

Fire detection and fire alarm devices for dwellings —

Part 1: Specification for smoke alarms

ICS 13.220.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee FSH/12, Fire detection and alarm systems, upon which the following bodies were represented:

- British Cables Association
- British Entertainments and Discotheque Association
- British Fire Consortium
- British Fire Protection Systems Association
- British Nuclear Fuels plc
- British Telecommunications plc
- Chartered Institution of Building Services Engineers
- Consumer Policy Committee of BSI
- Department of the Environment, Transport and the Regions (Building Research Establishment)
- Department of the Environment, Transport and the Regions (Construction Directorate)
- Electrical Contractors' Association
- Health and Safety Executive
- Home Office
- Institution of Electrical Engineers
- Institute of Fire Prevention Officers
- Institute of Fire Safety
- Institute of Petroleum
- Line of Fire
- London Fire and Civil Defence Authority
- Loss Prevention Council
- Maritime and Coastguard Agency
- Ministry of Defence
- National Association of Fire Officers
- National Caravan Council Ltd.
- National Inspection Council for Electrical Installation Contracting
- Nuclear Industry Fire Safety Coordination
- Royal Society of Health
- Trades Union Congress

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

- BSI Testing
- Electricity Association
- Energy Industries Council
- Maritime and Coastguard Agency
- Royal National Institute for Deaf People

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Foreword

This part of BS 5446 has been prepared by Technical Committee FSH/12. It supersedes BS 5446-1:1990, which is withdrawn. It specifies the requirements for smoke alarms intended for use in dwellings.

Guidance on siting, installation, maintenance and user actions are given in BS 5839-6.

This revision includes new fire tests which bring this standard into line with prEN 54-7 for point type smoke detectors (to be published as BS EN 54-7), which are no longer included within the scope of BS 5446-1.

The tests are type tests and are not intended as manufacturers' tests to maintain uniformity of quality in production, which is dealt with in the BS EN ISO 9000 series. While the tests are intended to assess the most important features of the design and construction of smoke alarms they cannot remove the necessity for regular inspection and maintenance, which is essential for reliable operation.

Product certification. Users of this British Standard are advised to consider the desirability of third-party certification of product conformity with this British Standard. Appropriate conformity attestation arrangements are described in the appropriate part of the BS EN ISO 9000 series. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

For a period of one year from the date of publication of this revision of BS 5446-1, new product certification submissions may be carried out either to this edition or the previous edition of the standard. After this one year period, all new submissions for product certification will be made to this edition of the standard.

Any product certified to the previous edition of the standard can retain its certification up to a maximum of three years after publication of this edition. After this period, only products certified to this edition of the standard will be able to bear the approval mark.

NOTE Devices giving a non-continuous alarm signal, although not precluded by this standard, may not conform to the requirements of some regulations.

Annex A, Annex B, Annex D, Annex F, Annex G, Annex H, Annex I, Annex J and Annex K are normative. Annex C and Annex E are informative.

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 does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 35 and a back cover.

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1 Scope

This part of BS 5446 specifies requirements and test methods for smoke alarms using scattered light, transmitted light, or ionization intended for permanent installation on ceilings or walls of dwellings for the purpose of life safety.

It also covers smoke alarms suitable for use in leisure accommodation vehicles (LAVs).

NOTE 1 Equipment conforming to this standard may not be suitable for use in boats due to the corrosive atmosphere.

NOTE 2 Although not covered by this standard, equipment is available for use with smoke alarms in order to provide a suitable warning system for use by the deaf and hearing impaired.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 1474:1987, *Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections.*

BS 4422 (all parts), *Glossary of terms associated with fire.*

BS 5445-7, *Components of automatic fire detection systems — Part 7: Specification for point-type smoke detectors using scattered light, transmitted light or ionization.*

BS 5839-6:1995, *Fire detection and alarm systems for buildings — Part 6: Code of practice for the design and installation of fire detection and alarm systems in dwellings.*

BS 7671, *Requirements for electrical installations — IEE Wiring Regulations — Sixteenth edition.*

BS EN 60065:1998, *Audio, video and similar electronic apparatus — Safety requirements.*

ISO 209-1, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition.*

IEC 68-2-42:1982, *Environmental testing — Part 2: Tests — Test Kc: Sulphur dioxide test for contacts and connections.*

3 Terms and definitions

For the purposes of this standard the terms and definitions given in BS 4422 and BS 5839-6 and the following apply.

3.1

smoke alarm

device containing within one housing all the components, except possibly the energy source, necessary for detecting smoke and for giving an audible alarm

3.2

fixed sensitivity alarm

alarm, the response threshold of which cannot be varied manually after the completion of the manufacturing process without the breakage of a seal or some equivalent permanent indication of adjustment, and in which any such breakage is clearly visible during servicing

3.3

adjustable sensitivity alarm

alarm, the response threshold of which can be varied within specified limits without permanent indication of such variation

NOTE Limits are specified in 10.2.

