BRITISH STANDARD

BS 476-31.1: 1983
Incorporating Amendment No. 1 and Corrigendum No. 1

Fire tests on building materials and structures —

Part 31: Methods for measuring smoke penetration through doorsets and shutter assemblies —

Section 31.1 Method of measurement under ambient temperature conditions

ICS 13.220.50

Committees responsible for this British Standard

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

Aluminium Federation
Asbestos Cement Manufacturers' Association Limited
Association of British Roofing Felt Manufacturers
Association of Building Component Manufacturers Limited
Association of Structural Fire Protection Contractors and Manufacturers
British Fire Services' Association
British Floor Covering Manufacturers' Association
British Plastics Federation
British Railways Board
British Rigid Urethane Foam Manufacturers' Association
British Rubber Manufacturers' Association
British Wood Preserving Association
British Woodworking Federation
Cement and Concrete Association
Chemical industries Association
Chief and Assistant Chief Fire Officers' Association
Concrete Society
Constructional Steel Research and Development Organisation
Department of Education and Science
Department of the Environment (Building Research Establishment, Fire Research Station)
Department of the Environment (Construction Industry Directorate)
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Institution of Fire Engineers
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National Council of Building Materials Producers
National GRP Cladding Federation
Royal Institute of British Architects
Rubber and Plastics Research Association of Great Britain
The Wood Wool Slab Manufacturers' Association
Timber Research and Development Association
United Kingdom Antimony Oxide Manufacturers' Association
United Kingdom Atomic Energy Authority
Warrington Research Centre

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

Association of Builders Hardware Manufacturers
British Steel Industry
Door and Shutter Association
Electric Cable Makers Confederation
Guild of Architectural Ironmongers
Hevac Association
Intumescent Fire Seals Association
National Association of Lift Makers
Suspended Ceilings Association
Yarsley Technical Centre Ltd.

This British Standard, having been prepared under the direction of the Fire Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 October 1983

The following BSI references relate to the work on this standard:
Committee reference FSM/1
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Amendments/corrigenda issued since publication

Amd. No.	Date	Comments
AMD 8366	November 1994	Indicated by a sideline in the margin
C1	March 2014	Information added to Foreword

Contents

Foreword

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

This standard has been superseded by the current BS EN 1634-3, but it has been retained based on legitimate need for the standards within non-EU markets.

This Section of this British Standard has been prepared under the direction of the Fire Standards Committee. The committee responsible for this standard has undertaken the revision of existing methods and the preparation of new methods and these will be published as a new series which is described in BS 476-10.

The method described in this Section is one which has been prepared in cooperation with the International Organization for Standardization (ISO), to assess the performance of doorsets and shutter assemblies to the penetration of smoke and gaseous products from fires under ambient temperature conditions. When smoke and gases from a fire start to spread in a building, a pressure difference can develop between the two sides of a closed doorset or shutter assembly. Leakage of smoke can occur through the clearances between the door leaf and the frame and other openings. This method simulates the conditions which doorsets and shutter assemblies may be subjected to in practice during either the very early stages of fire development or at positions remote from the seat of the fire. Further methods are under consideration which describe procedures for evaluating the performance of doorsets and shutter assemblies at medium and high temperatures. It is intended that these will be published as Sections 31.2 and 31.3 respectively of this Part of this standard.

The apparatus described in this Section is equivalent to that described in ISO 5925/1. However, BSI is developing a common philosophy on where fire doors should be used and on their fire performance criteria. This Section reflects this philosophy and in particular the terminology used for fire doors differs slightly from that used in ISO 5925/1. Guidance information on how the results from this method are used in determining the performance of different types of fire doors is also under consideration.

In preparing the methods described in this Part of this standard, every effort has been made to design out possible situations which might cause hazard to the operator. However, situations can exist which are unforeseen and therefore attention is drawn to the Health and Safety at Work etc. Act 1974, and the need to ensure that the methods specified in this Part of this standard are carried out under suitable environmental conditions to provide adequate protection of personnel against the risk of fire, inhalation of smoke and/or toxic products of combustion.

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

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Section of this British Standard describes a method for measuring smoke penetration, as represented by the measurement of air leakage rate, through doorsets and vertically oriented shutter assemblies under ambient temperature conditions.

This method is used to evaluate the performance of a fire door used for smoke control purposes but gives no information on the fire resistance of a fire door for which the methods described in BS 476-22 are applicable.

