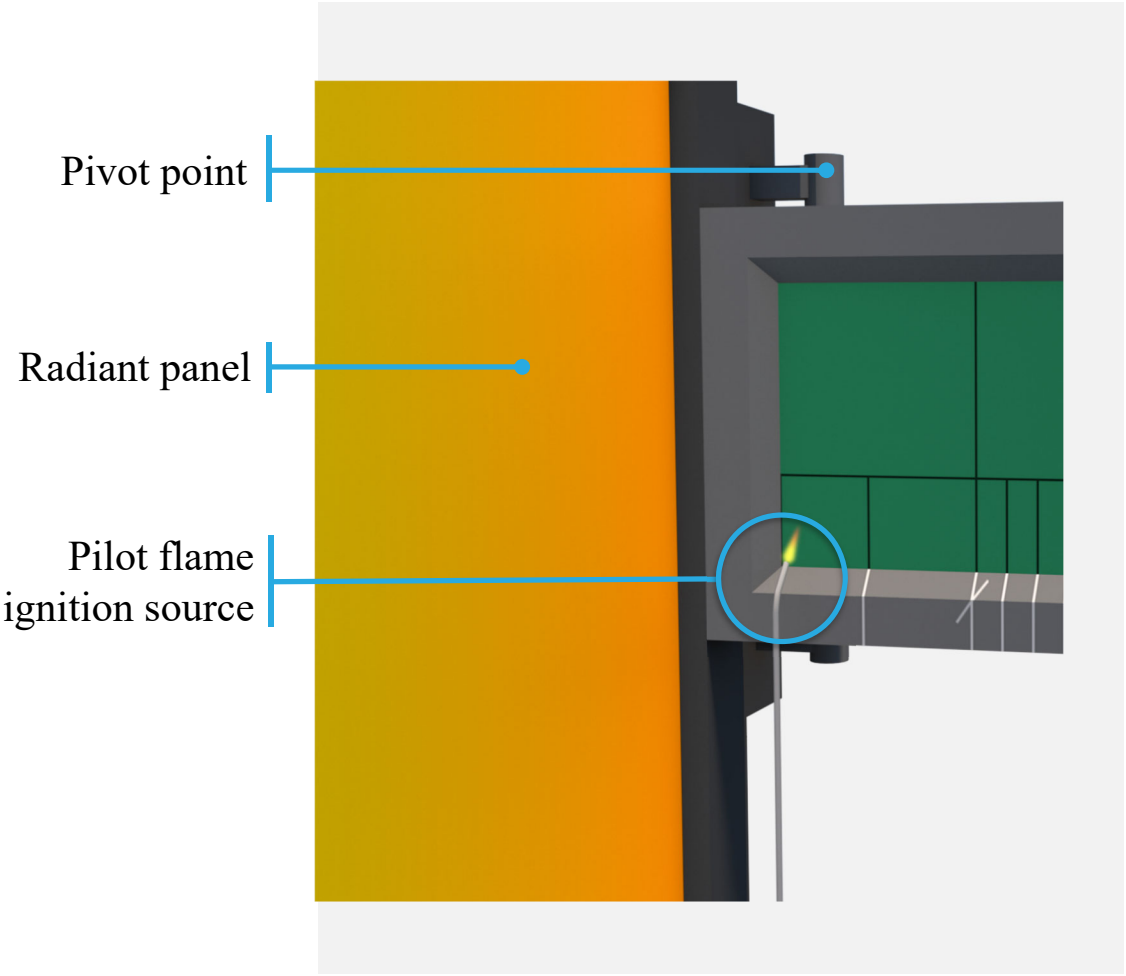
b) Where the product is normally used as a free-standing sheet and the characteristics noted in a) do not apply, then an air space should be provided at the back of the product by testing over spacers of non-combustible insulation board 20 mm wide and 25mm thick

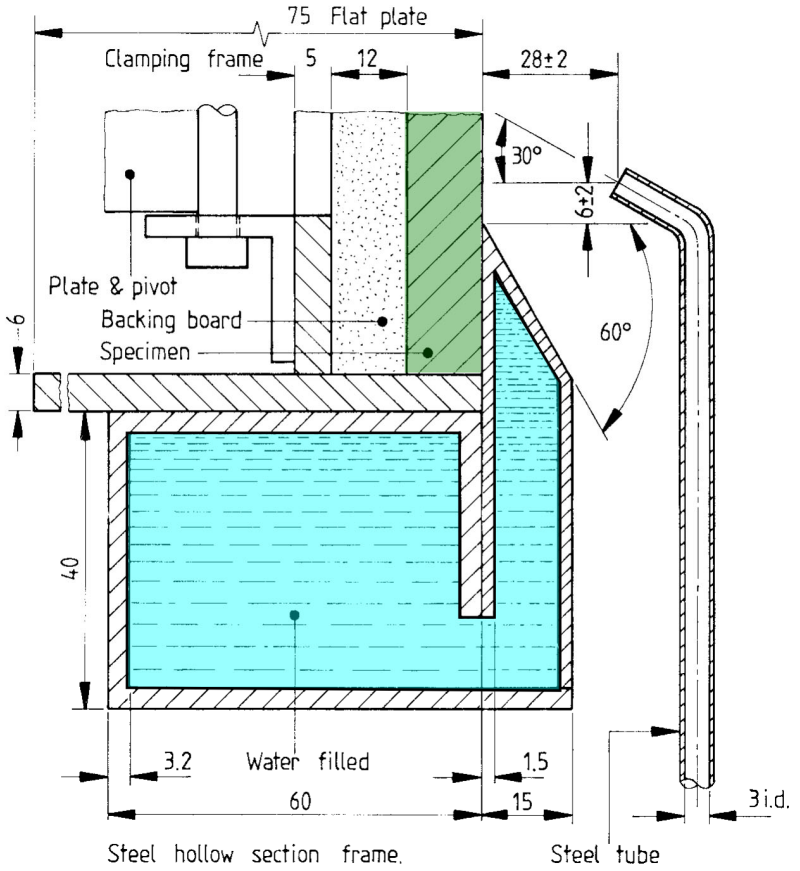
c) Where the product is to be used over a low density non-combustible substrate and the characteristics noted in a) do not apply, then the product should be tested in conjunction with that substrate.

