BRITISH STANDARD

BS 5446-2:2003

Fire detection and fire alarm devices for dwellings —

Part 2: Specification for heat alarms

ICS 13.220.20

Committees responsible for this British Standard

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British Fire Protection Systems Association

BRE/LPC Laboratories

BSI Testing — Product Certification

Building Research Establishment

Consumer Policy Committee of BSI

Department of Health — NHS Estates

Electricity Association

Energy Industries Council

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Contents

Foreword

This part of BS 5446 has been prepared by Subcommittee FSH/12/2 under the direction of Technical Committee FSH/12.

It is an addition to the BS 5446 series and specifies requirements and test methods for heat alarms intended for use in dwellings. (See BS 5839-6.)

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 heat 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.

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

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 29 and a back cover.

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1 Scope

This part of BS 5446 specifies requirements and type test methods for heat alarms. It is applicable to heat alarms intended solely for permanent installation on ceilings or walls of dwellings, and to heat alarms suitable for use in leisure accommodation vehicles (LAVs).

NOTE 1 Equipment conforming to this part of BS 5446 might not be suitable for use in boats due to the corrosive atmosphere.

NOTE 2 Although not covered by this part of BS 5446, equipment is available for use with heat alarms in order to provide a suitable warning system for use by the deaf and hearing impaired.

NOTE 3 This part of BS 5446 does not include point type detectors.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 2011 (IEC 60068) (all parts), *Environmental testing.*

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

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 EN 54-5, *Fire detection and fire alarm systems — Part 5: Heat detectors — Point detectors.*

BS EN 60065:2002, *Audio, video and similar electronic apparatus — Safety requirements.*

BS EN 60068 (IEC 60068) (all parts), *Environmental testing.*

BS EN 60651, *Specification for sound level meters.*

BS EN 60950-1:2002, *Information technology equipment — Safety — Part 1: General requirements.*

ISO 209-1:1989, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition.*

3 Terms and definitions

For the purposes of this part of BS 5446 the terms and definitions given in BS 4422, BS 5839-6, BS EN 54-5 and the following apply.

3.1
alarm condition
condition in which a heat alarm is giving a signal as specified by the manufacturer

3.2 application temperatures

3.2.1
maximum application temperature
maximum temperature that an installed heat alarm can be expected to experience, even for short periods of time, in the absence of a fire condition

NOTE This temperature is deemed to be 4 °C below the minimum static response temperature for the appropriate class marked on the heat alarm, as specified in Table 1.

3.2.2
typical application temperature
temperature that an installed heat alarm can be expected to experience for long periods of time in the absence of a fire condition

NOTE This temperature is deemed to be 29 °C below the minimum static response temperature for the appropriate class marked on the heat alarm, as specified in Table 1.

3.3
fault warning
signal intended to indicate an actual or incipient fault that might prevent the emitting of a heat alarm signal

3.4
heat alarm
device containing within one housing all the components, except possibly the energy source, necessary for detecting heat and for giving an audible alarm

3.5
normal condition
condition in which a heat alarm is energized but is not giving either an alarm signal or a fault warning, although able to give such signals if the occasion arises

3.6
static response temperature
temperature at which a heat alarm would produce an alarm signal if subjected to a vanishingly small rate of rise of temperature

4 Constructional requirements

4.1 Visual indication of operation

Mains-powered apparatus shall include a power supply indicator. This shall be coloured green and shall be continuously illuminated when mains power is present.

If an alarm indicator is fitted, it shall be red and shall be separate from the mains power supply indicator. The alarm indicator shall be illuminated when an alarm condition is present.

NOTE 1 The fitting of alarm indicators is optional.

NOTE 2 It is usual for an alarm indicator to be continuously illuminated, or flashing at least once per second, when an alarm condition is present.

When the failure of an alarm indicator or a power supply indicator is simulated by open circuit or short-circuit, there shall be no failure of the fire alarm signal.

NOTE 3 This is to ensure that the failure of an indicator lamp does not prevent the emitting of a fire alarm signal.

4.2 Terminals for external conductors

The alarm or base, as appropriate, if intended to have external connections, shall be provided with terminals for the connection of conductors by means of screws, nuts or equally effective devices.

Terminals shall allow the connection of conductors having nominal cross-sectional areas of between 0.4 mm^2 and 1.5 mm^2.

Terminals shall be designed such that:

a) it is not possible to disconnect the conductors, or access the conductors for disconnection, without the use of a tool;

b) they clamp the conductor between metal surfaces without rotation of those surfaces but with sufficient contact pressure and without damage to the conductor.

4.3 Alignment of alarms

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

4.4 Failure of components

If a component is fitted that has a mean time before failure of less than 5 years, the heat alarm shall be designed in such a way that a fault warning is given on the failure of that component. Any such warning shall be readily distinguishable from the alarm signal.

NOTE It is usual to fit components that have a mean time before failure of more than 5 years.

4.5 Battery removal indication

The heat alarm shall be designed in such a way that removal of any user-replaceable battery used to power, or provide back-up power for, the heat detection circuit/sounder, from a battery or mains-powered d.c.-backed heat alarm, results 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.

4.6 Position of heat-sensitive elements

The heat alarm shall be constructed such that at least part of its heat-sensitive element(s), except elements with auxiliary functions (e.g. characteristic correctors), is $\leqslant$15 mm from the mounting surface of the heat alarm.

4.7 Routine testing facility

Provision shall be made in the construction of the heat alarm, and in the manufacturer's instructions (see Clause **7**), for testing by the domestic user. Such testing shall include the whole of the operating system of the heat alarm, including the integrity of the heat-sensing thermistor.

NOTE This testing is normally carried out by the use of a test switch mounted in the heat alarm cover. Failure of the thermistor (e.g. due to physical damage or corrosion of the leads) is critical to the heat alarm's operation.

4.8 Battery connections

For heat alarms intended for use in LAVs, any leads connecting the terminal connectors of batteries in heat alarms to the heat alarm circuit board shall be provided with strain-relieving devices adjacent to both battery terminal connectors and the heat alarm circuit board so that when the leads are subjected to a pull of 20 N without jerks for 1 min in any direction allowed by the design, the pull is not transmitted to the joints between the leads and the battery terminal connectors or between the leads and the heat alarm circuit board.

4.9 Monitoring of back-up power source

NOTE See also **5.24.2**.

A means shall be provided for monitoring the back-up power source for fault conditions, including low back-up, open circuit and short-circuit failure.

5 Operational requirements

5.1 General

When tested in accordance with the appropriate method specified in Annex A, using the test schedule specified in Annex B, heat alarms shall conform to the requirements specified in **5.3** to **5.20**. Heat alarms shall also conform to the requirements specified in **5.21**, **5.22**, **5.23** and **5.24**, as appropriate.

Where response times are to be measured, the specimen shall be mounted in a heat tunnel as specified in Annex C.

NOTE Further information regarding the construction of the heat tunnel is given in Annex D.

The general procedures specified in **A.1** shall be carried out for all tests.

5.2 Classification

Heat alarms shall conform to class A1, A2 or B, as specified in Table 1.

Table 1 — Heat alarm classification temperatures

Heat alarm class	Typical application temperature °C	Maximum application temperature °C	Minimum static response temperature °C	Maximum static response temperature °C
A1	25	50	54	65
A2	25	50	54	70
B	40	65	69	85

5.3 Directional dependence

When tested in accordance with **A.2**, class A1 heat alarms shall respond between 1 min 0 s and 4 min 20 s at all eight orientations, and class A2 and B heat alarms shall respond between 2 min 0 s and 5 min 30 s at all eight orientations.

5.4 Static response temperature

When tested in accordance with **A.3**, the response temperatures shall lie between the minimum and maximum static response temperatures specified in Table 1 for the appropriate alarm class.

5.5 Response times from typical application temperature

When tested in accordance with **A.4**, the response times shall lie between the lower and upper response time limits specified in Table 2 for the appropriate alarm class.

Table 2 — Response time limits from typical application temperature

Rate of rise of air temperature	Class A1 heat alarms				Class A2, B heat alarms			
	Lower limit of response time		Upper limit of response time		Lower limit of response time		Upper limit of response time	
°C/min	min	s	min	s	min	s	min	s
1	29	0	40	20	29	0	46	0
3	7	13	13	40	7	13	16	0
5	4	9	8	20	4	9	10	0
10	1	0	4	20	2	0	5	30
20	—	30	2	20	1	0	3	13
30	—	20	1	40	—	40	2	25
NOTE Information concerning the derivation of the limits in Table 2 is given in Annex E.								

5.6 Response times from 25 °C

NOTE This requirement is applicable only to class B heat alarms.