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 Section of this British Standard, the definitions given in BS 4422 apply together with the following.

2.1
doorset (shutter assembly)

an assembly consisting of a fixed part (the frame), one or more movable parts (the leaves), and their hardware, the function of which is to allow or prevent access

2.2
fire door (shutter)

a door (shutter) provided for the passage of persons, air or objects which together with its frame and furniture as installed in a building, is intended, when closed, to resist the passage of fire and/or gaseous products of combustion and is capable of meeting specified performance criteria

2.3
ambient temperature

a temperature of 25 ± 15 °C, representative of that normally found in buildings

3 Apparatus

3.1 *General*. The apparatus shall consist essentially of an air leakage chamber with one vertical side open, and of sufficient size to allow the fitting of a doorset or shutter assembly including, if required, a surround (see Figure 1) and a means of providing a differential air pressure across the faces of the specimen.

3.2 *Air leakage chamber*. The chamber shall be constructed so that, with the surround fitted and its opening sealed, the rate of air leakage from the apparatus does not exceed 7 m^3/h or 0.25 m^3/h per metre of any perimeter sealing, whichever is the greater, at a pressure of 50 Pa above atmospheric pressure. It shall be provided with a means of ensuring that the airflow pattern in the chamber gives a uniform pressure over the face of the specimen (see clause **5**).

NOTE The uniform airflow pattern may be achieved by either the use of baffle plates or by deflection of the airflow.

3.3 *Surround*

3.3.1 The surround, if required, shall be capable of being fixed and sealed against the chamber opening and shall be so constructed as to allow the specimen to be installed in the apparatus in its test position and, if appropriate, to be tested from either direction.

3.3.2 If the surround is also to be used to test the specimen for fire resistance it shall be treated as a supporting construction and be selected accordingly and shall meet the requirements of BS 476-22 for the appropriate duration.

3.4 *Airflow system*

3.4.1 The chamber shall be equipped with a fan system capable of applying and maintaining an adjustable pressure differential of up to 100 Pa between the two faces of the specimen, together with connections to provide for the supply of air to and exhaustion of air from the chamber.

NOTE The specimen is required to be tested in two directions, and this may be achieved by either the use of a reversible airflow system (see Figure 2) or by reversing the surround containing the specimen (see **3.3.1**).

3.4.2 The chamber shall be provided with a means of measuring rate of air leakage, when the specimen is in place, with an accuracy of ± 5 %.

NOTE It may be necessary to use more than one instrument to achieve the specified accuracy. In general the rate of air leakage will depend upon the size of the door or shutter and the area of the leakage paths. It is not anticipated that for doors designed for smoke control purposes that the rate of air leakage will exceed 16 m^3/h per metre of the leakage path.

4 Ancillary equipment

4.1 Barometer. The barometer shall be capable of measuring atmospheric pressure with an accuracy of ± 1 %.

4.2 Static pressure measuring head. The measuring head shall be capable of measuring and recording the static pressure over the range from 5 Pa to 100 Pa with an accuracy of ± 10 % of the specified value, with a maximum of ± 5 Pa.

4.3 Thermometer. The thermometer shall be of the dry bulb type and shall be capable of measuring atmospheric temperature with an accuracy of 1 °C.

4.4 Hygrometer. The hygrometer shall be of the hair type and shall be capable of measuring relative humidity of the air with an accuracy of ± 5 %. The hair type hygrometer shall be calibrated regularly against an aspirated wet and dry bulb type instrument.

4.5 Timing device. The timing device shall have an accuracy of 1 s in 1 h and be capable of being read to the nearest minute.

5 Specimen preparation and construction

5.1 General. The specimen shall be a doorset or shutter assembly as intended to be used in practice incorporating all hardware seals and other equipment. The finish and form of the specimen shall be representative of the finish and form of the doorset or shutter as installed in its intended position of use.

NOTE The term "hardware" includes such items as hinges, latches, door handles, locks, keyholes (excluding keys), letter plates, sliding gear, closing devices, electrical wiring and any other items which may influence the performance of the specimen being tested.

5.2 Number of specimens. One specimen shall normally be used providing that provision has been made for reversing either the direction of airflow through the chamber or the specimen in its surround.

5.3 Size of specimen. The specimen shall be full size.

5.4 Conditioning. Specimens containing hydroscopic materials or other materials which can be affected by moisture shall be conditioned to equilibrium at a temperature of 25 ± 15 °C and a relative humidity of 55 ± 10 %.