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.

BS 476-7 – Heating apparatus

ARUP





All dimensions are in millimetres

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

BS 476-7 – test arrangements

ARUP

BS 476-7 – measurements taken

ARUP

BS 476-7 – Classifications and contents of the test report

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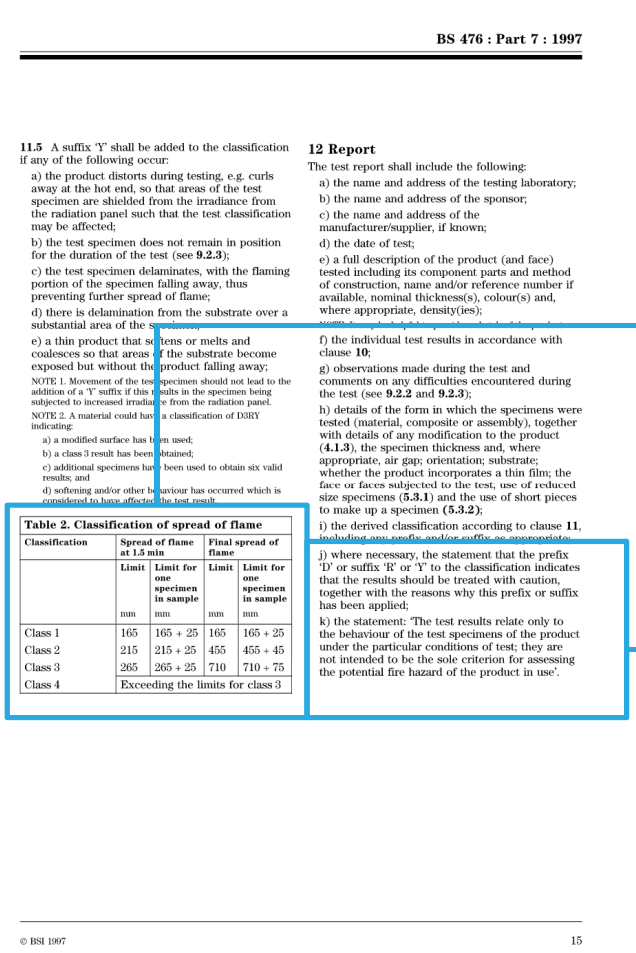

BS 476 : Part 7 : 1997

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);

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'.

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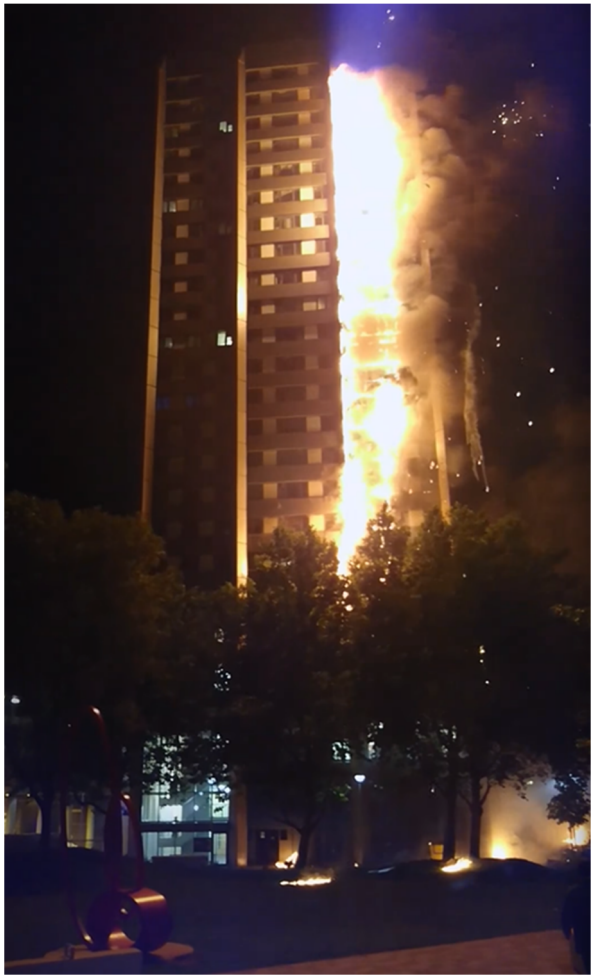
Table 2. Classification of spread of flame

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			

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'.

BS 476 – Part 7: horizontal flame spread

ARUP



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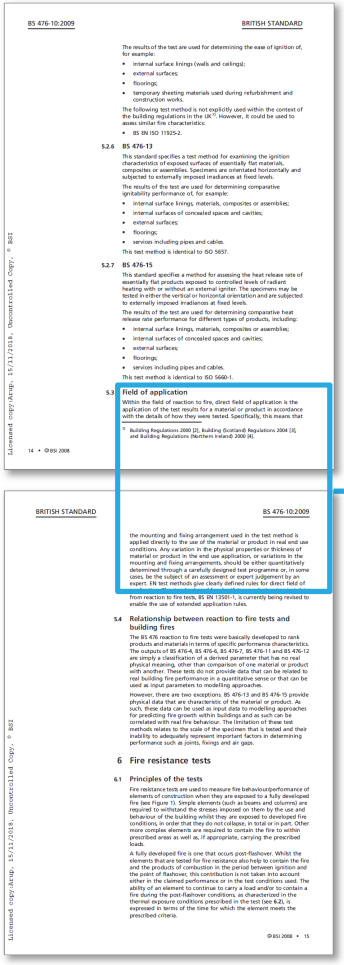
Extending the Field of Application

Field of application

ARUP



BS 476-10:2009 BRITISH STANDARD

The results of the test are used for determining the ease of ignition of, for example:

- internal surface linings (walls and ceilings);
- external surfaces;
- flooring;
- temporary sheeting materials used during refurbishment and construction works.

The following test method is not explicitly used within the context of the building regulations in the UK[1]. However, it could be used to assess similar fire characteristics:

- BS EN ISO 11925-2.

5.2.6 **BS 476-13**

This standard specifies a test method for examining the ignition characteristics of exposed surfaces of essentially flat materials, composites or assemblies. Specimens are orientated horizontally and subjected to externally imposed irradiances at fixed levels.