When tested in accordance with **A.5**, the response time at 3 °C/min shall exceed 7 min 13 s, and the response time at 20 °C/min shall exceed 1 min 0 s.

5.7 Response times from high ambient temperature (dry heat operational)

When tested in accordance with **A.6**, no alarm or fault signal shall be given during the period when the temperature is increasing to the stabilization temperature or during the stabilization period, and the response times shall lie between the lower and upper response time limits specified in Table 3 for the appropriate alarm class.

Table 3 — Response time limits from maximum application temperature

Rate of rise of air temperature	Class A1 heat alarms				Class A2, B heat alarms			
	Lower limit of response time		Upper limit of response time		Lower limit of response time		Upper limit of response time	
°C/min	min	s	min	s	min	s	min	s
3	1	20	13	40	1	20	16	0
20	—	12	2	20	—	12	3	13

NOTE Information concerning the derivation of the limits in Table 3 is given in Annex E.

5.8 Supply voltage

When tested in accordance with **A.7**, the response times shall lie between the lower and upper response time limits specified in Table 2 for the appropriate heat alarm class.

5.9 Reproducibility

When tested in accordance with **A.8**, the response times shall lie between the lower and upper response time limits specified in Table 2 for the appropriate heat alarm class.

5.10 Operation at low temperature

When tested in accordance with **A.9**:

a) no alarm or fault signal shall be given during the transition to the conditioning temperature or during the period at the conditioning temperature;

b) the response time of the heat alarm at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

c) the response time of the heat alarm at 20 °C/min shall be not less than 30 s for class A1 detectors, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s.

5.11 Humidity

When tested in accordance with **A.10**, the response times shall lie between the lower and upper response time limits specified in Table 2 for the appropriate heat alarm class.

5.12 Corrosion

When tested in accordance with **A.11**:

a) no fault signal, attributable to the endurance conditioning, shall be given on reconnection of the specimen;

b) the response time at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

c) the response time at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s.

5.13 Impact

When tested in accordance with **A.12**:

a) the response time at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

b) the response time at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s, unless, within 30 s of the impact, the heat alarm gives a fault warning that cannot be reset;

c) the impact shall not detach the heat alarm from its mounting.

NOTE An example of a typical test rig for the impact test is described in Annex F.

5.14 Vibration

When tested in accordance with **A.13**:

a) no fire alarm signal or fault warning shall be given during the vibration;

b) no defect that might lead to subsequent failure shall be observed after the vibration;

c) the response time at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

d) the response time at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s.

5.15 Battery fault warning

NOTE This requirement is applicable only to heat alarms incorporating a battery.

When tested in accordance with **A.14**:

a) the response time at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

b) the response time at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s.

5.16 Sound output

When tested in accordance with **A.15**:

a) for mains-powered alarms, the sound output shall be not less than 85 dBA after 4 min of alarm operation;

b) for battery-operated alarms, the sound output shall be not less than 85 dBA after 1 min of alarm operation and not less than 82 dBA after 4 min of alarm operation.

5.17 Interconnection of heat alarms

NOTE See also **5.24**.

5.17.1 When tested in accordance with **A.16.2**, **A.16.3** and **A.16.4**, and with **A.16.1** if appropriate, all the interconnected heat alarms shall give an audible alarm signal.

5.17.2 When tested in accordance with **A.16.5**, with **A.16.1** if appropriate, and, for battery-operated heat alarms, with **A.16.6**:

a) the response time at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

b) the response time at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s.

5.17.3 When tested in accordance with **A.16.7**, and with **A.16.1** if appropriate, the sound output for mains-powered alarms shall be not less than 85 dBA after 4 min of alarm operation.

5.17.4 When tested in accordance with **A.16.7** and **A.16.8**, and with **A.16.1** if appropriate, the sound output for battery-operated alarms shall be not less than 85 dBA after 1 min of alarm operation and not less than 82 dBA after 4 min of alarm operation.

5.18 Battery reversal

When tested in accordance with **A.17**:

a) the response time of the heat alarm measured at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

b) the response time of the heat alarms measured at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s.

5.19 Additional requirements for alarms suitable for installation in LAVs

NOTE The requirements specified in **5.19.1** and **5.19.2** are applicable only to heat alarms that are intended to be suitable for installation in LAVs.

5.19.1 *Vibration (additional)*

When tested in accordance with **A.18.1**:

a) the response time at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

b) the response time at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s.

5.19.2 *Temperature cycle*

When tested in accordance with **A.18.2**:

a) the response time at 3 °C/min shall be not less than 7 min 13 s and any change in the response time compared with the time obtained in **A.8** shall not exceed 2 min 40 s;

b) the response time at 20 °C/min shall be not less than 30 s for class A1 heat alarms, 1 min 0 s for all other classes, and any change in the response time compared with the time obtained in **A.8** shall not exceed 30 s;

c) the specimen shall not emit an alarm signal during the conditioning at –10 °C.

5.20 Battery installation

When tested in accordance with **A.19**, all 25 combinations of batteries and alarms shall operate correctly.

5.21 Safety

5.21.1 Heat alarms shall be protected against electric shock, either in accordance with BS EN 60065:2002, Clause **8**, or by operation from a supply not greater than 34 V (peak or d.c.), which is either independent of the supply mains, or isolated from it by double or reinforced insulation.

5.21.2 For mains-powered equipment, the rated supply voltage shall be 230 V a.c., 50 Hz. If a range of supply voltages is specified, the range shall include 230 V a.c., 50 Hz.

5.21.3 When tested in accordance with the test methods specified in the appropriate part of BS EN 60065:2002, heat alarms shall conform to the appropriate part of BS EN 60065:2002, as specified in Annex G. All safety tests shall be carried out both under normal operating conditions as specified in BS EN 60065:2002, **4.2**, and under fault conditions as specified in BS EN 60065:2002, **4.3**.

5.22 Heat alarms with additional facilities, and heat alarms incorporated into other equipment

Heat alarms with additional facilities, and heat alarms incorporated into other equipment, shall conform to the same requirements as standard heat alarms and shall have a separate power supply to any facilities requiring power (e.g. escape lights).

5.23 Battery capacity

Heat alarms, whether used individually or interconnected, shall only use batteries that can be shown to have the following characteristics:

a) they are capable of supplying the quiescent load of the heat alarm(s) together with the additional load resulting from routine weekly testing, for at least 1 year before the battery fault warning is given;

b) at the point when the battery fault warning commences, they have sufficient capacity to give an alarm signal as specified in **5.16** for at least 4 min in the event of fire, or, in the absence of fire, a battery fault warning for at least 30 days.

NOTE As it is not practicable to run a unit and battery combination for a period of 1 year real-time testing, the test house may accept data concerning the heat alarm loads and the battery characteristics to determine whether these requirements can be met. For interconnected heat alarms, this includes the load introduced by interconnecting the maximum permitted number of heat alarms.

5.24 Back-up power source

5.24.1 *General*

Heat alarms intended for connection to an external power supply, for which an integral back-up/standby power facility is provided, shall only use back-up power sources that can be shown to have the following characteristics:

a) for primary cell battery back-up, the batteries have the characteristics specified in **5.23**;

b) for rechargeable back-up power sources, the back-up power source is capable of supplying the quiescent load of the heat alarm for a minimum period of 72 h followed by an alarm signal as specified in **5.16** for at least 4 min in the event of fire, or in the absence of a fire, a fault warning for at least 24 h.

NOTE As it is not practicable to run a unit and battery combination for a period of 1 year real-time testing, the test house may accept data concerning the heat alarm loads and the battery characteristics to determine whether these requirements can be met.

5.24.2 *Monitoring of back-up power source*

NOTE See also **4.9**.

5.24.2.1 *Low back-up*

When the back-up supply voltage is decreased to below the minimum level specified by the manufacturer, a low back-up signal shall be obtained both with mains power to the unit and without mains power to the unit.

5.24.2.2 *Open circuit*

When the back-up power supply is disconnected or removed as appropriate and mains power applied to the unit, the alarm shall give an audible and/or visual warning.

5.24.2.3 *Short-circuit*

When the back-up power supply is disconnected and replaced with a short-circuit between the back-up terminals and the mains power applied to the unit, the alarm shall give an audible and/or visual warning.

