



BSI Standards Publication

## Fire detection and fire alarm devices for dwellings

Part 4: Specification for multi-sensor fire alarms using any  
combination of smoke, heat and carbon monoxide sensors

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# Foreword

## Publishing information

This part of BS 5446-4 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 November 2020. It was prepared by Technical Committee FSH/12, *Fire Detection and Alarm Systems*. A list of organizations represented on this committee can be obtained on request to its committee manager.

## Relationship with other publications

BS 5446 is published in the following parts:

- Part 2: *Specification for heat alarms*;
- Part 3: *Specification for fire and carbon monoxide alarm systems for deaf and hard of hearing people*; and
- Part 4: *Specification for multi-sensor fire alarms using any combination of smoke, heat and carbon monoxide sensors*.

This part of BS 5446 is aligned with the Working Group drafts of prEN 14604 (dated 21/02/2018) and prEN 54-31 (dated 12/10/2018). The former includes several significant changes from BS EN 14604:2005. The latter was presented to CEN-TC72 (N3063) as the first example of how to prepare a product standard using the Open Descriptions (OD) approach (see Introduction).

For information, prEN 14604 includes the following changes compared to BS EN 14604:2005:

- a) as required by the mandate, Clause 4 has been revised to state all the product characteristics, and Clause 5 has been revised to state all the corresponding tests;
- b) additional product characteristics are specified for ingress for foreign bodies;
- c) the sound output test method was modified;
- d) product characteristics for smoke alarms using radio links have been added;
- e) product characteristics for visual alarm indication have been added;
- f) alarms with built-in batteries are required to automatically be connected to their power source on installation (8.3 in the revised standard);
- g) requirements in 4.2.4.2.1, 5.2.2.2.1 and Annex M were revised and now require primary battery powered smoke alarms to have a minimum of 3 years battery service life, and details of the assessment of battery service life are included;
- h) mains powered smoke alarms are required to have an integral back-up power supply;
- i) the alarm silence facility test function was revised and replaced by temporary disablement and alarm muting;
- j) a new Clause 6, "Assessment and verification of constancy of performance (AVCP)", has been added;
- k) a new Clause 7, "Classification and designation", has been added;
- l) a new Clause 8, "Marking, labelling and packaging", has been added;
- m) text on the content of the user manual has been added in Clause 8; and
- n) a new Annex A, Annex L, Annex M and Annex N have been added.

### Information about this document

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Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

### Use of this document

This British Standard follows the Open Descriptions (OD) approach being considered by TC72 for the EN 54 series. The OD approach provides for a common technical language to express the performance of a product. As such the only requirement of such European standards is that the manufacturer publishes a Declaration of Performance using the descriptors defined. For this British Standard the technique of using simple descriptors has been adopted, but the option of a descriptor “0” has been omitted.

### Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

### Contractual and legal considerations

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

Other requirements for multi-sensor fire alarms might be specified by general legislation on, for example, electromagnetic compatibility (EMC), safety and the environment.

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

## Introduction: Open Descriptions

Many of the product standards in the EN 54 series fall under the Construction Product Regulation (CPR) [1] and, as such, are cited in the Official Journal of the European Union (OJEU) as Harmonized standards (hENs). They will subsequently be transferred to the UK list of designated standards to support the new UKCA mark from 1 January 2021. The CPR [1] places constraints on how the EN 54 product standards are prepared and an approach using “Open Descriptions” is being phased in to realize the “common technical language” expected by the CPR [1] and thus facilitate ongoing citation in the OJEU.

In the past, the EN 54 series specified the minimum performance using pass/fail criteria. The CPR [1] does not permit pass/fail criteria. This contradiction can be overcome by using descriptions of performance, which are allowed by the CPR [1], particularly if the descriptions are open (allow open trade for products with different performances). This “Open Descriptions” (OD) approach introduces standard descriptors “X” and “0” to express, respectively, when an optional characteristic is not provided (X) and when the performance of a characteristic is not within defined criteria (0). Other descriptors (e.g. “1”, “2”, “A1”, “A2”) express when the performance of a characteristic is within defined criteria. Together, these descriptors establish a “common technical language” which can be used by member states to specify the requirements for the components of fire detection and alarm systems (FDAS).

The OD approach is being considered for the EN 54 series. It will be easy to recognize those parts which have adopted the OD approach because the descriptors/options and corresponding criteria for each product characteristic are expressed in tabular form.

The OD approach is focused on providing the “common technical language” for expressing the performance of a product under the CPR [1] to be used by the manufacturer in the Declaration of Performance (DoP) required by the CPR [1].

This British Standard requires a DoP, as described in [Annex A](#), which is analogous to the DoP required by the CPR [1].

## 1 Scope

This part of BS 5446 specifies requirements and type test methods for multi-sensor fire alarms, using one of the following combinations of sensors:

- a) smoke and heat;
- b) smoke and carbon monoxide;
- c) carbon monoxide and heat; and
- d) smoke, carbon monoxide and heat.

It is applicable to multi-sensor fire alarms intended solely for permanent installation on ceilings or walls of dwellings, and to multi-sensor fire alarms suitable for use in leisure accommodation vehicles (LAVs).