The results of the test are used for determining comparative ignitability performance of, for example:

- internal surface linings, materials, composites or assemblies;
- internal surfaces of concealed spaces and cavities;
- external surfaces;
- flooring;
- services including pipes and cables.

This test method is identical to ISO 5657.

5.2.7 **BS 476-15**

This standard specifies a method for assessing the heat release rate of essentially flat products exposed to controlled levels of radiant heating with or without an external igniter. The specimens may be tested in either the vertical or horizontal orientation and are subjected to externally imposed irradiances at fixed levels.

The results of the test are used for determining comparative heat release rate performance for different types of products, including:

- internal surface linings, materials, composites or assemblies;
- internal surfaces of concealed spaces and cavities;
- external surfaces;
- flooring;
- services including pipes and cables.

This test method is identical to ISO 5660-1.

5.3 **Field of application**

Within the field of reaction to fire, direct field of application is the application of the test results for a material or product in accordance with the details of how they were tested. Specifically, this means that

[1] Building Regulations 2000 [2], Building (Scotland) Regulations 2004 [3], and Building Regulations (Northern Ireland) 2000 [4].

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BRITISH STANDARD BS 476-10:2009

the mounting and fixing arrangement used in the test method is applied directly to the use of the material or product in real end use conditions. Any variation in the physical properties or thickness of material or product in the end use application, or variations in the mounting and fixing arrangements, should be either quantitatively determined through a carefully designed test programme or, in some cases, be the subject of an assessment or expert judgement by an expert. EN test methods give clearly defined rules for direct field of

from reaction to fire tests, BS EN 13501-1, is currently being revised to enable the use of extended application rules.

5.4 **Relationship between reaction to fire tests and building fires**

The BS 476 reaction to fire tests were basically developed to rank products and materials in terms of specific performance characteristics. The outputs of BS 476-4, BS 476-6, BS 476-7, BS 476-11 and BS 476-12 are simply a classification of a derived parameter that has no real physical meaning, other than comparison of one material or product with another. These tests do not provide data that can be related to real building fire performance in a quantitative sense or that can be used as input parameters to modelling approaches.

However, there are two exceptions. BS 476-13 and BS 476-15 provide physical data that are characteristic of the material or product. As such, these data can be used as input data to modelling approaches for predicting fire growth within buildings and as such can be correlated with real fire behaviour. The limitation of these test methods relates to the scale of the specimen that is tested and their inability to adequately represent important factors in determining performance such as joints, fixings and air gaps.

6 Fire resistance tests

6.1 **Principles of the tests**

Fire resistance tests are used to measure fire behaviourperformance of elements of construction when they are exposed to a fully developed fire (see Figure 1). Simple elements (such as beams and columns) are required to withstand the stresses imposed on them by the use and behaviour of the building whilst they are exposed to developed fire conditions, in order that they do not collapse, in total or in part. Other more complex elements are required to contain the fire to within prescribed areas as well as, if appropriate, carrying the prescribed loads.

A fully developed fire is one that occurs post-flashover. Whilst the elements that are tested for fire resistance also help to contain the fire and the products of combustion in the period between ignition and the point of flashover, this contribution is not taken into account either in the claimed performance or in the test conditions used. The ability of an element to continue to carry a load and/or to contain a fire during the post-flashover conditions, as characterized in the thermal exposure conditions prescribed in the test (see 6.2), is expressed in terms of the time for which the element meets the prescribed criteria.

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"Within the field of reaction to fire, direct field of application is the application of the test results for a material or product in accordance with the details of how they were tested. Specifically, this means that the mounting and fixing arrangement used in the test method is applied directly to the use of the material or product in real end use conditions. Any variation in the physical properties or thickness of material or product in the end use application, or variations in the mounting and fixing arrangements, should be either quantitatively determined through a carefully designed test programme or, in some cases, be the subject of an assessment or expert judgement by an expert."

Extension of results

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BRITISH STANDARD

BS ISO/TR 12470:1998

Fire resistance tests — Guidance on the application and extension of results

ICS 13.220.50

BSI

PFPF PASSIVE FIRE PROTECTION FEDERATION

GUIDE TO UNDERTAKING ASSESSMENTS IN LIEU OF FIRE TESTS

Extension of results

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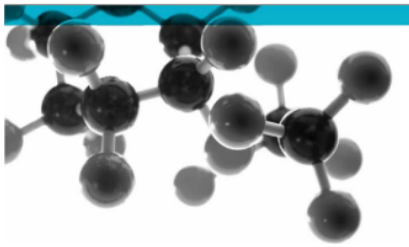
Exova Warringtonfire

Class 1 Assessment Report



Assessment of the ability of a range of foil-faced polyisocyanurate (PIR) insulation board materials to comply with the requirements of Class 1 when tested in accordance with BS 476: Part 7: 1997

A Report To: Kingspan Insulation Limited

Document Reference: 381173

Date: 15th March 2017

Issue No.: 1

Page 1

Testing
Advising
Assuring

Executive Summary

Objective To carry out an assessment of the ability of a range of thicknesses of the following foil-faced polyisocyanurate (PIR) insulation board material to comply with the requirements of Class 1 when tested in accordance with BS 476: Part 7: 1997.

Generic Description	Product reference	Thickness	Weight per unit area or density
Foil-faced polyisocyanurate (PIR) insulation board	"TF70/TP10/TW55/TW50"	20-50mm	28-32kg/m^3
Individual components used to manufacture composite:			
Foil	Confidential	Confidential	Confidential
Foam insulation	"TF70/TP10/TW55/TW50"	20-50mm	28-32kg/m^3
Please see page 5 of this test report for the full description of the product tested			