NOTE Doorsets or shutter assemblies made entirely of metal and/or glass do not normally need to be conditioned.

6 Setting up procedure

6.1 Environmental conditions. The environmental conditions shall be at a temperature of 25 ± 15 °C and relative humidity 55 ± 10 %.

6.2 Specimen mounting

6.2.1 Take a specimen prepared in accordance with clause **5** and mount it in its surround so that it is representative of its use in practice with appropriate clearances between the door leaves and the frame and its surround.

6.2.2 Before measuring the air leakage, seal any joint or clearance between the frame of the doorset or shutter assembly and its surround. If the surround is to be used for a separate fire resistance test according to BS 476-22, then the surface of the surround shall also be sealed.

6.2.3 Mount the specimen and its surround into the air leakage chamber as specified in clause **3** and seal the joints.

6.2.4 Place the heads for measuring static pressure inside the chamber at a distance of 100 ± 10 mm from the plane of a single leaf door, one at the top and one at the bottom of the door along its vertical axis, or in the case of a double leaf door, one at the top centre of one leaf and one at the bottom centre of the other (see Figure 3).

6.3 Operational procedure. After installation of the door assembly, and with the surround in position in the test chamber open each leaf or moving element of the assembly and close it 10 times, using the automatic closer if provided, to ensure that the assembly operates normally.

NOTE This procedure is not intended to be a durability test representing the wear and tear normally found in use.

7 Test procedure

7.1 Procedure

7.1.1 With the specimen set up in accordance with clause **6**, both before and after the series of pressure measurement readings, determine the rate of air leakage of the apparatus by blocking off or sealing the specimen and by taking measurements at the pressure differentials specified in **7.1.3**. Record the rate of air leakages from the apparatus.

7.1.2 Providing that the rate of air leakage for the apparatus, corrected for standard conditions (see clause **8**) is not more than 7 m^3/h at 50 Pa above atmospheric pressure, unseal the specimen and carry out the following procedure.

a) Measure the barometric pressure (P_a), the temperature (T_a) and relative humidity (M_w) of the air in the laboratory.

b) Start the fan system and note the rate of airflow.

c) Establish the pressure differential at its intended level ± 2 Pa at the two measuring points specified in **6.2.4**.

d) As soon as the test conditions have been stable for at least 3 min, measure and record the total rate of air leakage through the specimen for each pressure probe.

7.1.3 Measure the rate of air leakage at accurately determined pressure differentials that approximate to 5, 10, 25 and 50 Pa, up to the maximum pressure differential for which information is required and then again at 5 Pa. Then measure the rate of air leakage once more at the maximum pressure differential.

7.1.4 Repeat the procedures described in **7.1.1** to **7.1.3** inclusive for the second face of the specimen, unless it can be ascertained that the face tested and the direction of airflow represented the worse situation. Record the reasons for the latter decision in the report.

7.2 Observations. Record any unusual behaviour of the specimen during the tests.

8 Expression of results

8.1 For each pressure differential, calculate the mean of the two readings given by the probes and correct the value to a reference temperature of 20 °C (293.15 K) and standard atmospheric pressure (1 atmosphere, 101325 Pa) for:

a) the rate of air leakage for the apparatus;

b) the total rate of air leakage;

by using the following formula:

$$Q = Q_a \times \frac{(P_a + \Delta p)}{101325} \times \frac{293.15}{(T_a + 273.15)} \times \times \left[1 - \left(0.3795 \times \frac{M_w}{100} \times \frac{E_s}{P_a + \Delta p} \right) \right]$$

where

Q is the adjusted rate of airflow (in m^3/h);

Q_a is the measured rate of airflow (in m^3/h);

Δp is the pressure increase (in Pa);

P_a is the barometric pressure (in Pa);

T_a is the air temperature (in °C);

M_w is the relative humidity (in %);

E_s is the saturated water vapour pressure (in Pa).

Record the results calculated for each pressure differential.

8.2 Calculate and record the adjusted rate of airflow, in m^3/h, for the specimen for each pressure differential measured from the following.

Adjusted rate of airflow for the specimen = adjusted total rate of air leakage – adjusted rate of air leakage for the apparatus.