It is not applicable to multi-sensor fire alarms incorporating ionization smoke sensors.

*NOTE 1 Equipment conforming to this part of BS 5446 might not be suitable for use in boats used as a means of accommodation on inland waterways, due to the corrosive atmosphere.*

*NOTE 2 Although not covered by this part of BS 5446, equipment is available for use with multi-sensor fire alarms to provide a suitable warning system for use by deaf and hard of hearing people (see [BS 5446-3](#)).*

*NOTE 3 This part of BS 5446 does not cover the requirements for devices intended for incorporation in fire detection and alarm systems (see BS EN 54-1).*

*NOTE 4 This part of BS 5446 does not include detection of carbon monoxide as a toxic gas (see BS EN 50291-1).*

*NOTE 5 This part of BS 5446 does not include detection of fire using heat only (see [BS 5446-2](#)).*

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## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document<sup>1)</sup>. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 573-3, *Aluminium and aluminium alloys – Chemical composition and form of wrought products – Part 3: Chemical composition and form of products*

BS EN 14604:2005, *Smoke alarm devices*

BS EN 50130-4:2011+A1:2014, *Alarm systems – Part 4: Electromagnetic compatibility – Product family standard: Immunity requirements for components of fire, intruder, hold up, CCTV, access control and social alarm systems*

BS EN 50291, *Gas detectors – Electrical apparatus for the detection of carbon monoxide in domestic premises – Part 1: Test methods and performance requirements*

BS EN 60068-1, *Environmental testing – Part 1: General and guidance*

BS EN 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

BS EN 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

BS EN 60068-2-6:2008, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

BS EN 60068-2-27:2009, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

BS EN 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

BS EN 60068-2-42:2003, *Environmental testing – Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

BS EN 60068-2-78:2013, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

BS EN 61672-1:2013, *Electroacoustics – Sound level meters – Part 1: Specifications*

BS ISO 209, *Aluminium and aluminium alloys – Chemical composition*

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## 3 Terms, definitions, symbols and abbreviations

For the purposes of this part of BS 5446, the following terms and definitions apply.

### 3.1 Terms and definitions

#### 3.1.1 alarm condition

condition in which the alarm is giving an audible signal specified by the manufacturer as indicating the existence of a fire

#### 3.1.2 alarm muting facility

means of temporarily silencing a multi-sensor fire alarm after smoke or fire has been detected

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<sup>1)</sup> Documents that are referred to in an informative manner are listed in the Bibliography.

**3.1.3 ancillary device**

piece of equipment for supplementary purposes designed to be used with a multi-sensor fire alarm and which does not prevent the basic function of a multi-sensor fire alarm

**3.1.4 audible alarm signal**

sound signal intended to indicate an alarm condition

**3.1.5 battery service life**

duration of normal operation of the multi-sensor fire alarm with the battery fitted prior to the battery fault warning

**3.1.6 detachable multi-sensor fire alarm device**

multi-sensor fire alarm device, which consists of two components: the head and the base, and which allows these to be separated from each other for maintenance without damaging any of the components

**3.1.7 fault condition**

condition in which the operation of the individual multi-sensor fire alarm is affected by an adverse condition

**3.1.8 fault warning**

signal intended to indicate a fault condition

**3.1.9 fire sensitivity**

ability of the multi-sensor fire alarm device to generate an alarm under fire condition

**3.1.10 interconnectable multi-sensor fire alarm**

multi-sensor fire alarm which can be interconnected with other devices to provide a common alarm

**3.1.11 leisure accommodation vehicle (LAV)**

unit of living accommodation for temporary or seasonal occupation that might meet requirements for construction and use of road vehicles

[SOURCE: [BS EN 13878:2019](#), 3.19, modified]

EXAMPLE Mobile home, caravan, motorhome

**3.1.12 life expectancy (of battery)**

period of time that the battery can remain essentially unused (apart from electrical checks on the battery condition)

[SOURCE: BS EN 45510-7-2:2000, 3.3.5, modified]

**3.1.13 multi-sensor fire alarm device**

unit containing all the components, except possibly the normal power source, necessary for detecting smoke and for giving an audible alarm, which can comprise one or more parts such as a base (socket) and a head (body)

**3.1.14 non-volatile memory**

memory elements which do not require the presence of an energy source for the retention of their contents

**3.1.15 normal condition**

condition in which the multi-sensor fire 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

**3.1.16 normal power source**

primary source of power intended to supply the multi-sensor fire alarm, e.g. a battery or mains

**3.1.17 radio frequency link**

means of communication between at least two multi-sensor fire alarm devices, using radio frequency wave propagation

**3.1.18 response value**

smoke or CO concentration or temperature at which the multi-sensor fire alarm changes to its alarm condition

**3.1.18.1 smoke response value**

aerosol density in the proximity of a test specimen at the moment it generates a reference signal in a smoke tunnel

**3.1.18.2 heat response value**

temperature in the proximity of a test specimen at the moment it generates a reference signal in a heat tunnel

**3.1.18.3 carbon monoxide (CO) response value**

CO concentration in the proximity of the specimen at the moment it generates a reference signal in a gas test chamber

*NOTE The CO response value can depend on signal processing in the multi-sensor fire alarm and in the control and indicating equipment.*