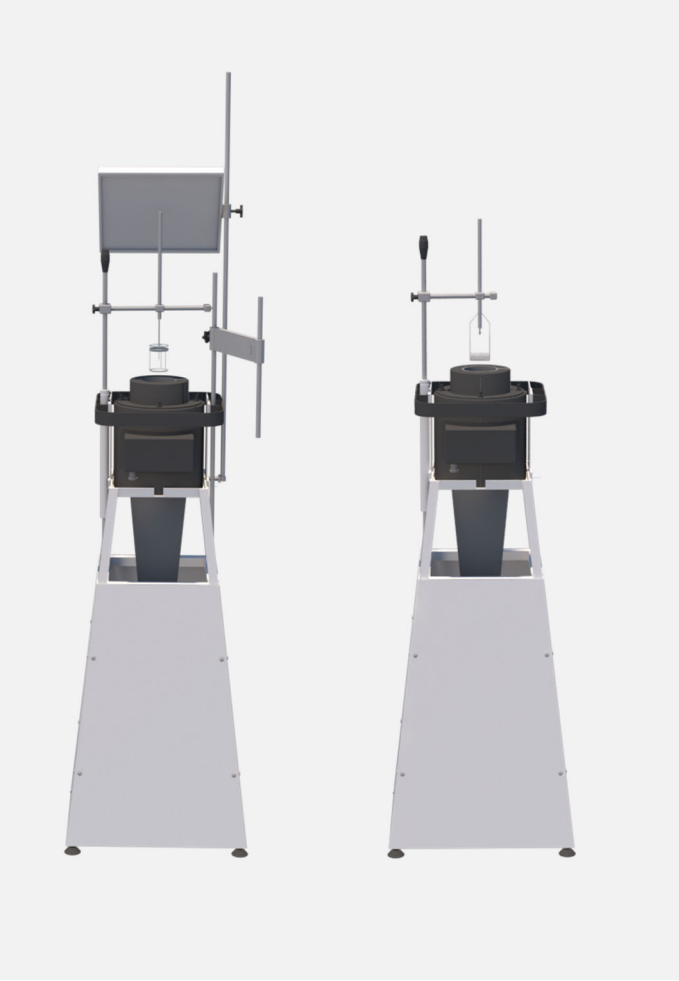
Test Sponsor Kingspan Insulation Limited, Pembridge, Leominster, Hertfordshire, HR6 9LA

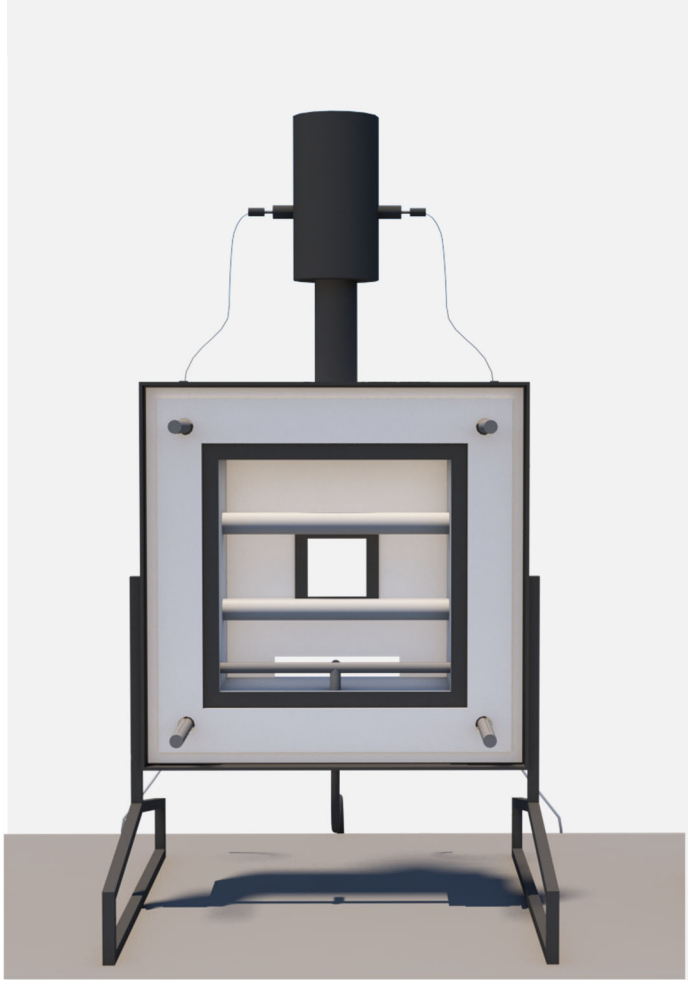
Opinion: On the basis of the information which has been generated during the test programme which is described in this report, it is the opinion of **Exova Warringtonfire** that all products within the Kingspan Insulation Limited "TF70/TP10/TW55/TW50" thickness range manufactured to the specifications described in this report will achieve a Class 1 designation when tested in accordance with BS 476: Part 7: 1997.

Date of Tests 29th May 2014 & 9th March 2017

Summary of national reaction to fire tests

ARUP





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The National Classes

National framework – reaction to fire definitions

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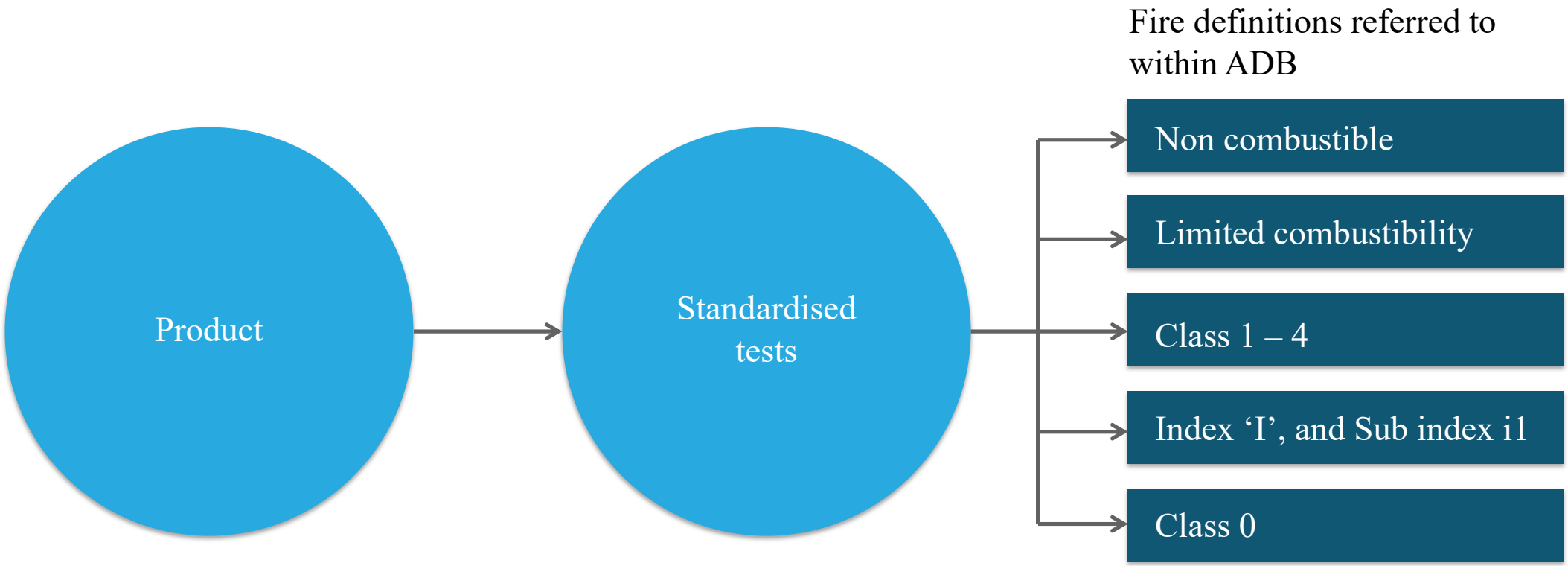