6 Marking

6.1 Each heat alarm shall be indelibly marked in accordance with BS EN 60065:2002, **5.1** and BS EN 60065:2002, **5.2**, and with the following:

a) the number and date of this part of BS 5446, i.e. BS 5446-2:2003[1]);

b) the name or trade mark of the manufacturer or supplier;

c) the model designation and class, i.e. A1, A2 or B;

d) the date of manufacture, or the batch number;

e) the address of an organization capable of being responsible for servicing or repair, which shall be visible after installation;

f) the manufacturer's recommended date for replacement, subject to normal, regular maintenance, which shall be visible after installation;

g) the voltage and frequency at which the alarm is intended to be operated;

h) on heat alarms incorporating user-replaceable batteries, the type or numbers of batteries recommended by the manufacturer and the instruction "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;

i) on heat alarms incorporating non-replaceable batteries: the warning "WARNING — Battery not replaceable — see instruction manual", which shall be visible during normal use.

NOTE It is not necessary for the marking to be visible after installation except where specified.

[1]) Marking BS 5446-2:2003 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.

6.2 For class I apparatus, as defined in BS EN 60065:2002, the following information shall be given close to the mains input terminals: "WARNING — THIS APPARATUS MUST BE EARTHED".

6.3 If live parts are made accessible when a cover is removed or opened, a warning shall be displayed which is visible before the cover is removed or opened.

6.4 There shall be a clear statement that the heat alarm is not suitable for use as a fire safety device unless it is part of a planned fire safety system, i.e. when interconnected to one or more smoke alarm(s).

6.5 When rubbed lightly with a piece of cloth soaked with petroleum spirit or with water, as specified in BS EN 60065:2002, Clause **5**, the marking shall not deteriorate.

7 Provision of information

The following information shall be supplied on or with heat alarms.

a) All heat alarms shall include instructions on siting, installation, maintenance and user actions in accordance with BS 5839-6:1995, Clause **10** and Clause **22**. They shall also include a recommendation that the operation of the alarm is tested with the test facility at regular intervals, and instructions on how to use the facility.

b) All heat alarms 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.

c) For heat alarms incorporating user-replaceable batteries, specific guidance shall be given on changing the batteries. This guidance shall include any advice that is necessary to ensure that the battery is properly connected. It shall also include the instruction specified in **6.1**h) regarding the test facility.

NOTE It is recommended that the guidance should also state that if the alarm fails to operate correctly, the advice of the servicing/repair organization marked on the alarm should be sought.

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

e) Information shall be given on the maximum number of alarms that may be interconnected. Details of suitable cables shall also be given.

f) For heat alarms intended for connection to mains supplies, a warning shall be given that draws attention to the hazards associated with mains voltages and recommends that the heat alarm, together with any associated supply and interconnect wiring, be installed in accordance with BS 7671.

g) If it is claimed that a heat alarm is suitable for use in leisure accommodation vehicles (LAVs), this shall be clearly stated in the information supplied on or with the heat alarm (see also **5.19**).

Annex A (normative) Test methods

A.1 General

A.1.1 *Test specimens*

The specimens used in the tests shall be representative of the manufacturer's normal production with regard to their construction and calibration.

A minimum of 15 specimens, including mounting brackets and bases, shall be provided for the tests specified in **A.2** to **A.19**, which shall be carried out in accordance with the schedule specified in Annex B. Additional specimens shall be provided as necessary or as specified in individual tests.

A.1.2 *Atmospheric conditions for tests*

Unless otherwise specified in the test procedure, testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as follows:

a) temperature: (15 to 35) °C;

b) relative humidity: (25 to 75) %;

c) air pressure: (86 to 106) kPa.

NOTE If variations in these parameters have a significant effect on a measurement, then such variations should be kept to a minimum during a series of measurements carried out as part of one test on one specimen.

A.1.3 *Operating conditions for tests*

If a test requires a specimen to be operational, the specimen shall be connected to the power source as marked on the specimen (see Clause **6** and BS EN 60065:2002, Clause **5**).

Unless otherwise specified in the test procedure, the power source parameters applied to the specimen shall be within the manufacturer's specified range(s), as marked on the specimen (see Clause **6** and BS EN 60065:2002, Clause **5**), throughout the test.

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

A.1.4 *Tolerances*

Unless otherwise specified in the test procedure, the tolerances for the environmental test parameters shall be as given in the basic reference standards for the test (i.e. the relevant part of BS 2011 or BS EN 60068).

If a requirement or test procedure does not specify a tolerance or deviation limits, then deviation limits of ±5 % shall be applied.

A.1.5 *Associated equipment*

In all tests requiring the heat alarm to be in an operating condition, any associated equipment (such as control equipment or power supplies) shall meet any requirements specified by the manufacturer of that equipment.

A.1.6 *Warm-up and resetting times*

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

A.1.7 *Measurement of response time*

A.1.7.1 Before commencing the tests specified in **A.3** to **A.19**, determine the orientation of the alarm giving the maximum response time in accordance with **A.2**. Carry out all measurements of the response time in the remaining tests with the alarm in this orientation, unless otherwise specified for particular tests.

NOTE The procedure in **A.2** is carried out first to determine the orientation that has to be used in all subsequent testing. Once the procedure in **A.2** has been carried out, there is no need to repeat it except where specified.

A.1.7.2 The specimen for which the response time is to be measured shall be mounted by its normal means of attachment in accordance with the manufacturer's instructions (see Clause **7**), in a heat tunnel conforming to Annex C. The specimen shall be mounted in its normal operating position on the underside of the board specified in **C.3**.

NOTE Further information concerning the construction of the heat tunnel is given in Annex D.

A.1.7.3 Before the response time is measured, the temperature of the air stream and the specimen shall be stabilized to the temperature specified in the relevant test procedure. The measurement shall then be made by increasing the air temperature in the heat tunnel linearly with respect to time, at the rate of rise specified in the relevant test procedure, until the supply and monitoring equipment indicates an alarm or until the upper limit of response time for the test is exceeded.

A.1.7.4 During the measurement the airflow shall be maintained at a constant mass flow, equivalent to (0.8 ± 0.1) m/s at 25 °C, and the air temperature shall be controlled to within ±2 °C of the nominal temperature required at any time during the test (see Annex C). The response time shall be taken as the time interval between the start of the temperature increase and the indication of an alarm from the heat alarm or monitoring equipment.

NOTE 1 Linear extrapolation of the stabilized and the increasing temperature against time lines may be used to establish the effective start time of the temperature increase.

NOTE 2 Care should be taken not to subject heat alarms to a damaging thermal shock when transferring them to and from a stabilization or alarm temperature.

A.2 Directional dependence test

NOTE The objective of this test is to determine whether the response time of a heat alarm is unduly dependent on the direction of airflow around the heat alarm.

Before each test, stabilize the specimen(s) to the typical application temperature specified in Table 1 according to the class marked on the specimen.

Test each specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at a rate of rise of air temperature of 10 °C/min. Make eight such tests, rotating the specimen about a vertical axis by 45° between successive tests so that tests are made with eight different orientations.

Record the response time at the eight orientations, and the orientations at which the maximum and minimum response times were measured.

A.3 Static response temperature test

NOTE The objective of this test is to determine whether a heat alarm is able to respond correctly to a slow rate of rise of air temperature.

Before each test, stabilize the specimens to the typical application temperature specified in Table 1 according to the class marked on each specimen.

Test each specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at a rate of rise of air temperature of 1 °C/min until the maximum application temperature is reached as specified in Table 1 according to the class marked on the specimen. Thereafter, continue the test to a maximum rate of rise of air temperature of 0.2 °C/min. Test one specimen at the orientation that gave the maximum response time and the other at the orientation that gave the minimum response time in **A.2**.

Record the temperature at which each specimen responds.

A.4 Test for response times from typical application temperature

NOTE The objective of this test is to determine whether a heat alarm, when stabilized at its typical application temperature, is able to respond correctly over a range of rates of rise of air temperature.

Before each test, stabilize the specimens to the typical application temperature specified in Table 1 according to the class marked on each specimen.

Test each specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of (1, 3, 5, 10, 20 and 30) °C/min. For each rate of rise of air temperature, test one specimen at the orientation that gave the maximum response time and the other at the orientation that gave the minimum response time in **A.2**.

Record the response time for each rate of rise of air temperature for each specimen.

A.5 Test for response times from 25 °C

NOTE The objective of this test is to determine whether heat alarms in a class with a typical application temperature above 25 °C (see Table 1) exhibit an abnormally fast response to normal increases in temperature. This test is therefore not applicable to class A1 or A2 heat alarms.

Before each test, stabilize the specimen to 25 °C.

Test the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the minimum response time in **A.2**.

Record the response times for both rates of rise of air temperature.

A.6 Test for response times from high ambient temperature (dry heat operational)

NOTE The objective of this test is to determine whether a heat alarm is able to function correctly at high ambient temperatures.

Before each test, stabilize the specimen for 2 h at the maximum application temperature specified in Table 1 according to the class marked on the specimen, at a rate of rise of air temperature up to the stabilization temperature not greater than 1 °C/min.