**3.1.19 sensitivity**

inverse of the response value

*NOTE For example, the lowest sensitivity is the highest response value and the highest sensitivity is the lowest response value.*

**3.1.20 sensor**

transducer which is assigned to be receptive to a specific fire phenomenon and converts its information into an electrical output

**3.1.21 silencing**

action of stopping the audible alarm signal on an interlinked multi-sensor fire alarm that has not detected the fire

**3.1.22 site-specific data**

alterable data required for the multi-sensor fire alarm to operate in a defined configuration

**3.1.23 standby power source**

source of power intended to supply the multi-sensor fire alarm in the event of a failure of the normal power source

### 3.1.24 temporary disablement facility

means of temporarily disabling or desensitizing a multi-sensor fire alarm when it is in the normal condition

## 3.2 Symbols and abbreviations

For the purposes of this part of BS 5446, the following symbols and abbreviations apply.

|           |                                                                                                                                                            |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASCII     | American Standard Code for Information Interchange                                                                                                         |
| AVCP      | assessment and verification of constancy of performance                                                                                                    |
| CASE      | computer-aided software engineering                                                                                                                        |
| CO        | carbon monoxide                                                                                                                                            |
| CWFT      | classification without further testing                                                                                                                     |
| DoP       | declaration of performance                                                                                                                                 |
| EMC       | electromagnetic compatibility                                                                                                                              |
| FPC       | factory production control                                                                                                                                 |
| LAV       | leisure accommodation vehicle                                                                                                                              |
| $L_{AV}$  | calculated average of the sound output                                                                                                                     |
| $L_{Hii}$ | measurement result of the sound output                                                                                                                     |
| $L_i$     | measurements of the sound output                                                                                                                           |
| MIC       | measuring ionization chamber                                                                                                                               |
| OD        | Open Descriptions                                                                                                                                          |
| R         | resistor                                                                                                                                                   |
| $R_A$     | resistance in series between the voltage source, $V_R$ , and the multi-sensor fire alarm which causes battery fault warning                                |
| $R_B$     | resistance in series between the voltage source $0.5 \cdot (V_R - V_E) + V_E$ and the multi-sensor fire alarm which causes battery fault warning           |
| RF        | radio frequency                                                                                                                                            |
| RH        | relative humidity                                                                                                                                          |
| UKCA      | United Kingdom Conformity Assessed                                                                                                                         |
| $V_E$     | voltage at which the multi-sensor fire alarm gives a battery fault warning with zero resistance between the voltage source and the multi-sensor fire alarm |
| $V_R$     | nominal voltage (of a battery as specified by the manufacturer)                                                                                            |

## 4 Product characteristics and test procedures

### 4.1 General testing methods

#### 4.1.1 Atmospheric conditions for tests

Unless otherwise specified in the applicable assessment method (see [4.3](#) onwards), carry out testing after the test specimen has been allowed to stabilize in the following standard atmospheric conditions for testing specified in BS EN 60068-1:

- a) temperature: 15 °C to 35 °C;
- b) relative humidity (RH): 25% to 75%; and
- c) air pressure: 86 kPa to 106 kPa.

If variations in these parameters could have a significant effect on a measurement, keep such variations to a minimum during the measurements carried out on a test specimen.

#### 4.1.2 Operating conditions for tests

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

#### 4.1.3 Mounting arrangements

Mount the specimen by its normal means of attachment in accordance with the manufacturer's user manual. If the manual describes more than one method of mounting, choose the method considered to be most unfavourable for each test.

Select a means of attachment for the installation of the specimen to test equipment that represents the means specified by the manufacturer, but which is not necessarily identical to the means for the installation of the specimen to a room's ceiling and wall.

*NOTE The means can be chosen by the test laboratory in agreement with the manufacturer. If, for example, screws with plugs are intended, the screws to be inserted in a plug can be replaced by a screw with a nut for testing purposes.*

#### 4.1.4 Tolerances

If a specific tolerance or limit is not specified in a requirement or test procedure, apply a tolerance of  $\pm 5\%$ .

#### 4.1.5 Measurement of smoke response value

Install the specimen, for which the smoke response value is to be measured, in the smoke tunnel specified in [Annex B](#), in its normal operating position, by its normal means of attachment. The orientation of the specimen, relative to the direction of airflow, shall be the least sensitive orientation, as determined in the directional dependence test ([4.3.2.1.2](#)), unless otherwise specified in the test procedure.

Before commencing each measurement, purge the smoke tunnel to ensure that the tunnel and the specimen are free from the test aerosol.

The air velocity in the proximity of the specimen shall be  $(0.2 \pm 0.04) \text{ ms}^{-1}$  during the measurement, unless otherwise specified in the test procedure.

Unless otherwise specified in the test procedure, the air temperature in the tunnel shall be  $(23 \pm 5)^\circ\text{C}$  and shall not vary by more than 5 K for all the measurements on a particular type of multi-sensor fire alarm.

Unless otherwise specified in the test procedure, the CO concentration in the tunnel shall be less than  $3\ \mu\text{l/l}$  during the entire test.

Connect the specimen to its supply and monitoring equipment in accordance with [4.1.2](#) and allow to stabilize for at least 15 min, unless otherwise specified by the manufacturer.