National framework – reaction to fire definitions

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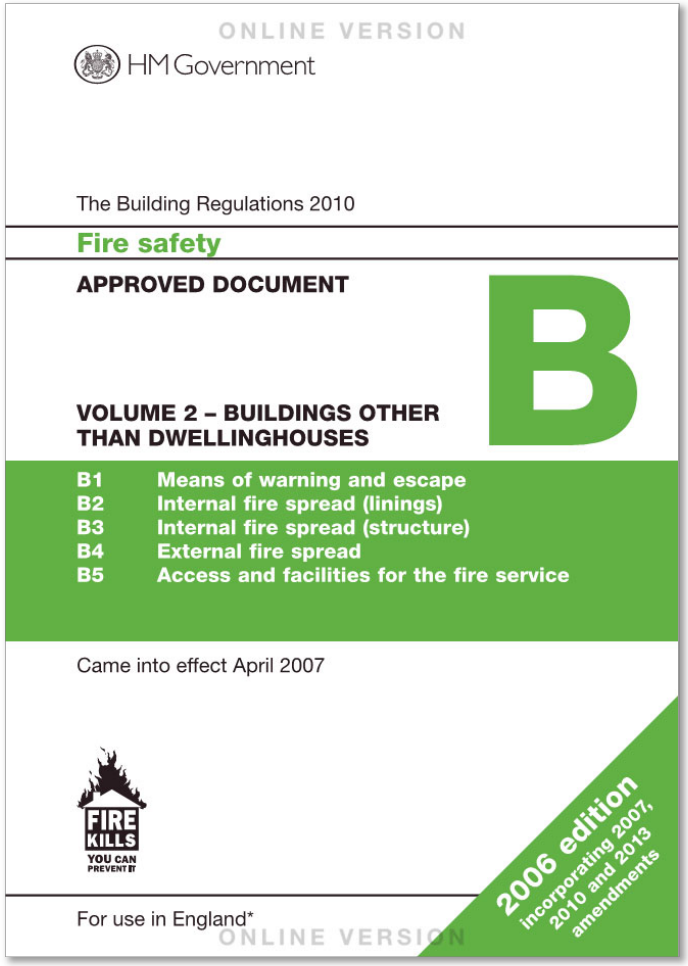

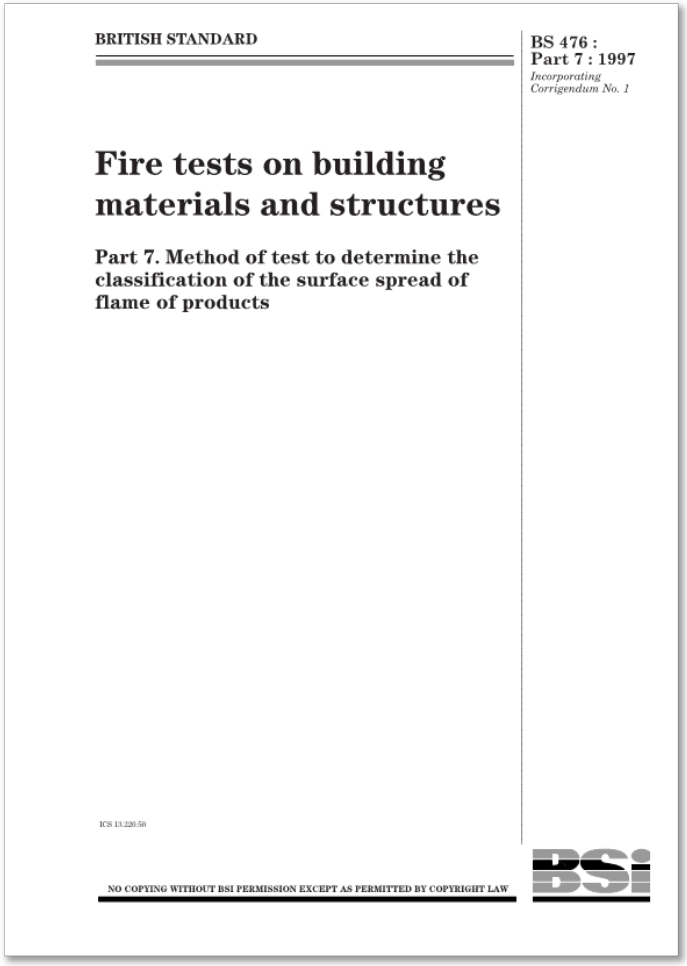

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Non combustible and limited combustibility