Test the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the maximum response time in **A.2**.

Record the response times for both rates of rise of air temperature.

A.7 Supply voltage test

A.7.1 *Voltage limits*

NOTE The objective of this test is to determine whether the heat alarm sensitivity is likely to be unduly affected by variations in supply voltage beyond the voltage range specified by the manufacturer.

A.7.1.1 For battery-operated heat alarms, carry out the tests with a supply voltage corresponding to that of a new battery, and also with a supply voltage of V_E as determined in **A.14**b).

A.7.1.2 For heat alarms intended for operation from mains supplies, test the specimen with supply voltages of 0.85 times the lower limit and 1.1 times the upper limit of the nominal supply voltage range specified by the manufacturer. If the heat alarm is provided with a rechargeable battery, allow time for the battery voltage to stabilize before the response time is measured.

A.7.1.3 For heat alarms intended to operate from any external supply other than mains, conduct the tests at the maximum and minimum voltage marked on the heat alarm (see Clause **6**).

A.7.2 *Procedure*

Before each test, stabilize the specimens to the typical application temperature specified in Table 1 according to the class marked on each specimen.

Test each specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the maximum response time in **A.2**, at the upper and lower limits of the supply parameters (e.g. voltage) range specified by the manufacturer.

Record the response times for both rates of rise of air temperature at each supply parameter limit.

A.8 Reproducibility test

NOTE The objectives of this test are to determine whether the response times of the specimens are within the required limits and to establish response time base data for comparison with the response times measured after the environmental tests.

Before each measurement, stabilize the specimens to the typical application temperature specified in Table 1 according to the class marked on each specimen.

Measure the response time of each specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the maximum response time in **A.2**.

Record the response times for both rates of rise of air temperature for each specimen.

A.9 Test for operation at low temperature

NOTE The objective of this test is to determine whether a heat alarm is able to function correctly after exposure to low ambient temperatures appropriate to the anticipated service temperature.

A.9.1 *General*

The apparatus shall be as described in BS EN 60068-2-1. The procedure shall be in accordance with BS EN 60068-2-1 and additionally as specified in **A.1.5**, **A.1.7.2**, **A.9.2** and **A.9.3**.

A.9.2 *Conditioning*

Condition the specimen as follows:

— temperature: (–10 ± 3) °C;

— duration: 16 h.

NOTE BS EN 60068-2-1 specifies rates of change of temperature of ⩽1 °C/min for the transitions to and from the conditioning temperature.

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

A.9.3 *Final measurements*

Before each measurement, stabilize the specimen to the typical application temperature specified in Table 1 according to the class marked on the specimen.

Measure the response time of the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the maximum response time in **A.2**.

Record the response times for both rates of rise of air temperature.

A.10 Humidity test

NOTE The objective of this test is to determine whether a heat alarm is able to function correctly at high relative humidities, which can occur for short periods in the anticipated environment.

Dry the specimen at a temperature of (40 ± 3) °C and a relative humidity of less than 45 % for a period of at least 24 h without energizing. Energize the specimen and after a 15 min stabilization period, increase the relative humidity over a period of 1 h to (92 ± 3) %, keeping the temperature at (40 ± 3) °C.

Maintain this temperature and humidity for a period of 10 days. At the end of this period reduce the temperature to (30 ± 3) °C keeping the humidity at (92 ± 3) %. Reset the alarm if it emits an alarm signal or gives a fault warning.

Maintain these conditions for 24 h. Test the specimen at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the maximum response time in **A.2**. Keep the specimen for three days at a temperature of (22 ± 3) °C and a relative humidity of (60 ± 3) %, and measure it again at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the maximum response time in **A.2**.

For heat alarms incorporating an alarm silence facility, make a further measurement in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4**.

Record the response times for both rates of rise of air temperature.

A.11 Corrosion test

NOTE The objective of this test is to determine whether a heat alarm is able to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

A.11.1 *General*

The apparatus and procedure shall be in accordance with BS 2011-2.1Kc, except that the mounting shall be in accordance with **A.1.7.2** and the conditioning with **A.11.2**.

A.11.2 ***Conditioning***

Condition the specimen(s) as follows:

a) temperature: (25 ± 2) °C;

b) relative humidity: (93 ± 3) %;

c) SO_2 concentration: a volume fraction of (0.002 5 ± 0.000 5) %;

d) duration: 4 days.

The specimen(s) shall not be supplied with power during the conditioning, but shall have untinned copper wires, of the appropriate diameter, connected to sufficient terminals to allow the final measurement to be made without making further connections to the specimen.

A.11.3 ***Final measurements***

Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, ⩽50 % relative humidity, followed by a recovery period of at least 1 h at the standard laboratory conditions. After this, measure the response time of the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min at the orientation that gave the maximum response time in **A.2**. Before each measurement, stabilize the specimen to the typical application temperature specified in Table 1 according to the class marked on the specimen.

Record the response times for both rates of rise of air temperature.

A.12 Impact test

NOTE The objective of this test is to determine whether a heat alarm is immune to mechanical impacts upon its surface, which it might sustain in its normal working environment and which it can reasonably be expected to withstand.

A.12.1 ***Apparatus***

A.12.1.1 *Swinging hammer*, having a rectangular-section aluminium alloy head (aluminium alloy AlCu4SiMg conforming to ISO 209-1:1989), solution-treated and precipitation-treated, with the plane impact face chamfered to an angle of 60° to the horizontal, when in the striking position (i.e. when the hammer shaft is vertical). The hammer head shall be (50 ± 2.5) mm high, (76 ± 3.8) mm wide and (80 ± 4) mm long at mid height.

NOTE An example of a typical test rig for the impact test is described in Annex F.

A.12.2 ***Procedure***

Mount the specimen on a rigid surface by means of its normal fastenings and in its normal operating position at the orientation that gave the maximum response time in **A.2**. Strike the specimen with the hammer. Deliver the blow in a horizontal direction with the point of impact on the upper half of the impact face. Choose the azimuthal direction and impact point relative to the specimen as that most likely to impair the correct operation of the heat alarm. The kinetic energy and the velocity of the hammer immediately before impact shall be 1.9 J ± 10 % and 1.5 m/s ± 10 % respectively. After the impact, measure the response time of the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min.

Record the response times for both rates of rise of air temperature.

A.13 Vibration test

NOTE The objective of this test is to determine whether a heat alarm is immune to vibration at levels considered appropriate to its normal working environment.

Mount the specimen on a vibrating platform secured by its normal fastenings and in its normal operating position at the orientation that gave the maximum response time in **A.2**. Apply sinusoidal vibration in a direction perpendicular to the plane of the mounting bracket while the specimen is in its normal condition.

Sweep the frequency of vibration from 5 Hz to 60 Hz at a rate of (1.8 ± 0.2) octaves per hour, making a single sweep of approximately 2 h duration, giving a peak acceleration of the mounting, measured in metres per second squared (m/s^2), of $(0.7 \times \sqrt{f}) \pm 10\ \%$, where f is the instantaneous frequency in hertz (Hz) (see BS 5446-1:2000, Clause **19**).

After the vibration sweep, remove the specimen from the platform and measure the response time of the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min.

Record the response times for both rates of rise of air temperature.

A.14 Battery fault warning test

NOTE This test is applicable only to heat alarms incorporating a battery. The objective of this test is to determine whether a heat alarm gives an audible fault warning before an increase in the internal resistance or decrease in the terminal voltage of the battery prevents correct operation.

Connect the specimen as shown in Figure A.1 and carry out the following tests.

a) With the series resistor R set to zero and the supply voltage V set to the rated battery voltage V_R, measure the response time of the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min.

b) With the series resistor R set to zero, decrease the supply voltage V in increments of 0.1 V at intervals of at least 1 min, until the fault warning is given. Record the supply voltage at which the fault warning is given as V_E and measure the response time of the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min.

c) With the supply voltage V set at V_R, increase the resistance of the series resistor R from zero in increments of 0.1 Ω at intervals of at least 1 min until the fault warning is given. Record the resistance of the series resistor at which the fault warning is given as R_A and measure the response time of the specimen in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min.

d) Repeat the procedure described in c) with the supply voltage V set at $0.75(V_R - V_E) + V_E$, $0.5(V_R - V_E) + V_E$ and $0.25(V_R - V_E) + V_E$ in turn, and record the resistances of the series resistor at which the fault warning is given as R_B, R_C, and R_D respectively.

Record the response times for both rates of rise of air temperature.