For a multi-sensor fire alarm using scattered or transmitted light, introduce the test aerosol specified in [Annex C](#) into the tunnel such that the rate of increase of aerosol density is as follows:

$$0.015 \leq \frac{\Delta m}{\Delta t} \leq 0.1\ \text{dBm}^{-1}\ \text{min}^{-1} \quad (1)$$

where  $m$  is determined in accordance with [Annex D](#).

*NOTE 1 These ranges are intended to allow the selection of a convenient rate, depending on the multi-sensor fire alarm's sensitivity, to get a response in a reasonable time.*

The rate of increase in aerosol density shall be similar for all measurements on a particular type of multi-sensor fire alarm.

Increase the aerosol density until either an alarm signal is generated or a designated signal specified by the manufacturer is produced by the smoke sensor. This designated smoke signal shall be obtained after having been routed via any applicable amplification circuit and signal processing unit.

If the multi-sensor fire alarm is not capable of giving an alarm signal from smoke alone, the manufacturer shall provide special means by which the designated smoke response signal can be evaluated.

*NOTE 2 For example, it can be acceptable to provide a supplementary output that varies with smoke density, or specially modified software to indicate when the smoke density has caused an internal threshold to be reached. In such cases the special means should preferably be chosen such that the nominal smoke response value is in the range of  $0.05\ \text{dB m}^{-1}$  to  $1.0\ \text{dB m}^{-1}$  ( $m$ ) for multi-sensor fire alarms using scattered or transmitted light. The tests require smoke response values,  $m$ , not less than  $0.05\ \text{dB m}^{-1}$  for multi-sensor fire alarms using scattered or transmitted light.*

Record the measured aerosol density as  $m\ (\text{dB m}^{-1})$  for multi-sensor fire alarms using scattered or transmitted light (see [Annex D](#)). Take this as the smoke response value.

#### 4.1.6 Measurement of CO response value

Install the specimen, for which the CO response value is to be measured, in the gas test chamber specified in [Annex E](#), in its normal operating position, by its normal means of attachment. The orientation of the specimen, relative to the direction of airflow, shall be the least sensitive orientation, as determined in the directional dependence test (see [4.3.2.2.2](#)), unless otherwise specified in the test procedure.

Before commencing each measurement, purge the gas test chamber with clean air to ensure that the concentration of CO in the gas test chamber is less than  $1.5\ \mu\text{l/l}$ .

The air velocity in the proximity of the specimen shall be  $(0.2 \pm 0.04)\ \text{m/s}$  during the measurement, unless otherwise specified in the test procedure.

Unless otherwise specified in the test procedure, the air temperature in the gas test chamber shall be  $(23 \pm 5)^\circ\text{C}$  and shall not vary by more than 5 K for all the measurements.

Connect the specimen to its power supply and monitoring equipment in accordance with [4.1.2](#) and allow to stabilize for a period of at least 15 min, unless otherwise specified by the manufacturer.

Introduce CO into the gas test chamber such that the rate of increase of CO concentration is between 1 µl/l per minute and 6 µl/l per minute, unless otherwise specified in the test procedure.

*NOTE 1 For a multi-sensor fire alarm with a rate sensitive behaviour, the manufacturer may specify a rate of increase within this range to ensure that the measured CO response value is representative of the static CO response value of the multi-sensor fire alarm.*

The rate of increase in CO concentration shall be similar for all measurements on a particular detector type.

Increase the CO concentration until either an alarm signal is generated or a designated signal specified by the manufacturer is produced by the CO sensor. This designated CO signal shall be obtained after having been routed via any applicable amplification circuit and signal processing unit.

If the multi-sensor fire alarm is not capable of giving an alarm signal from CO alone, the manufacturer shall provide special means by which the designated CO response signal can be evaluated.

*NOTE 2 For example, it can be acceptable to provide a supplementary output that varies with CO concentration, or specially modified software to indicate when the CO concentration has caused an internal threshold to be reached. In such cases the special means should be chosen such that the CO response value is in the range 25 µl/l to 60 µl/l. The tests require CO response values, S, not less than 25 µl/l.*

Record the measured CO concentration as  $S$  (µl/l). Take this as the CO response value.

#### 4.1.7 Measurement of heat response value

Install the specimen for which the heat response value is to be measured in a heat tunnel, as specified in [Annex F](#), in its normal operating position, by its normal means of attachment. The orientation of the specimen, relative to the direction of airflow, shall be the least sensitive one, as determined in the directional dependence test ([4.3.2.3.2](#)), unless otherwise specified in the test procedure.

Connect the specimen to its supply and monitoring equipment in accordance with [4.1.2](#) and allow to stabilize for at least 15 min, unless otherwise specified by the manufacturer.

Before the test, stabilize the temperature of the air stream and the specimen to  $(25 \pm 2)$  °C. Maintain the air stream at a constant mass flow equivalent to a velocity of  $(0.8 \pm 0.1)$  m/s at 25 °C.

Increase the air temperature at a rate specified in the test until either an alarm signal is generated or a designated signal specified by the manufacturer is produced by the heat sensor. This designated heat signal shall be obtained after having been routed via any applicable amplification circuit and signal processing unit.