Non-combustible National Class

ARUP

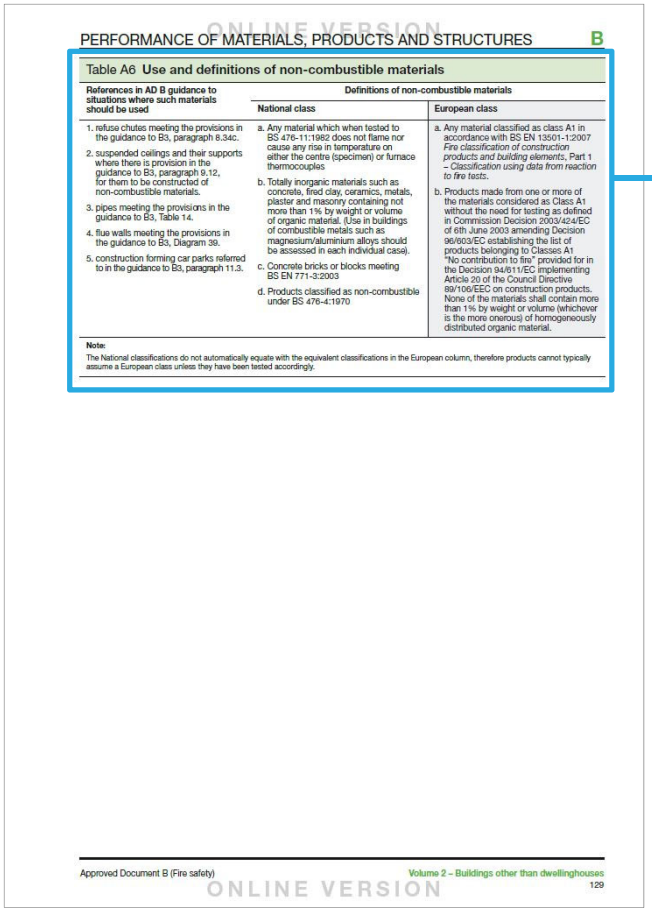


Table A6 Use and definitions of non-combustible materials

References in AD B guidance to situations where such materials should be used	Definitions of non-combustible materials	
	National class	European class
1. refuse chutes meeting the provisions in the guidance to B3, paragraph 8.34c. 2. suspended ceilings and their supports where there is provision in the guidance to B3, paragraph 9.12, for them to be constructed of non-combustible materials. 3. pipes meeting the provisions in the guidance to B3, Table 14. 4. flue walls meeting the provisions in the guidance to B3, Diagram 39. 5. construction forming car parks referred to in the guidance to B3, paragraph 11.3.	a. Any material which when tested to BS 476-11:1982 does not flame nor cause any rise in temperature on either the centre (specimen) or furnace thermocouples b. Totally inorganic materials such as concrete, fired clay, ceramics, metals, plaster and masonry containing not more than 1% by weight or volume of organic material. (Use in buildings of combustible metals such as magnesium/aluminium alloys should be assessed in each individual case). c. Concrete bricks or blocks meeting BS EN 771-3:2003 d. Products classified as non-combustible under BS 476-4:1970	a. Any material classified as class A1 in accordance with BS EN 13501-1:2007 *Fire classification of construction products and building elements*, Part 1 – *Classification using data from reaction to fire tests*. b. Products made from one or more of the materials considered as Class A1 without the need for testing as defined in Commission Decision 2003/424/EC of 6th June 2003 amending Decision 96/603/EC establishing the list of products belonging to Classes A1 "No contribution to fire" provided for in the Decision 94/611/EC implementing Article 20 of the Council Directive 89/106/EEC on construction products. None of the materials shall contain more than 1% by weight or volume (whichever is the more onerous) of homogeneously distributed organic material.

Note:

The National classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly.

Non-combustible as defined in ADB

ARUP

Test Standard	ADB Table A6 limit on specimen thermocouple temperature rise	ADB Table A6 limit on specimen furnace temperature rise	ADB Table A6 limit on duration of flaming
BS 476-4	50° C	50° C	10s
BS 476-11	0° C	0° C	0s

Limited combustibility National Class

ARUP

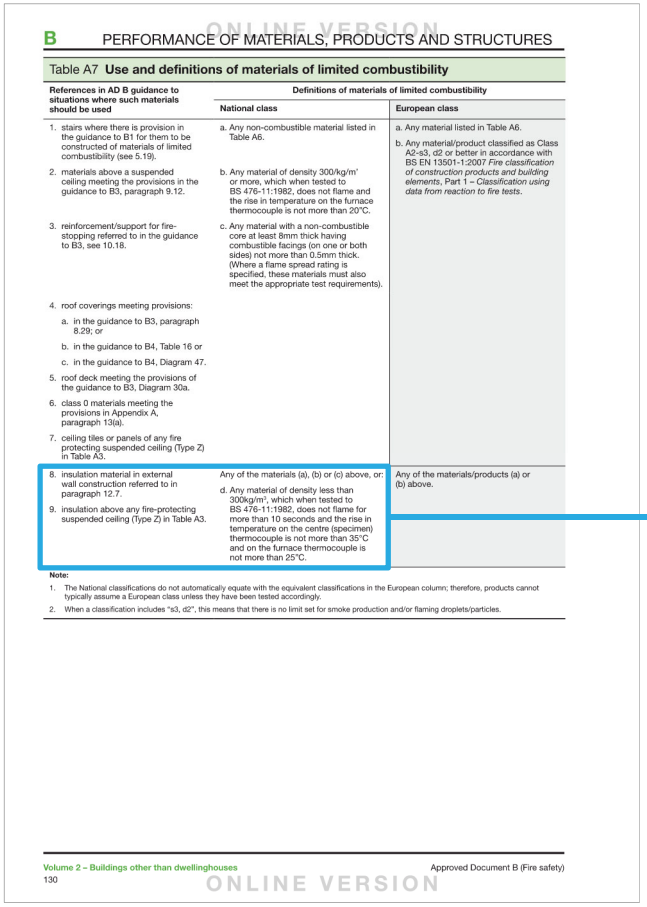


Table A7 **Use and definitions of materials of limited combustibility**

References in AD B guidance to situations where such materials should be used	Definitions of materials of limited combustibility	
	National class	European class
1. stairs where there is provision in the guidance to B1 for them to be constructed of materials of limited combustibility (see 5.19).	a. Any non-combustible material listed in Table A6.	a. Any material listed in Table A6.
2. materials above a suspended ceiling meeting the provisions in the guidance to B3, paragraph 9.12.	b. Any material of density 300/kg/m³ or more, which when tested to BS 476-11:1982, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C.	b. Any material/product classified as Class A2-s3, d2 or better in accordance with BS EN 13501-1:2007 *Fire classification of construction products and building elements*, Part 1 – *Classification using data from reaction to fire tests*.
3. reinforcement/support for fire-stopping referred to in the guidance to B3, see 10.18.	c. Any material with a non-combustible core at least 8mm thick having combustible facings (on one or both sides) not more than 0.5mm thick. (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements).	
4. roof coverings meeting provisions: a. in the guidance to B3, paragraph 8.29; or b. in the guidance to B4, Table 16 or c. in the guidance to B4, Diagram 47.		
5. roof deck meeting the provisions of the guidance to B3, Diagram 30a.		
6. class 0 materials meeting the provisions in Appendix A, paragraph 13(a).		
7. ceiling tiles or panels of any fire protecting suspended ceiling (Type Z) in Table A3.		
8. insulation material in external wall construction referred to in paragraph 12.7. 9. insulation above any fire-protecting suspended ceiling (Type Z) in Table A3.	Any of the materials (a), (b) or (c) above, or: d. Any material of density less than 300kg/m³, which when tested to BS 476-11:1982, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25°C.	Any of the materials/products (a) or (b) above.