3.4

response threshold

smoke concentration at which the alarm changes to its alarm condition

NOTE For the purposes of this standard, response threshold is determined in accordance with Clause 8.

3.5

energized condition

state in which the alarm is supplied with power

3.6

normal condition

condition in which the alarm is energized but is not giving either a fire alarm signal or a fault warning, although able to give such signals if the occasion arises

3.7

alarm condition

condition in which the alarm is giving a signal specified by the manufacturer's requirements as indicating the existence of a fire

3.8

fault warning

signal intended to indicate an actual or incipient fault that might prevent the emitting of a fire alarm signal

3.9

manufacturer's requirements

requirements specified by the manufacturer and/or supplier

NOTE See Clause 5.

3.10

alarm silence facility

means of temporarily disabling or desensitizing a smoke alarm

4 Marking

NOTE Marking and safety information may be required by legislation. For alarms containing radioactive material, advice should be sought from the National Radiological Protection Board, Chilton, Didcot, Oxfordshire OX11 0RQ.

Each alarm shall be indelibly marked with the following:

- a) the number and date of this British Standard, i.e. BS 5446-1:2000;¹⁾
- b) the name or trade mark of the manufacturer or supplier;
- c) the type of alarm;
- d) the date of manufacture, or the batch number;
- e) the address of an organization capable of being responsible for servicing or repair;
- f) the manufacturer's recommended date for replacement, subject to normal, regular maintenance;
- g) smoke alarms incorporating user replaceable batteries: the type or numbers of batteries recommended by the manufacturer and an instruction to the user "Test the alarm for correct operation using the test facility, whenever the battery is replaced."; which shall be visible during the operation of changing the batteries;
- h) smoke alarms incorporating non-replaceable batteries: the warning "WARNING — Battery not replaceable — See instruction manual" which shall be visible during normal use.

Conformity shall be checked by visual inspection. The indelibility and durability of the marking shall be checked by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit. After this test the marking shall still be legible and labels shall not be removable and shall have no curling.

¹⁾ Marking BS 5446-1:2000 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

5 Provision of information

Information supplied on or with smoke alarms shall include instructions on siting, installation, maintenance and user actions in accordance with the recommendations in BS 5839-6:1995, Clause 22.

The information provided with smoke alarms incorporating user-replaceable batteries shall include specific guidance on changing the batteries. This guidance shall include any advice which is necessary to ensure that the battery is properly connected. It shall also include a recommendation that the operation of the alarm is tested with the test facility whenever the batteries are replaced.

NOTE It is recommended that the guidance should also state that if the alarm fails to operate correctly, the advice of the manufacturer should be sought.

For smoke alarms incorporating non-replaceable batteries, information shall be given on the action to be taken if a battery fault warning is emitted.

Information for interconnectable smoke alarms shall state the maximum number that may be interconnected. Details of suitable cables shall also be given.

Information for smoke alarms intended for connection to mains supplies shall include a warning that draws attention to the hazards associated with mains voltages and recommends that the smoke alarm, together with any associated supply and interconnect wiring, be installed in accordance with BS 7671, published by the Institution of Electrical Engineers²⁾.

Information shall include a warning that if there is any question as to the cause of an alarm it should be assumed that the alarm is due to an actual fire and the dwelling should be evacuated immediately.

If it is claimed that the smoke alarm is also suitable for use in leisure accommodation vehicles (LAVs) this shall be clearly stated in the information supplied on or with the smoke alarm (see also Clause 30).

6 Constructional requirements

6.1 Visual indication of operation

NOTE Visual indication of operation may be fitted.

Alarm indicators shall be red and shall be separate from the mains power supply indicator. Mains-powered apparatus shall include a power supply indicator. This shall be coloured green and shall be continuously illuminated when mains power is present. The failure of any indicator lamp shall not prevent the emitting of a fire alarm signal.

6.2 Terminals for external conductors

The alarm or base, as appropriate, if intended to have external connections, shall provide for the connection of conductors by means of screws, nuts or equally effective devices. For mains-powered alarms which utilize a “flying lead”-type connector, this connector shall be regarded as a conductor. If terminals are provided, they shall allow the connection of conductors having nominal cross-sectional areas of between 0.4 mm² and 1.5 mm². Disconnection of the conductors, or access to the conductors for disconnection, shall not be possible without the use of a tool. Terminals shall be designed so that they clamp the conductor between metal surfaces without rotation of those surfaces but with sufficient contact pressure and without damage to the conductor.

6.3 Alignment of alarms

Where separate bases are used, a means to prevent incorrect alignment of the alarm in the base shall be provided.