If the multi-sensor fire alarm is not capable of giving an alarm signal from heat alone, the manufacturer shall provide special means by which the designated heat response signal can be evaluated.

*NOTE For example, it can be acceptable to provide a supplementary output that varies with temperature, or specially modified software to indicate when the air temperature has caused an internal threshold to be reached. In such cases the special means should be chosen such that the nominal heat response value corresponds to a response time between the minimum and maximum times given in BS EN 54-5:2000+A1, Table 4, for a class A2 multi-sensor fire alarm.*

Assess the heat response value as the time taken from the start of the temperature increase to the point at which the heat response signal specified by the manufacturer is produced, or the multi-sensor fire alarm gives an alarm signal.

Record the measured heat response value as  $t$  (s).

## 4.2 Indicators

### COMMENTARY ON 4.2

*The requirements of this subclause do not apply to any activation of visual indicators during the installation, commissioning and maintenance phase of the multi-sensor fire alarm.*

### 4.2.1 Alarm indicator

#### 4.2.1.1 Requirement

The provision of an integral visual alarm indicator, by which the multi-sensor fire alarm that originated an alarm can be identified while the alarm condition is present, shall be expressed in accordance with [Table 1](#), applying the assessment method in [4.2.1.2](#).

**Table 1** — Individual alarm indicator

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>The device is interconnectable with other devices AND</p> <p>There is a minimum of one red alarm indicator AND</p> <p>An alarm is indicated by a continuous or rapid flashing light at least once per second AND</p> <p>For any other condition the alarm indicator flashes not more than once in 5 seconds, to make it clearly distinguishable from the alarm condition AND</p> <p>The visual indication of alarm is only indicated on the alarm device which has detected the fire. It is not indicated on interconnected devices unless they have themselves detected an alarm condition.</p> |
| 2      | <p>The device is stand-alone AND</p> <p>There is minimum one red alarm indicator AND</p> <p>An alarm is indicated by a continuous or rapid flashing light at least once per second AND</p> <p>For any other condition the alarm indicator flashes not more than once in 5 seconds, to make it clearly distinguishable from the alarm condition.</p>                                                                                                                                                                                                                                                 |
| X      | <p>The device is stand-alone AND</p> <p>There is no alarm indicator.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

#### 4.2.1.2 Assessment method

Mount one specimen in an ambient light intensity up to 500 lux at a distance of 1 m from the observer.

When the multi-sensor fire alarm is in alarm condition, confirm the visibility of the alarm indicator and record the colour of the indicator.

Where other conditions of the multi-sensor fire alarm can be visually indicated, confirm and record that they are clearly distinguishable from the alarm indication.

Inspect the visual alarm indicator to confirm it conforms to [4.2.1.1](#).

### 4.2.2 Mains-on indicator

#### 4.2.2.1 Requirement

The provision of a mains-on indicator shall be expressed in accordance with [Table 2](#), applying the assessment method in [4.2.2.2](#).

**Table 2** — *Mains-on indicator*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                       |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | The device is intended to be connected to the mains or a mains-derived power supply AND<br>There is one green mains-on indicator, physically separate from any other indicators AND<br>The indicator is exclusively used to indicate mains-on AND<br>The indicator is continuously illuminated when the multi-sensor fire alarm is energized by mains power AND off when mains is not present. |
| X      | The device is NOT intended to be connected to the mains or to a mains-derived power supply.                                                                                                                                                                                                                                                                                                    |

**4.2.2.2 Assessment method**

Inspect the visual mains-on indicator to confirm it conforms to [4.2.2.1](#).

**4.2.3 Additional indicators****4.2.3.1 Requirement**

The provision of additional indicators shall be expressed in accordance with [Table 3](#), applying the assessment method in [4.2.3.2](#).

**Table 3** — *Additional indicators*

| Option | Criteria                                                                                                                                                                                                                                                              |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | The device has one or more additional indicators which are neither red nor green AND<br>These additional indicator(s) are not used to indicate an alarm or mains-on condition AND<br>The function of these indicators is clearly described in the user documentation. |
| X      | The device has no additional indicators.                                                                                                                                                                                                                              |

**4.2.3.2 Assessment method**

Inspect additional indicators to confirm they conform to [4.2.3.1](#).

**4.2.4 Connection of external ancillary devices****4.2.4.1 Requirement**

The correct operation of the multi-sensor fire alarm with open-circuit or short-circuit failures of connections to ancillary devices (e.g. test facility, alarm muting facility, remote indicators, control relays, transmitters) by hard wiring, radio frequency or by another means shall be expressed in accordance with [Table 4](#), applying the assessment method in [4.2.4.2](#).

**Table 4** — *External ancillary devices*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | The multi-sensor fire alarm provides for connections to ancillary devices AND<br>The multi-sensor fire alarm initiates local alarm correctly during exposure to test aerosol with open-circuit failures on any connection to ancillary devices AND<br>The multi-sensor fire alarm initiates local alarm correctly during exposure to test aerosol with short-circuit failures on any connections to ancillary devices. |
| X      | The multi-sensor fire alarm does not provide for connections to ancillary devices.                                                                                                                                                                                                                                                                                                                                     |

**4.2.4.2 Assessment method**

Apply open-circuit and short-circuits conditions at the connections for external ancillary devices. For radio frequency link devices, disrupt the communication path.