Note:

1. The National classifications do not automatically equate with the equivalent classifications in the European column; therefore, products cannot typically assume a European class unless they have been tested accordingly.
2. When a classification includes "s3, d2", this means that there is no limit set for smoke production and/or flaming droplets/particles.

8. insulation material in external wall construction referred to in paragraph 12.7. 9. insulation above any fire-protecting suspended ceiling (Type Z) in Table A3.	Any of the materials (a), (b) or (c) above, or: d. Any material of density less than 300kg/m³, which when tested to BS 476-11:1982, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25”C.

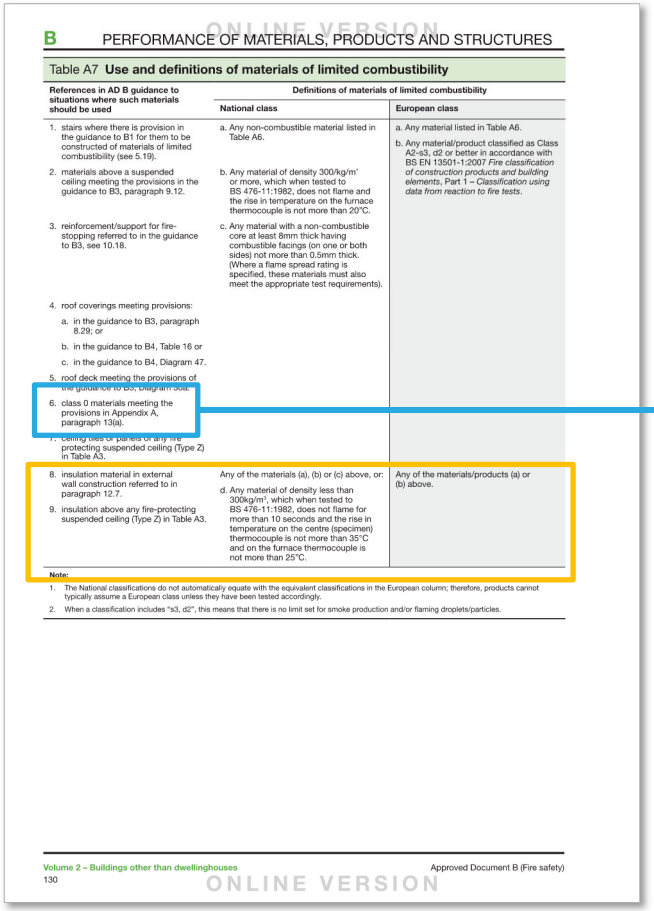
Limited combustibility as defined in ADB

ARUP

Test Standard	ADB Table A7 limit on specimen thermocouple temperature rise	ADB Table A7 limit on specimen furnace temperature rise	ADB Table A7 limit on duration of flaming
Material >300kg/m^3	No requirement set	20° C	0s
Material <300kg/m^3 (Insulation only)	35° C	25° C	10s

Limited combustibility as a method of demonstrating Class 0

ARUP



B PERFORMANCE OF MATERIALS, PRODUCTS AND STRUCTURES

Table A7 **Use and definitions of materials of limited combustibility**

References in AD B guidance to situations where such materials should be used	Definitions of materials of limited combustibility	
	National class	European class
1. stairs where there is provision in the guidance to B1 for them to be constructed of materials of limited combustibility (see 5.19).	a. Any non-combustible material listed in Table A6.	a. Any material listed in Table A6.
2. materials above a suspended ceiling meeting the provisions in the guidance to B3, paragraph 9.12.	b. Any material of density 300/kg/m³ or more, which when tested to BS 476-11:1982, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C.	b. Any material/product classified as Class A2-s3, d2 or better in accordance with BS EN 13501-1:2007 *Fire classification of construction products and building elements*, Part 1 – *Classification using data from reaction to fire tests*.
3. reinforcement/support for fire-stopping referred to in the guidance to B3, see 10.18.	c. Any material with a non-combustible core at least 8mm thick having combustible facings (on one or both sides) not more than 0.5mm thick. (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements).	
4. roof coverings meeting provisions: a. in the guidance to B3, paragraph 8.29; or b. in the guidance to B4, Table 16 or c. in the guidance to B4, Diagram 47.		
5. roof deck meeting the provisions of the guidance to B3, Diagram 50a.		
6. class 0 materials meeting the provisions in Appendix A, paragraph 13(a).		
7. ceiling tiles or panels of any fire protecting suspended ceiling (Type Z) in Table A3.		
8. insulation material in external wall construction referred to in paragraph 12.7.	Any of the materials (a), (b) or (c) above, or:	Any of the materials/products (a) or (b) above.
9. insulation above any fire-protecting suspended ceiling (Type Z) in Table A3.	d. Any material of density less than 300kg/m³, which when tested to BS 476-11:1982, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and on the furnace thermocouple is not more than 25°C.	

Note:
1. The National classifications do not automatically equate with the equivalent classifications in the European column; therefore, products cannot typically assume a European class unless they have been tested accordingly.
2. When a classification includes "s3, d2", this means that there is no limit set for smoke production and/or flaming droplets/particles.