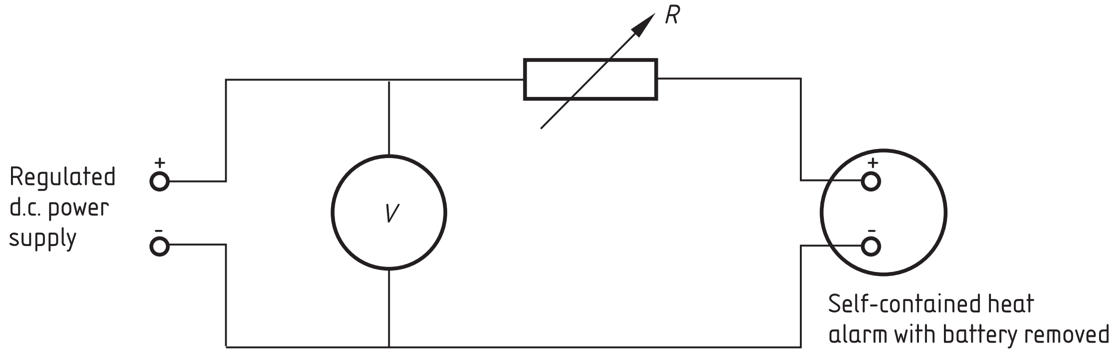


Figure A.1 — Battery fault warning test circuit

A.15 Sound output test

NOTE The objective of this test is to determine whether the sound output of a heat alarm is sufficient to draw attention to an alarm condition under normal circumstances.

The alarm condition used to measure sound output shall be generated in the specimen under test by exposure to heat, rather than by using the test facility.

The specimen shall be tested in either free field conditions or using an anechoic chamber, at a rate of rise of air temperature of 3 °C/min.

a) For free field testing, connect the specimen to a source of rated voltage and frequency and mount it on a wooden surface at least 125 mm by 150 mm, not less than 3 m from the ground and with a microphone located 3 m from the specimen. The front of the heat alarm shall be at 90° to the horizontal and facing the microphone. The test shall be conducted outdoors on a clear day with a wind velocity of not more than 8 km/h, an ambient temperature of 15 °C to 25 °C and an ambient noise level at least 10 dB below the measured level produced by the alarm.

b) For anechoic chamber testing, mount the specimen in an anechoic chamber of not less than 28 m^3, with no dimension less than 2 m and an absorption factor of 0.99 or greater from 100 Hz to 10 kHz for all surfaces, and with a microphone located 3 m from the specimen. The front of the heat alarm shall be at 90° to the horizontal and facing the microphone.

For a battery-operated (or equivalent) unit the battery shall be depleted to a point just above or at the battery fault warning level.

Measure the sound output using a sound level meter conforming to BS EN 60651.

Record the sound output.

A.16 Tests for interconnection of heat alarms

NOTE The objective of this test is to determine whether the means provided for connecting together a number of heat alarms is likely to affect the performance of any of the alarms.

A.16.1 Heat alarms intended for multiple-station interconnection shall be tested with the maximum line resistance.

A.16.2 Connect the specimen to be tested with the maximum number of heat alarms allowed in the manufacturer's instructions (see note and Clause **7**).

NOTE If more than five heat alarms may be interconnected it is permissible to interconnect a minimum of five alarms and simulate the remainder by an equivalent electrical load. Only the alarm to be tested is mounted within the heat tunnel.

A.16.3 Trigger one heat alarm into the alarm condition and check that each of the interconnected alarms emits an audible alarm signal. Only carry out the test if all the interconnected alarms are functioning correctly.

A.16.4 If the heat alarms have an alarm silence facility, operate the alarm silence control on one heat alarm and, during the alarm silence period, trigger another heat alarm into the alarm condition. Check the interconnected heat alarms for an audible alarm signal, including the heat alarm in the alarm silence condition.

A.16.5 With the heat alarms interconnected in accordance with the manufacturer's instructions, measure the response time of the specimen under test in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min. Record the response times for both rates of rise of air temperature.

A.16.6 For battery-operated heat alarms repeat the test in **A.16.5** twice: once with the interconnecting leads short-circuited and once with the interconnecting leads open circuited.

NOTE This test does not apply to mains or mains/battery supplied heat alarms, for which the supply and interconnect wiring should be installed in accordance with BS 7671 (see Clause **7**).

A.16.7 With heat alarms interconnected in accordance with the manufacturer's instructions, repeat the sound output test in **A.15** on one of the heat alarms.

NOTE During this test the other interconnected heat alarms should be screened or distanced so that their audible alarm signals do not influence the measurement.

A.16.8 For battery-operated heat alarms repeat the test in **A.16.7** with interconnecting leads short-circuited.

A.17 Battery reversal test

NOTE The objective of this test is to determine whether a heat alarm is able to function properly after being wrongly connected with respect to polarity.

Carry out the battery reversal test on heat alarms incorporating replaceable batteries if there is any possibility of the heat alarm being subjected to reversed polarity of the supply during normal battery replacement.

With a new battery fitted in the specimen, measure the response time in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min. Remove the battery and apply it to the specimen with reverse polarity for 10 s to 15 s. Refit the battery in the specimen with the correct polarity and measure the response time again. Apply a voltage to the specimen of V_{E-5}^{+0} % as determined in **A.14**.

Record the response times for both rates of rise of air temperature.

A.18 Additional tests for alarms suitable for installation in LAVs

A.18.1 *Vibration test (additional)*

NOTE The objective of this test is to determine whether a heat alarm is susceptible to damage from the type of vibration produced in LAVs.

After the test in **A.13** has been conducted, apply the following vibration conditioning with the battery fitted and the specimen rigidly mounted on the vibrating platform:

a) frequency range: 10 Hz to 150 Hz;

b) acceleration amplitude: 9.81 m/s^2;

c) number of axes: three;

d) number of sweep cycles per axis: 20.

Measure the response time of the heat alarm in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min.

Record the response times for both rates of rise of air temperature.

A.18.2 *Temperature cycle test*

NOTE 1 The objective of this test is to determine whether a heat alarm is susceptible to damage from the levels of temperature likely to be experienced in LAVs.

After the test in **A.10** has been conducted, stabilize the specimen at (25 ± 2) °C and apply the following temperature cycle 10 times.

NOTE 2 At 65 °C the heat alarm is expected to go into the alarm condition.

a) Raise the temperature to (65 ± 2) °C in (2 ± 0.5) h.

b) Hold the temperature at (65 ± 2) °C until 8.5 h after the beginning of the cycle.

c) Reduce the temperature to (–10 ± 2) °C in (4 ± 1) h.

d) Hold the temperature at (–10 ± 2) °C until 19.5 h after the beginning of the cycle.

e) Increase the temperature to (25 ± 2) °C in (2 ± 0.5) h.

f) Hold the temperature at (25 ± 2) °C until 24 h after the beginning of the cycle.

After this temperature cycle conditioning has been applied, measure the response time of the heat alarm in accordance with **A.1.7.2**, **A.1.7.3** and **A.1.7.4** at rates of rise of air temperature of 3 °C/min and 20 °C/min.

Record the response times for both rates of rise of air temperature.

A.19 Battery installation test

NOTE The objective of this test is to check a selection of alarms against a selection of batteries to ascertain whether they operate correctly after the battery has been replaced.

A.19.1 *General*

The battery installation test shall be conducted on any heat alarm that incorporates user-replaceable batteries. Five heat alarms shall be chosen at random from amongst the 15 specimens provided for the test.

A supply of 20 batteries recommended by the manufacturer of the alarm shall be used for this test. A random selection shall be made from the recommended batteries available at sales outlets.

Select the five batteries that will give the most adverse combinations of dimensions between the battery, its holder and the connector.

A.19.2 *Procedure*

Fit all the selected batteries to all the selected alarms so that all combinations are tried, following the manufacturer's fitting instructions (see Clause **7**).

Test each combination of battery and alarm for correct operation, using the test facility of the alarm.

Annex B (normative) Test schedule

The tests specified in **A.2** to **A.19** shall be carried out in accordance with the test schedule specified in Table B.1.

NOTE 1 Each specimen in the sample is allocated an identity number from 1 to 15; the identity numbers in Table B.1 indicate the individual specimen(s) to be used in each test. This is to ensure that where the tests are destructive, the same specimen is not used for more than one test.

NOTE 2 The battery installation and safety tests are not included in Table B.1.