Inspect the connection of external ancillary devices to confirm they conform to [4.2.4.1](#). Use a test aerosol to confirm that the multi-sensor fire alarm generates an alarm.

## 4.2.5 Manufacturer's adjustments

### 4.2.5.1 Requirement

The options for changing the manufacturer's settings of the multi-sensor fire alarm shall be expressed in accordance [Table 5](#), applying the assessment method in [4.2.5.2](#).

**Table 5** — *Manufacturer's adjustments*

| Option | Criteria                                                                                                                                     |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | The manufacturer's settings can only be changed by special means (e.g. the use of a special code or tool or by breaking or removing a seal). |

### 4.2.5.2 Assessment method

Conduct a visual inspection of one specimen and its supporting data to assess the possibilities of changing the manufacturer's settings.

## 4.2.6 On-site adjustment of response behaviour

### 4.2.6.1 Requirement

The provision for on-site adjustment of the multi-sensor fire alarm response behaviour shall be expressed in accordance with [Table 6](#), applying the assessment method in [4.2.6.2](#).

*NOTE* On-site adjustment of the multi-sensor fire alarm response behaviour may be carried out at the multi-sensor fire alarm or at the control and indicating equipment.

**Table 6** — *On-site adjustment of response behaviour*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | There is a provision for on-site adjustment of the response behaviour AND<br>The response behaviour can only be adjusted by use of a code or special tool or by removing the multi-sensor fire alarm from its base or mounting AND<br>Accessible by use of a code or special tool and is clearly marked on the multi-sensor fire alarm or in the associated data AND<br>All settings of the response behaviour have been assessed and declared according to this British Standard. |
| X      | There is no provision for on-site adjustment of the response behaviour.                                                                                                                                                                                                                                                                                                                                                                                                            |

### 4.2.6.2 Assessment method

Conduct a visual inspection of one specimen and its supporting data to assess the possibilities of on-site adjustment of the multi-sensor fire alarm response behaviour.

## 4.2.7 Power supply

### 4.2.7.1 Power supply type

#### 4.2.7.1.1 Requirement

The power supply for the multi-sensor fire alarm shall be expressed in accordance with [Table 7](#), applying the assessment method in [4.2.7.1.2](#).

**Table 7** — *Power supply type*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5      | <p>Mains or mains-derived power supply with a provision for an internal back-up which is a rechargeable power source AND</p> <p>The internal rechargeable back-up power source:</p> <ul style="list-style-type: none"> <li>• is capable of supplying the quiescent load of the multi-sensor fire alarm with the mains off for a minimum period of 72 h; AND</li> <li>• at the point when the battery fault warning commences, has sufficient capacity to give an alarm signal as specified in <a href="#">4.2.11</a> for at least 4 min in the event of fire and, in the absence of fire, give a battery fault warning for at least 24 h; AND</li> <li>• is monitored for faults in accordance with the criteria in <a href="#">4.2.7.2.1, Table 8</a>; AND</li> <li>• for a multi-sensor fire alarm with a radio frequency link, at the point when the battery fault warning commences, is additionally able to transmit at least one radio frequency alarm signal in the event of fire; AND</li> <li>• for replaceable batteries, the make and model of the batteries specified for use with the product are clearly identified on the declaration of performance (DoP).</li> </ul>                                       |
| 4      | <p>Mains or mains-derived power supply has a provision for an internal back-up power source which is a primary battery that is not replaceable by the user AND</p> <p>The internal primary battery back-up power source:</p> <ul style="list-style-type: none"> <li>• has a life expectancy in the multi-sensor fire alarm of 10 years or greater; AND</li> <li>• is capable of having a battery service life with the mains off of at least 1 year or a longer duration specified by the manufacturer before the battery fault warning is given; AND</li> <li>• at the point when the battery fault warning commences, has sufficient capacity to give an alarm signal as specified in <a href="#">4.2.11</a> for at least 4 min in the event of fire and, in the absence of fire, give a battery fault warning for at least 30 days; AND</li> <li>• for a multi-sensor fire alarm with a radio frequency link, at the point when the battery fault warning commences, is additionally able to transmit at least one radio frequency alarm signal in the event of fire; AND</li> <li>• is monitored for faults in accordance with the criteria in <a href="#">4.2.7.2.1, Table 8</a>.</li> </ul>                           |
| 3      | <p>Mains or mains-derived power supply with a provision for an internal back-up power source which is a primary battery that is replaceable by the user AND</p> <p>The internal primary battery back-up power source:</p> <ul style="list-style-type: none"> <li>• is capable of having a battery service life with the mains off of at least 1 year or a longer duration specified by the manufacturer before the battery fault warning is given; AND</li> <li>• at the point when the battery fault warning commences, has sufficient capacity to give an alarm signal as specified in <a href="#">4.2.11</a> for at least 4 min in the event of fire and, in the absence of fire, give a battery fault warning for at least 30 days; AND</li> <li>• for a multi-sensor fire alarm with a radio frequency link, at the point when the battery fault warning commences, is additionally able to transmit at least one radio frequency alarm signal in the event of fire; AND</li> <li>• is monitored for faults in accordance with the criteria in <a href="#">4.2.7.2.1, Table 8</a>; AND</li> <li>• the make and model of the batteries specified for use with the product are clearly identified on the DoP.</li> </ul> |
| 2      | <p>Internal battery power supply that is not replaceable by the user AND</p> <p>The internal battery power supply:</p> <ul style="list-style-type: none"> <li>• has a battery service life in the multi-sensor fire alarm of 10 years or greater; AND</li> <li>• at the point when the battery fault warning commences, has sufficient capacity to give an alarm signal as specified in <a href="#">4.2.11</a> for at least 4 min in the event of fire and, in the absence of fire, give a battery fault warning for at least 30 days; AND</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