9 Test report

The report shall include the results required by clause **8**, together with any observations (see clause **7**) for each face tested together with the following information:

a) name and address of the laboratory;

b) name and address of sponsor;

c) name of manufacturer/supplier, if known;

d) date of test;

e) full description of the doorset or shutter assembly tested, including trade name, its construction (including any glazing), clearances, gaps and physical characteristics and hardware, together with drawings;

f) a description of the apparatus including the measuring system and, if applicable, the direction of airflow with reference to the specimen;

g) a description of the conditioning and fixing of the specimen to the surround and of any joint, if any, between the specimen and surround;

h) the statement: "The results relate only to the behaviour of the specimens of the doorset or shutter assembly under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential fire hazard of the assembly in use."

A summary report, if requested shall contain the information given in Appendix A.

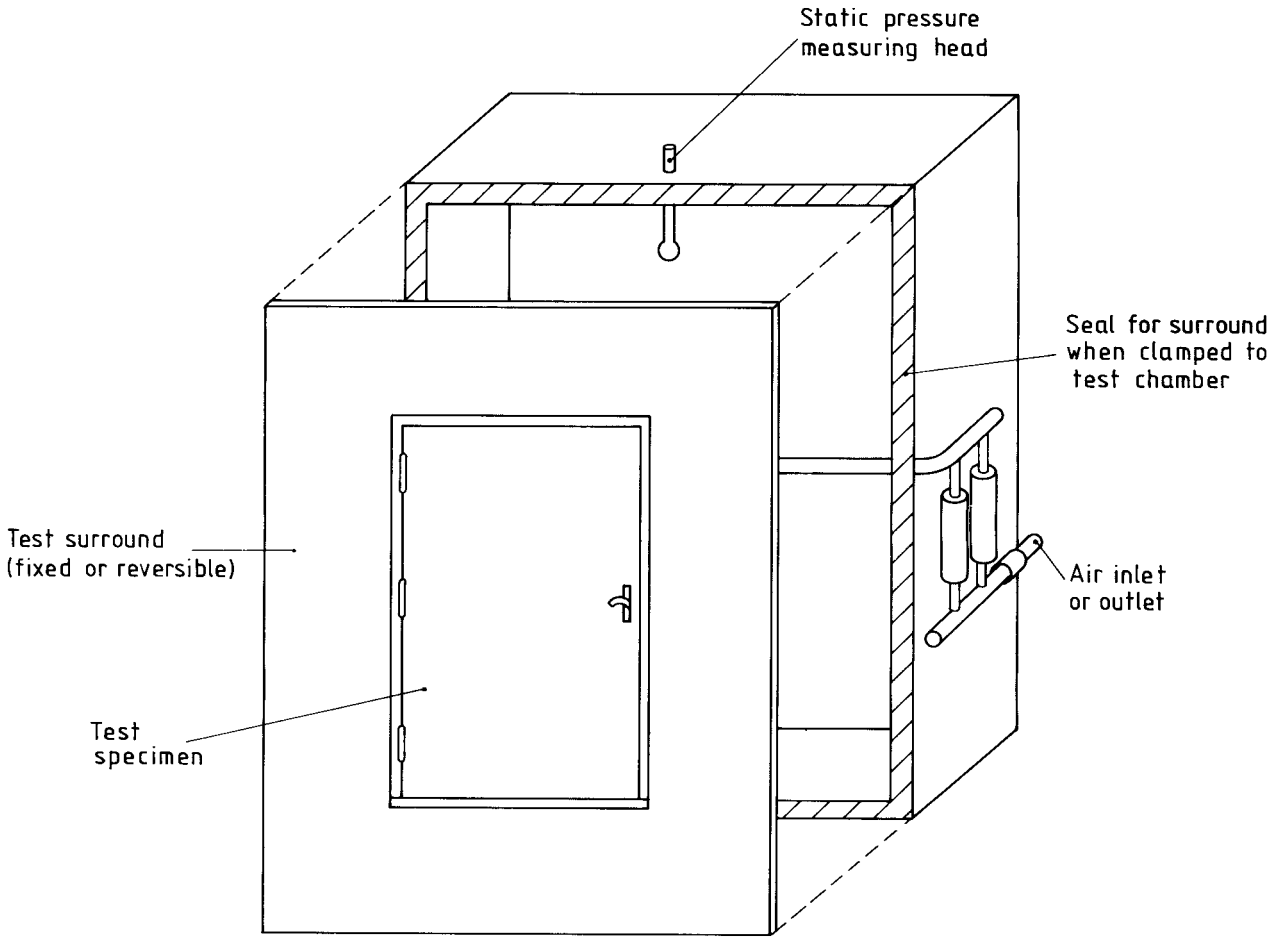
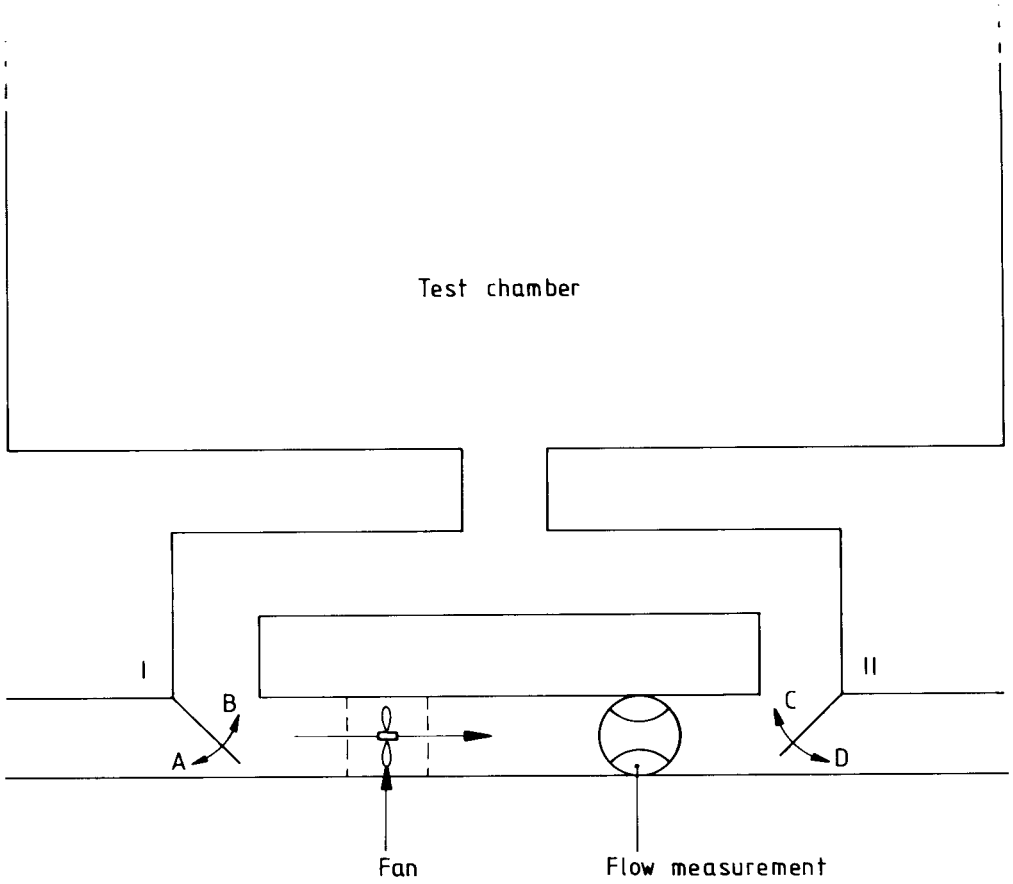