6.4 Failure of components

A fault warning shall be given on the failure of any component, apart from the battery, which would prevent the emitting of an alarm signal and for which the mean time before failure is less than five years. Any such warning shall be readily distinguishable from the alarm signal.

²⁾ BS 7671, *Requirements for electrical installations, IEE Wiring Regulations, Sixteenth edition*. Available from Station House, Nightingale Rd, Hitchin, Herts.

6.5 Battery removal indication

The removal of any user-replaceable battery used to power, or provide back-up power, for the smoke detection circuit/sounder, from a battery or mains powered d.c. backed smoke alarm, shall result in a visual, mechanical or audible warning that the battery has been removed. The visual warning shall not depend upon a power source.

NOTE Conformity may be achieved by, but is not restricted to, one of the following examples:

- a) a warning flag that will be exposed with the battery removed and the cover closed;
- b) a hinged cover or battery compartment that cannot be closed when the battery is removed;
- c) a unit that cannot be replaced upon its mounting with the battery removed.

7 Testing

7.1 Test specimens

Thirteen smoke alarms shall be provided for use in the tests described in Clauses 9 to 34. Additional samples may be required for Clauses 26 and 28.

7.2 Test schedule

The alarms shall be numbered as specified in Clause 10. The tests on each alarm indicated in Table 1 shall be carried out in the order in which they are listed.

The battery installation test shall be conducted on alarms selected in accordance with 34.3 from amongst the 13 samples provided for test.

7.3 Associated equipment

In all tests requiring the alarm to be in an operating condition, any associated equipment (such as control equipment or power supplies) shall satisfy the manufacturer's requirements.

7.4 Warm-up and resetting times

Where the manufacturer places requirements on the warm-up or resetting times of the alarm, these shall be observed in all tests unless otherwise specified for particular tests.

7.5 Power supply during test

If a test requires a specimen to be operational, the specimen shall be connected to a suitable power source with characteristics as required by the manufacturer's data. Unless otherwise specified in the test method, the power source parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range.

NOTE The details of the power source used should be given in the test report.

7.6 Tolerances

If a specific tolerance or limit is not specified in a method of test a tolerance of $\pm 5\%$ shall be applied.

Table 1 — Test schedule

Test	Clause	Alarm number												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Directional dependance	9	One alarm selected at random												
Preliminary test	10	x	x	x	x	x	x	x	x	x	x	x	x	x
Repeatability	11	x												x
Supply voltage	12	x												x
Air movement	13	x												x
Ambient light	14	x												x
Temperature	15	x												x
Humidity	16			x								x		
Corrosion	17				x						x			
Impact	18					x				x				
Vibration	19								x					
Fire sensitivity	20	x	x										x	x
Final test	21	x	x										x	x
Battery fault warning	22						x							
Sound output	24							x						
Tests on interconnectable smoke alarms	26						x							
Test on alarm silence facility	27						x							
Battery reversal	29							x						
Additional tests for alarms suitable for installation in LAVs	30													
Vibration	30.2								x					
Temperature cycle	30.3			x										

8 Measurement of response threshold

8.1 Apparatus

8.1.1 Wind tunnel, as specified in Annex A with, unless otherwise specified for particular tests, an air velocity of (0.2 ± 0.05) m/s and an air temperature of (22 ± 3) °C.

8.2 Smoke generation

Generate test smoke by heating filter paper³⁾ with a mass between 80 g/m² and 110 g/m², on an electric heating element. Adjust the amount of paper used and the temperature of the heating element so that the optical density of the smoke increases at a rate not exceeding 0.2 dB/m per minute to a maximum level of at least 1.5 dB/m, when determined using an instrument as specified in Annex B.

NOTE Care should be taken to ensure that the rate of generation of smoke is similar in all tests of a given alarm type.

8.3 Method of test

Mount the alarm in the wind tunnel, with the tunnel clear of smoke, and leave the alarm in its normal condition for at least 15 min, unless otherwise specified for particular tests. Mount alarms intended for ceiling mounting and alarms intended for wall mounting in the same position in the wind tunnel, and oriented as described in 8.4. Generate smoke as described in 8.2 and determine the smoke density at the moment of transition to the alarm condition. Record this as the response threshold of the alarm.

NOTE The measuring instrument used to determine the response threshold of the alarm should work on the same principle as the alarm, in accordance with the recommendations in Annex C.

³⁾ A Whatman No. 2 filter paper is suitable.

8.4 Orientation of the alarm

Before commencing the tests described in Clauses 10 to 34 determine the orientation of the alarm giving the lowest response threshold in accordance with Clause 9. Carry out all measurements of the response threshold in the remaining tests with the alarm in this orientation, unless otherwise specified for particular tests.