Table 7 (continued)

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | <ul style="list-style-type: none"> <li>for a multi-sensor fire alarm with a radio frequency link, at the point when the battery fault warning commences, is additionally able to transmit at least one radio frequency alarm signal in the event of fire.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 1      | <p>Internal battery power supply that is replaceable by the user AND</p> <p>The internal battery power supply:</p> <ul style="list-style-type: none"> <li>is capable of having a battery service life of at least 3 years or a longer duration specified by the manufacturer before the battery fault warning is given; AND</li> <li>at the point when the battery fault warning commences, has sufficient capacity to give an alarm signal as specified in 4.2.11 for at least 4 min in the event of fire and, in the absence of fire, give a battery fault warning for at least 30 days; AND</li> <li>for a multi-sensor fire alarm with a radio frequency link, at the point when the battery fault warning commences, is additionally able to transmit at least one radio frequency alarm signal in the event of fire; AND</li> <li>the make and model of the batteries specified for use with the product are clearly identified on the DoP.</li> </ul> |

The battery service life shall include the following loads:

- a) the quiescent load of the multi-sensor fire alarm;
- b) the additional load resulting from at least a monthly test or more often if specified by the manufacturer;
- c) loads due to the radio circuitry and radio frequency messages (if applicable); and
- d) the additional load of the interconnection test at least every six months or more often if specified by the manufacturer (if applicable).

If a separate battery is used for the radio frequency link, the criteria in Table 7 shall be applied for each battery. In this case, the maximum battery service life shall be based on the battery service life for the battery which has the shortest duration.

If the power for additional features not covered by this British Standard is provided by a separate battery, there shall be no audible indication of low battery for this separate battery on the multi-sensor fire alarm.

#### 4.2.7.1.2 Assessment method

Conduct a visual inspection and a technical assessment to determine:

- a) the type of power supply in the multi-sensor fire alarm device; and
- b) the type of internal back-up power source.

Data concerning the multi-sensor fire alarm loads and the battery characteristics shall be provided in accordance with Annex G.

Document the underlying assumptions about the average frequency of usage of any additional features not covered by this the British Standard, for inclusion in the user manual [see 7.2w)].

Measure the mean current consumption of a multi-sensor fire alarm at the nominal voltage for at least 1 h in normal condition after the stabilization period given by the manufacturer, at ambient temperature. Also, measure the mean consumption in alarm, test and warning of low battery status.

Conduct a technical assessment of battery service life and the life expectancy of primary back-up batteries in mains-powered alarms, involving where appropriate calculations based on the measurement results and the manufacturer's data and documentation.

*NOTE* [Annex H](#) gives examples of how the expected battery service life can be calculated.

#### 4.2.7.2 Monitoring of back-up power source

##### 4.2.7.2.1 Requirement

The monitoring of the back-up power source in a multi-sensor fire alarm intended for connection to a mains or mains-derived power supply shall be expressed in accordance with [Table 8](#), applying the assessment method in [4.2.7.2.2](#).

**Table 8** — *Monitoring of back-up power source*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                     |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Each source is monitored by the multi-sensor fire alarm for low-battery fault condition AND<br>Replaceable back-up power source is monitored by the multi-sensor fire alarm for open-circuit and short-circuit failure of the back-up AND<br>In the case of a fault or an open-circuit or short-circuit failure, the audible low battery warning signal is given at least once every minute. |
| X      | Multi-sensor fire alarm is not mains-powered.                                                                                                                                                                                                                                                                                                                                                |

##### 4.2.7.2.2 Assessment method

Follow the test procedures set out in [4.2.8.2](#) to simulate the depletion of the back-up power source to the point where a low back-up warning is given, both with mains power to the multi-sensor fire alarm and without mains power to the multi-sensor fire alarm.

Disconnect or remove (open-circuit) the replaceable back-up power supply, as appropriate, and the mains power applied to the multi-sensor fire alarm.

Disconnect the replaceable back-up power supply and replace it with a short-circuit between the back-up terminals, then apply the mains power to the multi-sensor fire alarm.

#### 4.2.7.3 Replaceable power sources

##### 4.2.7.3.1 Power source missing prevention

##### 4.2.7.3.1.1 Requirement

The ability of the multi-sensor fire alarm to be installed only with all intended power supplies connected shall be expressed in accordance with [Table 9](#), applying the assessment method in [4.2.7.3.1.2](#).