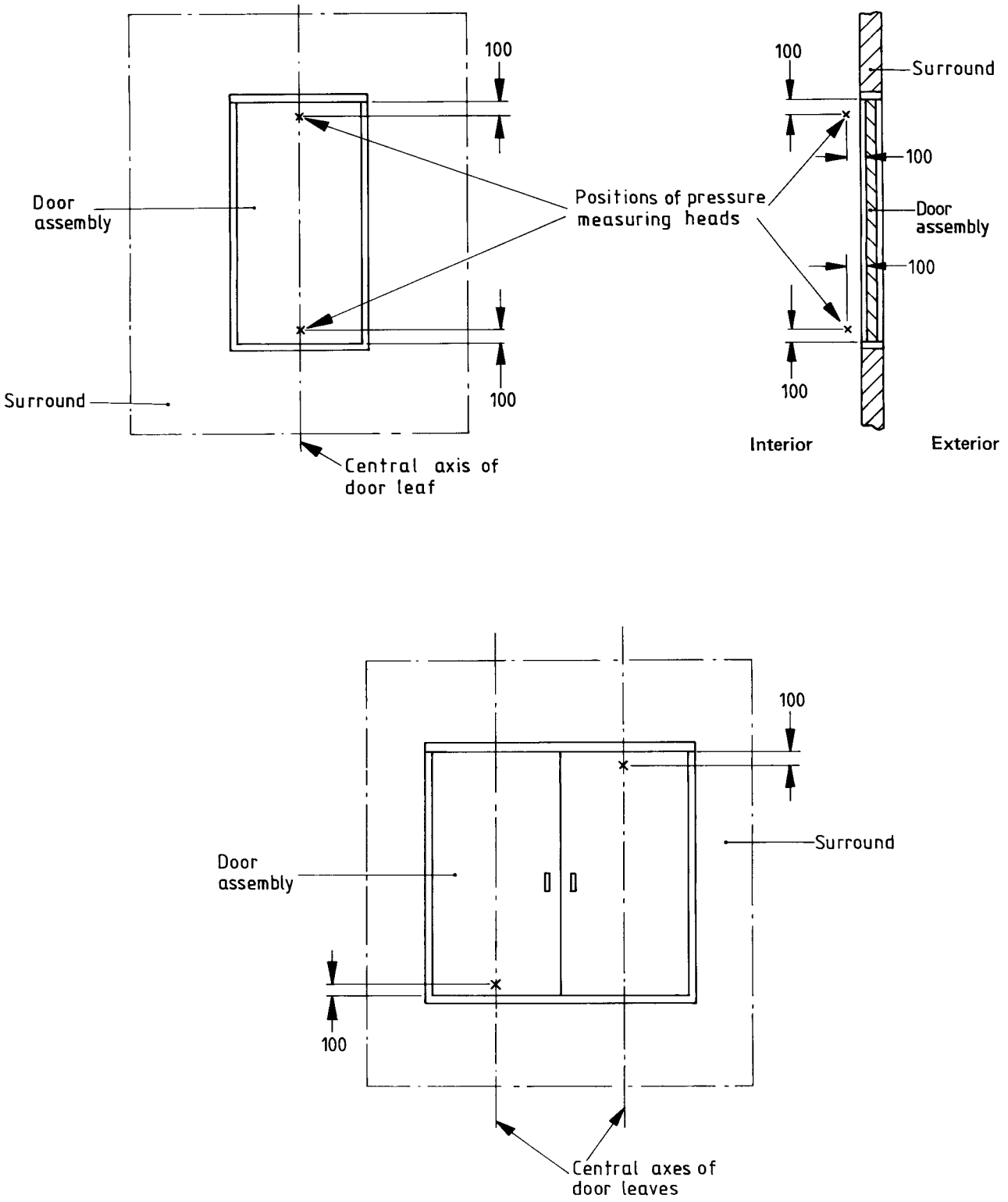
Figure 1 — An example of an air leakage apparatus designed for different sized doorset and shutter assemblies in a reversible surround