Table B.1 — Test schedule for resettable heat alarms

Test	Test specified in	Identity number of specimen(s) to be tested at each rate of rise of air temperature						
		<0.2 °C/min	1 °C/min	3 °C/min	5 °C/min	10 °C/min	20 °C/min	30 °C/min
Directional dependence	**A.2**	—	—	—	—	1	—	—
Static response temperature	**A.3**	1, 2	—	—	—	—	—	—
Response times from typical application temperature	**A.4**	—	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2
Response times from 25 °C	**A.5**	—	—	1	—	—	1	—
Response times from high ambient temperature	**A.6**	—	—	1	—	—	1	—
Supply voltage	**A.7**	—	—	1, 2	—	—	1, 2	—
Reproducibility	**A.8**	—	—	3 to 15	—	—	3 to 15	—
Low temperature	**A.9**	—	—	3	—	—	3	—
Humidity	**A.10**	—	—	4	—	—	4	—
Corrosion	**A.11**	—	—	5	—	—	5	—
Impact	**A.12**	—	—	6	—	—	6	—
Vibration	**A.13**	—	—	7	—	—	7	—
Battery fault warning	**A.14**	—	—	8	—	—	8	—
Sound output	**A.15**	—	—	9	—	—	—	—
Interconnection of heat alarms	**A.16**	—	—	10[a]	—	—	10[a]	—
Battery reversal	**A.17**	—	—	11	—	—	11	—
Additional tests for LAVs:								
— Vibration (additional)	**A.18.1**	—	—	14	—	—	14	—
— Temperature cycle	**A.18.2**	—	—	14	—	—	14	—

[a] This number relates to the specimen that is to be placed in the heat tunnel. The total number of specimens to be provided for the test is determined by the maximum number of heat alarms allowed in the manufacturer's instructions.

Annex C (normative) Heat tunnel for response time and response temperature measurements

NOTE This annex specifies those properties of the heat tunnel that are of primary importance for making repeatable and reproducible measurements of response time and static response temperature of heat alarms. However, since it is not practical to specify and measure all parameters that might influence the measurements, the background information in Annex D should be taken into account when a heat tunnel is designed and used to make measurements in accordance with this part of BS 5446.

C.1 The heat tunnel shall be in accordance with **C.1** to **C.7** for each class of heat alarm it is used to test.

C.2 The heat tunnel shall have a horizontal working section containing a working volume, which shall be large enough to fully enclose the heat alarm to be tested, the required amount of mounting board and the temperature-measuring sensor. The working volume shall be a defined part of the working section, where the air temperature and airflow conditions are within ±2 °C and ±0.1 m/s of the nominal test conditions, respectively.

NOTE Figure D.1 shows an example of a working section.

C.3 The heat tunnel shall include a flat board, on the underside of which the specimen to be tested can be mounted in its normal operating position, aligned with the airflow in the working volume. The board shall be (5 ± 1) mm thick and of such dimensions that the edge(s) of the board are at least 20 mm from any part of the heat alarm. The edge(s) of the board shall be semi-circular and the airflow between the board and the tunnel ceiling shall not be unduly obstructed. The material from which the board is made shall have a thermal conductivity not greater than 0.52 $W \cdot m^{-1} \cdot °C^{-1}$.

C.4 Means shall be provided for creating a stream of air through the working volume at the constant temperatures and rates of rise of air temperature specified for the classes of heat alarm to be tested. This air stream shall be essentially laminar and maintained at a constant mass flow, equivalent to (0.8 ± 0.1) m/s at 25 °C.

C.5 The temperature sensor shall be positioned at least 50 mm upstream of the heat alarm and at least 25 mm below the lower surface of the mounting board. The air temperature shall be controlled to within ±2 °C of the nominal temperature required at any time during the test.

C.6 The air temperature measuring system shall have an overall time constant of not greater than 2 s, when measured in air with a mass flow equivalent to (0.8 ± 0.1) m/s at 25 °C.

C.7 Means shall be provided for measuring the response time of the heat alarm under test to an accuracy of ±1 s.

Annex D (informative) Information concerning the construction of the heat tunnel

Heat alarms respond when the signal(s) from one or more sensors fulfil certain criteria. The temperature of the sensor(s) is related to the air temperature surrounding the heat alarm but the relationship is usually complex and dependent on several factors, such as orientation, mounting, air velocity, turbulence, rate of rise of air temperature, etc. Response times and response temperature and their stability are the main parameters considered when the fire detection performance of heat alarms is evaluated by testing in accordance with this part of BS 5446.

Many different heat tunnel designs are suitable for the tests specified in this part of BS 5446 but the following points should be considered when designing and configuring a heat tunnel.

There are two basic types of heat tunnel: recirculating and non-recirculating. All else being equal, a non-recirculating tunnel requires a higher power heater than a recirculating tunnel, particularly for the higher rates of rise of air temperature. More care is generally needed to ensure that the high power heater and control system of a non-recirculating tunnel are sufficiently responsive to the changes in heat demand necessary to attain the required temperature versus time conditions in the working section. On the other hand, maintaining a constant mass flow with increasing temperature is generally more difficult in a recirculating tunnel.

The temperature control system should be able to maintain the temperature within ±2 °C of the "ideal ramp" for all of the specified rates of rise of air temperature. Such performance can be achieved in different ways, e.g.:

— by proportional heating control, where more heating elements are used when generating higher rates of rise. Improved temperature control may be achieved by powering some of the heating elements continuously, while controlling others. With this control system the distance between the tunnel heater and the heat alarm under test should not be so large that the intrinsic delay in the temperature control feedback loop becomes excessive at an airflow of 0.8 m/s;

— by rate controlled feed forward heating control, assisted by proportional/integral (PI) feedback. This control system permits greater distance between the tunnel heater and the detector under test.

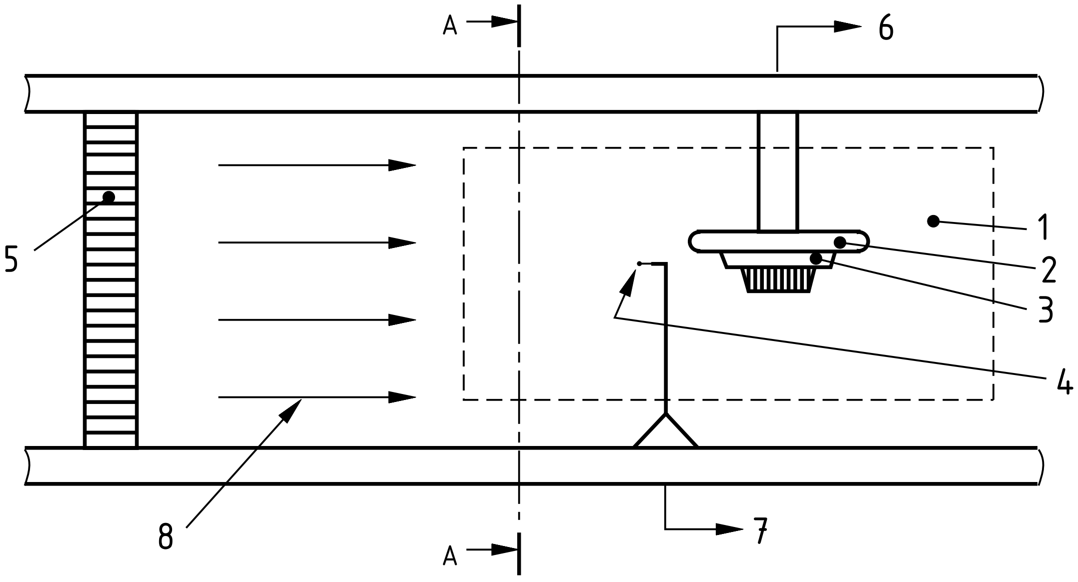
The important thing is that the specified temperature profiles are obtained with the required accuracy within the working section.

For a non-recirculating tunnel, the anemometer used for airflow control and monitoring may be placed in a section of the tunnel upstream of the heater where it will be subject to a substantially constant temperature, thereby eliminating any need to temperature-compensate its output. A constant velocity, indicated by an anemometer so positioned, should correlate with a constant mass flow through the working volume. However, to maintain a constant mass flow at normal atmospheric pressure in a recirculating tunnel, it is necessary to increase the air velocity as the air temperature is increased. Careful consideration should therefore be given to ensuring that an appropriate correction is made for the temperature coefficient of the anemometer monitoring the airflow. It should not be assumed that an automatically temperature-compensated anemometer will compensate sufficiently quickly at high rates of rise of air temperature.

The airflow created by a fan in the tunnel will be turbulent, and needs to pass through an air straightener to create a nearly laminar and uniform airflow in the working volume (see Figure D.1 and Figure D.2). This can be facilitated by using a filter, honeycomb or both, in line with, and upstream of the working section of the tunnel. Care should be taken to ensure that the airflow from the heater is mixed to a uniform temperature, before entering the flow straightener.