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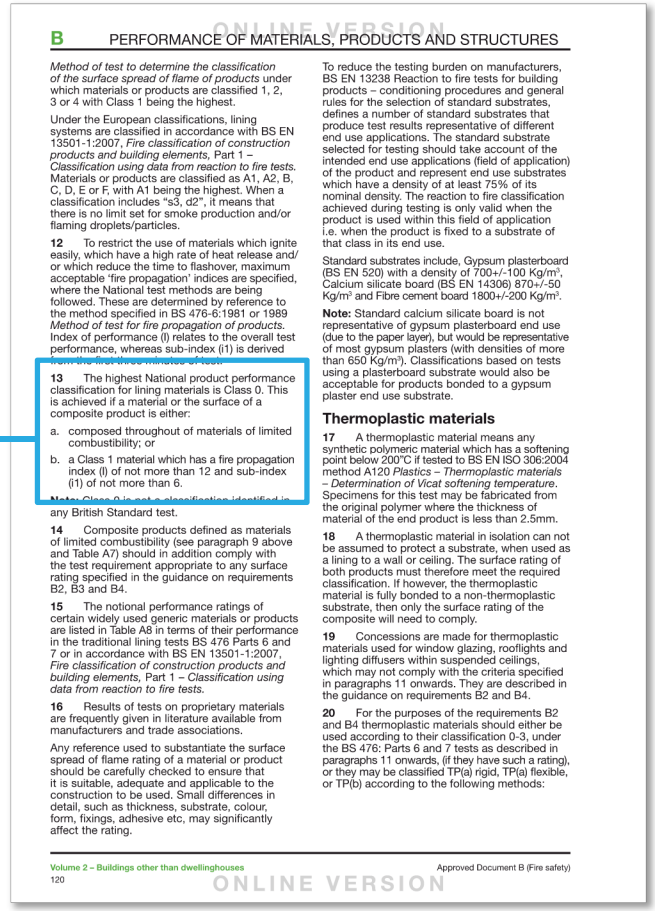
6. class 0 materials meeting the provisions in Appendix A, paragraph 13(a).

13 The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:

a. composed throughout of materials of limited combustibility; or

b. a Class 1 material which has a fire propagation index (I) of not more than 12 and sub-index (i1) of not more than 6.



B PERFORMANCE OF MATERIALS, PRODUCTS AND STRUCTURES

Method of test to determine the classification of the surface spread of flame of products under which materials or products are classified 1, 2, 3 or 4 with Class 1 being the highest.

Under the European classifications, lining systems are classified in accordance with BS EN 13501-1:2007, *Fire classification of construction products and building elements*, Part 1 – *Classification using data from reaction to fire tests*. Materials or products are classified as A1, A2, B, C, D, E or F, with A1 being the highest. When a classification includes "s3, d2", it means that there is no limit set for smoke production and/or flaming droplets/particles.

12 To restrict the use of materials which ignite easily, which have a high rate of heat release and/or which reduce the time to flashover, maximum acceptable 'fire propagation' indices are specified, where the National test methods are being followed. These are determined by reference to the method specified in BS 476-6:1981 or 1989 *Method of test for fire propagation of products*. Index of performance (I) relates to the overall test performance, whereas sub-index (i1) is derived from the first three minutes of test.

13 The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:

a. composed throughout of materials of limited combustibility; or

b. a Class 1 material which has a fire propagation index (I) of not more than 12 and sub-index (i1) of not more than 6.

Note: Class 0 is not a classification identified in any British Standard test.

14 Composite products defined as materials of limited combustibility (see paragraph 9 above and Table A7) should in addition comply with the test requirement appropriate to any surface rating specified in the guidance on requirements B2, B3 and B4.

15 The notional performance ratings of certain widely used generic materials or products are listed in Table A8 in terms of their performance in the traditional lining tests BS 476 Parts 6 and 7 or in accordance with BS EN 13501-1:2007, *Fire classification of construction products and building elements*, Part 1 – *Classification using data from reaction to fire tests*.

16 Results of tests on proprietary materials are frequently given in literature available from manufacturers and trade associations.

Any reference used to substantiate the surface spread of flame rating of a material or product should be carefully checked to ensure that it is suitable, adequate and applicable to the construction to be used. Small differences in detail, such as thickness, substrate, colour, form, fixings, adhesive etc, may significantly affect the rating.

To reduce the testing burden on manufacturers, BS EN 13238 Reaction to fire tests for building products – conditioning procedures and general rules for the selection of standard substrates, defines a number of standard substrates that produce test results representative of different end use applications. The standard substrate selected for testing should take account of the intended end use applications (field of application) of the product and represent end use substrates which have a density of at least 75% of its nominal density. The reaction to fire classification achieved during testing is only valid when the product is used within this field of application i.e. when the product is fixed to a substrate of that class in its end use.

Standard substrates include, Gypsum plasterboard (BS EN 520) with a density of 700+/-100 Kg/m³, Calcium silicate board (BS EN 14306) 870+/-50 Kg/m³ and Fibre cement board 1800+/-200 Kg/m³.

Note: Standard calcium silicate board is not representative of gypsum plasterboard end use (due to the paper layer), but would be representative of most gypsum plasters (with densities of more than 650 Kg/m³). Classifications based on tests using a plasterboard substrate would also be acceptable for products bonded to a gypsum plaster end use substrate.

Thermoplastic materials

17 A thermoplastic material means any synthetic polymeric material which has a softening point below 200°C if tested to BS EN ISO 306:2004 method A120 *Plastics – Thermoplastic materials – Determination of Vicat softening temperature*. Specimens for this test may be fabricated from the original polymer where the thickness of material of the end product is less than 2.5mm.

18 A thermoplastic material in isolation can not be assumed to protect a substrate, when used as a lining to a wall or ceiling. The surface rating of both products must therefore meet the required classification. If however, the thermoplastic material is fully bonded to a non-thermoplastic substrate, then only the surface rating of the composite will need to comply.

19 Concessions are made for thermoplastic materials used for window glazing, rooflights and lighting diffusers within suspended ceilings, which may not comply with the criteria specified in paragraphs 11 onwards. They are described in the guidance on requirements B2 and B4.

20 For the purposes of the requirements B2 and B4 thermoplastic materials should either be used according to their classification 0-3, under the BS 476: Parts 6 and 7 tests as described in paragraphs 11 onwards, (if they have such a rating), or they may be classified TP(a) rigid, TP(a) flexible, or TP(b) according to the following methods:

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