Overpressure: baffle I in position B
baffle II in position D

Underpressure: baffle I in position A
baffle II in position C

Figure 2 — A diagrammatic representation of a reversible airflow system



Dimensions in millimetres.

Figure 3 — Positions of pressure measuring heads on the interior of the chamber

Appendix A Summary test report

Name of laboratory	Laboratory reference no.
Address	Date of test
Tel. no. (Telex)	

Report in accordance with BS 476-31.1
Part 31: Methods for measuring smoke penetration through doorsets and shutter assemblies
Section 31.1 Method of measurement under ambient temperature conditions

Sponsor
Address
Manufacturer/supplier and address

Description of specimen(s)	Trade name or reference no.
Construction of specimen(s)	
Observations during test	
Results:	

Pressure differential (in Pa)		Adjusted rate of air leakage of the specimen (in m^3/h)	
nominal	actual	face	face
5			
10			
20			
30			
50			
70			
100			
5			

The results relate only to the behaviour of the specimens of the doorset or shutter assembly under the particular conditions of test. They are not intended to be the sole criterion for assessing the potential fire hazard of the assembly in use.

NOTE Complete test details may be obtained from the full report available from the sponsor of the test.

blank

Publications referred to

BS 476, *Fire tests on building materials and structures.*

BS 476-10, *A guide to the principles and application of fire testing*[1)].

BS 476-22, *Methods for the determination of the fire resistance of non-load bearing elements of building construction.*

BS 4422, *Glossary of terms associated with fire.*

ISO 5925/1, *Fire tests — Evaluation of performance of smoke control door assemblies — Part 1: Ambient temperature test*[1)].

[1)] Referred to in the foreword only.

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