9 Directional dependence

9.1 Method of test

Select one alarm at random from those submitted for testing. Mount the alarm in the wind tunnel in an arbitrary orientation relative to the direction of the air flow, and measure the response threshold as described in Clause 8. Rotate the alarm through 45° about an axis perpendicular to the mounting surface and measure the response threshold again. Repeat this procedure until measurements have been made with the alarm in eight different orientations. Note the orientation giving the highest response threshold and the lowest response threshold.

9.2 Requirements

The ratio of the highest response threshold of the alarm to the lowest response threshold shall not exceed 1.5.

10 Preliminary test and numbering

10.1 Fixed sensitivity alarms

10.1.1 Method of test

Determine the response threshold of each alarm in accordance with Clause 8. Number the alarms in the order 1 to 13, such that number 1 has the lowest response threshold, number 13 has the highest.

10.1.2 Requirements

The ratio of the response thresholds of alarms 1 and 13 shall not exceed 2.

10.2 Adjustable sensitivity alarms

10.2.1 Method of test

Adjust each alarm to its maximum response threshold setting, and measure this using the method described in Clause 8. Number the two alarms with the highest response thresholds number 12 and number 13, number 13 having the higher threshold. Adjust each alarm to its minimum response threshold setting and measure this in accordance with Clause 8. Number the remaining alarms in the order 1 to 11 such that number 1 has the lowest response threshold and number 11 has the highest. Re-adjust alarms 12 and 13 to their maximum threshold settings. Retain these sensitivity settings for other tests.

10.2.2 Requirements

The ratio of the minimum response threshold of any alarm to that of any other alarm shall not exceed 2. The ratio of the maximum response threshold of any alarm to that of any other alarm shall not exceed 2.

11 Repeatability

11.1 Method of test

Measure the response threshold of the alarm in accordance with Clause 8. Clear the tunnel and alarm of smoke and reset the alarm. After 15 min, or a longer period if specified in accordance with Clause 5, measure the response threshold again. Repeat this procedure until six measurements have been obtained.

11.2 Requirements

The ratio of the highest response threshold of the alarm to the lowest response threshold shall not exceed 1.5.

12 Supply voltage

12.1 Voltage limits

12.1.1 For battery-operated smoke alarms, the tests shall be carried out with a supply voltage corresponding to that of a new battery, and also with a supply voltage of V_E as determined in **22.2.3**.

12.1.2 For smoke alarms intended for operation from mains supplies, the alarm shall be tested with supply voltages of 0.85 times the lower limit and 1.1 times the upper limit of the nominal supply voltage range specified in the manufacturer's requirements. If the smoke alarm is provided with a rechargeable battery, sufficient time shall be allowed for the battery voltage to stabilize before the response threshold is measured.

12.1.3 For smoke alarms intended to operate from any external supply other than mains, the manufacturer shall specify a maximum and minimum voltage. Tests shall be conducted at the maximum and minimum voltage.

12.2 Method of test

Measure the response threshold of the alarm twice, in accordance with Clause 8, making one measurement with the supply voltage set to the higher level and the other with the supply voltage set to the lower level, determined in accordance with **12.1**.

12.3 Requirements

The ratio of the response thresholds measured in accordance with **12.2** to the mean of those measured on the same alarm in accordance with Clause 11 shall be not less than 0.67 and not greater than 1.5. During the test the smoke alarm shall not respond before the density reaches 0.05 dB/m.

13 Air movement

13.1 Method of test

13.1.1 Test the alarm in accordance with **13.1.2** and **13.1.3**.

13.1.2 Measure the response threshold of the alarm in accordance with Clause 8, but using an air velocity of (1 ± 0.2) m/s.

13.1.3 Mount the alarm in the tunnel in the orientation having the lowest response threshold (i.e. in the most sensitive orientation) determined in accordance with **9.1**, and subject it to an air velocity of (8 ± 0.8) m/s for a period of 2 min in the absence of smoke.

13.2 Requirements

The ratio of the response threshold measured in accordance with **13.1.2** to the mean of those measured on the same alarm in accordance with Clause 11 shall be not less than 0.67 and not greater than 1.5. No false alarms or fault warnings shall be given in the test described in **13.1.3**.

14 Ambient light

14.1 Method of test

Mount the alarm in its normal operating position in the testing tunnel specified in Annex A in such a way as to permit the alarm to be illuminated by the apparatus specified in Annex D. Switch the illumination on for 5 s, then on and off at a rate of 0.5 s on, 0.5 s off for a period of 10 s. Then leave the illumination on for a period of 10 min. Measure the response threshold as described in Clause 8, with the alarm illumination remaining on. Rotate the alarm through 90° about the vertical axis and repeat the procedure.

14.2 Requirements

No false alarm or fault warning shall be given during the tests described in **14.1**. The ratio of the response thresholds measured to the mean of the response thresholds measured in accordance with Clause 11 shall be not less than 0.67 and not greater than 1.5.