It is not possible to design a tunnel where uniform temperature and flow conditions prevail in all parts of the working section. Deviations will exist, especially close to the walls of the tunnel, where a boundary layer of slower and cooler air will normally be observed. The depth of this boundary layer and the temperature gradient across it can be reduced by constructing or lining the walls of the tunnel with a low thermal conductivity material.

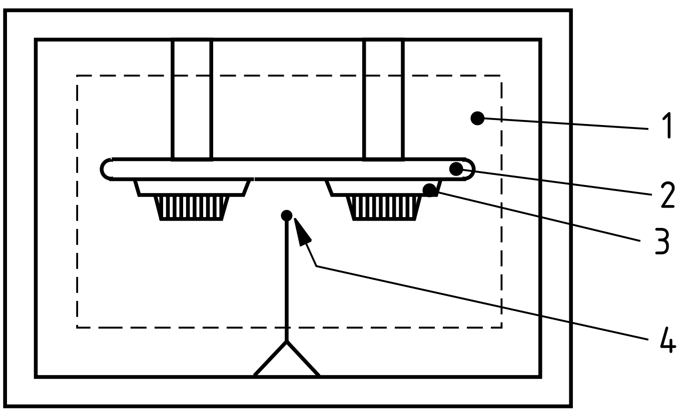
Particular attention should be given to the temperature measuring system in the tunnel. The required overall time constant of not greater than 2 s in air, means that the temperature sensor should have a very small thermal mass. In practice only the fastest thermocouples and similar small sensors will be adequate for the measuring system. The effect of heat loss from the sensor via its leads can normally be minimized by exposing several centimetres of the lead to the airflow.



Key

1 Working volume
2 Mounting board
3 Detector(s) under test
4 Temperature sensor
5 Flow straightener
6 To supply and monitoring equipment
7 To control and measuring equipment
8 Airflow
A See Figure D.2

Figure D.1 — Example of working section of heat tunnel



A - A

Key

1 Working volume
2 Mounting board
3 Detector(s) under test
4 Temperature sensor

Figure D.2 — Example of mounting arrangement for simultaneously testing two detectors (section A-A as shown in Figure D.1)

Annex E (informative) Derivation of upper and lower limits of response times

E.1 General

The upper and lower limits of response times specified in this part of BS 5446 were derived using the same equations that were used to derive the limits specified in BS EN 54-5. However, in the interest of harmonization and the light of experience, the value of some of the thermal constants used in the equations deviate slightly from their original value. For reference purposes the thermal constants and equations used for the derivation of the limits in this part of BS 5446 are set out below.

E.2 Upper limits

Upper limits of response times are derived from the theoretical response times of idealized detectors containing only a static element (fixed temperature detector). Assuming no heat losses from the sensing element, the response time of such a detector under constant conditions of air mass flow and rate of rise in air temperature depends on two design properties. The first is the time constant T of the sensing element as expressed by equation E.1.

$$T = \frac{C}{HA} \tag{E.1}$$

where

- A is the surface area of the element
- C is the thermal capacity of the heat-sensitive element
- H is the coefficient of convective heat transfer to the element

The second property is the temperature at which the detector will give an alarm when subjected to an infinitely slow rate of rise of air temperature, its fixed temperature setting, which is normally set by an adjustment of a gap between contacts, electrical resistance, etc.

A decrease in either of these properties will result in a decrease in the response time of the detector at any given rate of rise of air temperature. Hence a detector having a high response time (low sensitivity) will have a high temperature setting or a long time constant or both, while a detector having a low response time (high sensitivity) will have lower values of either or both.

Assuming no heat losses, the temperature rise θ of the heat-sensitive element at any time t, when subject to a constant mass flow with linearly increasing temperature α, is given by equation E.2.

$$T\frac{d\theta}{dt} + \theta = \alpha t \tag{E.2}$$

The solution of this equation is given by equation E.3.

$$\theta = \alpha\left\{t - T\left[1 - e^{(t/T)}\right]\right\} \tag{E.3}$$

If θ_0 is the operating temperature rise of the sensitive element (the difference between the alarm and the stabilization temperatures) then the response time is given by the root of equation E.2 with θ set to θ_0. The two sets of upper response time limits given in Table 2 and Table 3 were calculated using the values shown in Table E.1.

Table E.1 — Thermal constants used to derive upper limits in Table 2 and Table 3

Heat alarm class	Thermal constants for upper limits	
	Temperature rise θ_0 °C	Time constant T s
A1	40	20
A2, B	45	60

The time constants shown in Table E.1 are referenced to an airflow of 0.8 m/s and should not be confused with the response time index (*RTI* in $m^{1/2}$ $s^{1/2}$) commonly used in other heat detector standards. *RTI* referenced to 1 m/s is related to the time constant T_u at an airflow u by equation E.4.

$$RTI = T_u\sqrt{u} \tag{E.4}$$

A time constant referenced to 1 m/s has the same numerical value as the *RTI* referenced to 1 m/s.

E.3 Lower limits

The purpose of imposing lower limits on the response times of detectors is to minimize the incidence of false alarms due to changes in air temperature that occur under non-fire conditions.

An analysis of the performance of rate of rise detectors made by many manufacturers has shown that, with the exception of detectors that have a performance equivalent to class A1, they alarm at substantially the same temperature at rates of rise of between 1 °C/min and 30 °C/min. In the light of this finding and the wide range of application conditions in which these detectors may be installed, the minimum increase in temperature necessary to cause an alarm for detectors other than class A1 has been set at 20 °C for rates of rise of 10 °C/min and above, starting from an initial temperature at or below the typical application temperature. For class A1 detectors the minimum rise in temperature to cause an alarm has been set at 10 °C for rates of rise of 10 °C/min and above because it is envisaged that class A1 detectors will be installed in environments that are not subject to large, rapid changes in temperature.

The lower limits of response times specified in Table 2 and Table 3 for rates of rise up to 5 °C/min for class A1 and up to 30 °C/min for other classes were derived from the calculated performance of a rate of rise detector consisting of two heat-sensitive elements, one with a zero time constant and the other with a time constant of 34 min, and having a 19.51 °C initial temperature "setting" between the elements. These values were selected because they produce a smooth curve yielding an operating temperature rise of 29 °C for 1 °C/min and 20 °C for 10 °C/min and above. For this detector, assuming no heat losses, the response time t is given by equation E.5.

$$t = T\ln\left(1 - \frac{\theta}{\alpha T}\right) \tag{E.5}$$

where

T is the time constant of the second element

α is the rate of rise of air temperature

θ is the temperature setting between the elements

E.4 Change after environmental tests

For a single measurement, the response time of a detector can be measured to a high degree of accuracy, but the response temperature is usually subject to a proportionately greater uncertainty because the temperature is changing with time, and can deviate from the required temperature at any instant by 2 °C. For this reason response time measurements have been specified in this part of BS 5446 for tests in which the detector is subject to rates of rise of 1 °C/min and above.

Some heat detectors, particularly fixed temperature detectors with a very short thermal time constant, can produce a spread of response times from repeated measurements that reflect the temperature control limitations of the test apparatus rather than changes in the detector. This is because the response time of the detector can be more closely related to the temperature of the airflow than to the time it is subjected to a rate of rise of temperature. Conversely, the response time of other detectors can be more dependent on the initial stabilization temperature than the instantaneous temperature at the moment of response. These possibilities were considered in determining the maximum change in response time between measurements made before and after the environmental tests.

The maximum allowable change at 3 °C/min of 2 min 40 s equates to an 8 °C change in response temperature, 4 °C attributable to the measuring apparatus and 4 °C to the detector. Similarly the maximum allowable change of 30 s at 20 °C/min also equates to 8 °C plus a further 2 °C attributable to twice the rounded up, allowable uncertainty of 1 s in the measurement of response time.

Annex F (informative) Typical apparatus for impact test

The apparatus (see Figure F.1) consists essentially of a swinging hammer comprising a rectangular section head (striker), with a chamfered impact face, mounted on a tubular steel shaft. The hammer is fixed into a steel boss, which runs on ball bearings on a fixed steel shaft mounted in a rigid steel frame, so that the hammer can rotate freely about the axis of the fixed shaft. The design of the rigid frame is such as to allow complete rotation of the hammer assembly when the specimen is not present.

The striker is of dimensions 76 mm wide, 50 mm high and 94 mm long (overall dimensions) and is manufactured from aluminium alloy (AlCu4SiMg in accordance with ISO 209-1:1989), solution-treated and precipitation-treated. It has a plane impact face chamfered at (60 ± 1)° to the long axis of the head. The tubular steel shaft has an outside diameter of (25 ± 0.1) mm with walls (1.6 ± 0.1) mm thick.

The striker is mounted on the shaft so that its long axis is at a radial distance of 305 mm from the axis of rotation of the assembly, the two axes being mutually perpendicular. The central boss is 102 mm in outside diameter and 200 mm long and is mounted coaxially on the fixed steel pivot shaft, which is approximately 25 mm in diameter, however the precise diameter of the shaft will depend on the bearings used.

Diametrically opposite the hammer shaft are two steel counterbalance arms, each 20 mm in outside diameter and 185 mm long. These arms are screwed into the boss so that the length of 150 mm protrudes. A steel counterbalance weight is mounted on the arms so that its position can be adjusted to balance the weight of the striker and arms, as shown in Figure F.1. On the end of the central boss is mounted a 12 mm wide × 150 mm diameter aluminium alloy pulley and round this an inextensible cable is wound, one end being fixed to the pulley. The other end of the cable supports the operating weight.

The rigid frame also supports the mounting board on which the specimen is mounted by its normal fixings. The mounting board is adjustable vertically so that the upper half of the impact face of the hammer will strike the specimen when the hammer is moving horizontally, as shown in Figure F.1.

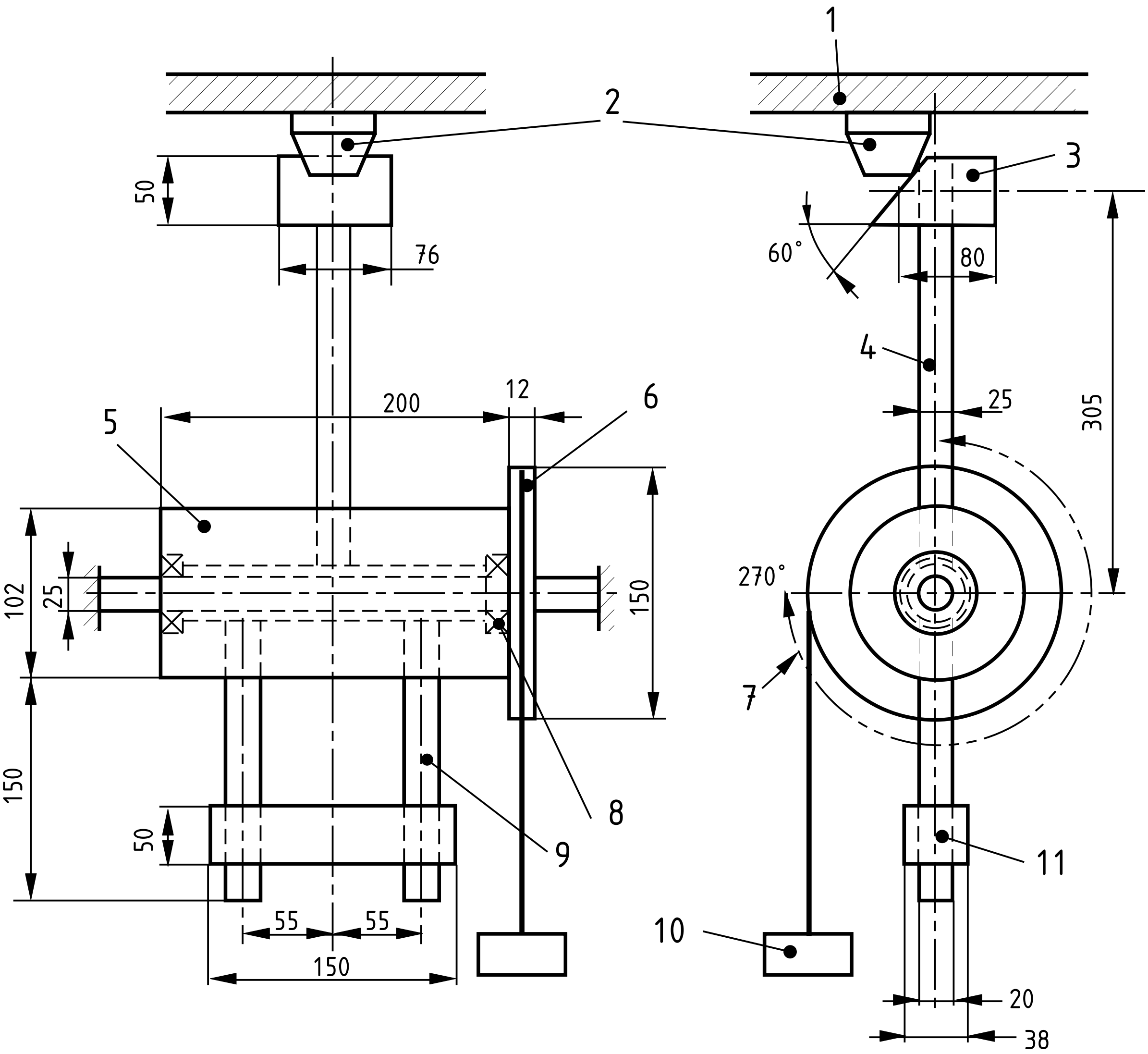
To operate the apparatus the position of the specimen and the mounting board is first adjusted as shown in Figure F.1 and the mounting board is then secured rigidly to the frame. The hammer assembly is then balanced carefully by adjustment of the counterbalance weight with the operating weight removed. The hammer arm is then drawn back to the horizontal position ready for release and the operating weight is reinstated. On release of the assembly the operating weight will spin the hammer and arm through an angle of $3\pi/2$ radians to strike the specimen. The mass of the operating weight, in kilograms (kg), to produce the required impact energy of 1.9 J equals:

$$\frac{0.388}{3\pi r}$$

where r is the effective radius of the pulley in metres (m). This equals approximately 0.55 kg for a pulley radius of 75 mm.

As the standard calls for a hammer velocity at impact of (1.5 ± 0.13) m/s, the mass of the hammer head will need to be reduced by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0.79 kg will be required to obtain the specified velocity, but this will have to be determined by trial and error.

Dimensions in millimetres



Key

1 Mounting board
2 Detector
3 Striker
4 Striker shaft
5 Boss
6 Pulley
7 270° angle of movement
8 Ball bearings
9 Counterbalance arms
10 Operating weight
11 Counterbalance weight

NOTE The dimensions shown are for guidance, apart from those relating to the hammer head.

Figure F.1 — Impact apparatus

Annex G (normative) Safety requirements

G.1 Marking

Marking shall be in accordance with Clause **6** and with BS EN 60065:2002, Clause **5**.

G.2 Heating under normal operating conditions

The apparatus shall conform to the requirements of BS EN 60065:2002, Clause **7**.

G.3 Shock hazard under normal operating conditions

The apparatus shall conform to the requirements of BS EN 60065:2002, Clause **9** when mounted in any orientation on a vertical surface and when mounted on the underside of a horizontal surface.

NOTE The requirement of BS EN 60065:2002, **9.1.7** applies to the pins of an appliance inlet on the apparatus following withdrawal of the connector attached to the mains supply wires.

G.4 Insulation requirements

Apparatus intended to be operated from a supply greater than 34 V (peak or d.c.) shall conform to the requirements of BS EN 60065:2002, Clause **10**, disregarding the test specified in BS EN 60065:2002, **10.1**.

G.5 Fault conditions

The apparatus shall conform to the requirements of BS EN 60065:2002, Clause **11**.

G.6 Mechanical strength

The apparatus shall conform to the requirements of BS EN 60065:2002, Clause **12**, disregarding BS EN 60065:2002, **12.1.1**.

G.7 Parts connected to the supply mains

The apparatus shall conform to the requirements of BS EN 60065:2002, Clause **13**.

G.8 Components

G.8.1 Resistors, capacitors, inductors and transformers, the short-circuiting or disconnecting of which would cause an infringement of the requirements for operation under fault conditions, in respect of overheating, fire or shock hazard, shall conform to the relevant requirements of BS EN 60065:2002, Clause **14**.

G.8.2 Fusing and interrupting devices, mains switches, protective switches, voltage setting devices and the housing arrangements for batteries shall conform to the relevant requirements of BS EN 60065:2002, Clause **14**.

G.8.3 The power, voltage and current ratings, as appropriate, of all components shall be suitable for the application in which they are used. Conformity to this requirement shall be checked by circuit measurement, analysis of the circuit design, measurements on the components in question or by inspection, as appropriate.

G.9 Resistance to the effects of heat and fire

The apparatus shall conform to the requirements of BS EN 60950-1:2002, **4.7**, **4.7.1**, **4.7.2**, and **4.7.3**.

Bibliography

BS 5446-1:2000, *Fire detection and fire alarm devices for dwellings — Part 1: Specification for smoke alarms.*

BS 7671:2001, *Requirements for electrical installations — IEE Wiring Regulations — Sixteenth edition.*

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