**Table 9** — *Power source missing prevention*

| Option | Criteria                                                                                                                                                                                 |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | It is only possible to install a multi-sensor fire alarm on its mounting base or bracket where all the power sources are connected before installation or automatically on installation. |

*NOTE 1* It is acceptable for the mains supply to be switched on at a fuse board or similar after the multi-sensor fire alarm has been installed.

*NOTE 2* This characteristic is not applicable for a battery dedicated to additional features.

##### 4.2.7.3.1.2 Assessment method

Conduct a visual inspection and a technical assessment.

### 4.2.7.3.2 Battery leads or terminal connections

#### 4.2.7.3.2.1 Requirement

The polarity indication and robustness of leads or terminal connections to replaceable batteries in the multi-sensor fire alarm shall be expressed in accordance with [Table 10](#), applying the assessment method in [4.2.7.3.2.2](#).

*NOTE This requirement also applies to separate battery(ies) used for the radio frequency interlink.*

**Table 10** — Battery leads or terminal connections

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Lead or terminal connections are identified with correct polarity unless the connector geometry prevents reverse connection AND<br><br>The polarity is indicated on the multi-sensor fire alarm adjacent to the battery terminals or leads AND<br><br>Any user-accessible leads connecting the terminal connectors of batteries to the multi-sensor fire alarm circuit board are designed so that when the leads are subjected to normal handling, they are not likely to become damaged or detached. |
| X      | No accessible battery/leads.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

#### 4.2.7.3.2.2 Assessment method

Conduct a visual inspection of the indication of polarity.

Subject any leads connecting the terminal connectors of batteries in multi-sensor fire alarms to the multi-sensor fire alarm circuit board to a pull of 20 N without jerks for 1 min in any direction allowed by the design. Ensure the pull is not transmitted to the joints between the leads and the battery terminal connectors or beyond the strain relieving part.

### 4.2.7.3.3 Battery reversal

#### 4.2.7.3.3.1 Requirement

The battery reversal characteristics of the multi-sensor fire alarm shall be expressed in accordance with [Table 11](#), applying the assessment method in [4.2.7.3.3.2](#).

*NOTE This requirement also applies to separate battery(ies) used for the radio frequency interlink.*

**Table 11** — Battery reversal

| Option | Criteria                                                                                                                                                                     |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2      | It is only possible for the user to fit the battery(ies) into the multi-sensor fire alarm with reverse polarity by causing mechanical damage to the multi-sensor fire alarm. |

**Table 11** (continued)

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>It is possible for the user to fit the battery(ies) into the multi-sensor fire alarm with reverse polarity AND:</p> <ul style="list-style-type: none"> <li>• after a period of reverse polarity, if a smoke sensor is included in the multi-sensor fire alarm the ratio of smoke response values is <math>\leq 1.6</math> AND (<math>m_{\min} \geq 0.05</math> dB/m); AND</li> <li>• after a period of reverse polarity, if a heat sensor is included in the multi-sensor fire alarm the ratio of heat response values is <math>\leq 1.3</math>; AND</li> <li>• after a period of reverse polarity, if a CO sensor is included in the multi-sensor fire alarm the ratio of CO response values is <math>\leq 1.6</math> AND (<math>S_{\min} \geq 25</math> µl/l); AND</li> <li>• after a period of reverse polarity, a battery fault is indicated at <math>V_E</math> minus 5%; AND</li> <li>• after a period of reverse polarity, a battery fault is indicated at voltage <math>V_R</math> with <math>R_A</math> plus 10% resistance in series</li> </ul> <p>AND</p> <p>After a period of reverse polarity for multi-sensor fire alarms with a radio frequency link, the radio interlink is still operational and causes an alarm signal to be received and transmitted within 30 s.</p> |

#### 4.2.7.3.3.2 Assessment method

Fit or place any user-replaceable batteries in contact with reversed polarity for  $(12 \pm 3)$  s, if it is possible to establish the reversed connection with the intended battery type without causing mechanical damage to the multi-sensor fire alarm.

Following the reverse polarity conditioning, connect the specimen to its power source in accordance with 4.1.2.

If the multi-sensor fire alarm includes a smoke sensor, measure the smoke response value in accordance with 4.1.5. Designate the greater of the smoke response value measured in this test and that measured for the same specimen in the reproducibility test as  $m_{\max}$ , and the lesser as  $m_{\min}$ . Calculate the ratio of the smoke response values as  $m_{\max} : m_{\min}$ .

If the multi-sensor fire alarm includes a heat sensor, measure the heat response value in accordance with 4.1.7 at a rate of rise of air temperature of 20 K/min. Designate the greater of the heat response value measured in this test and that measured for the same specimen in the reproducibility test as  $t_{\max}$ , and the lesser as  $t_{\min}$ . Calculate the ratio of the heat response values as  $t_{\max} : t_{\min}$ .

If the multi-sensor fire alarm includes a CO sensor, measure the CO response value in accordance with 4.1.6. Designate the greater of the CO response value measured in this test and that measured for the same specimen in the reproducibility test as  $S_{\max}$ , and the lesser as  $S_{\min}$ . Calculate the ratio of the CO response values as  $S_{\max} : S_{\min}$ .

When voltage  $V_E$  minus 5% is applied, record the occurrence of a battery fault warning.

When the voltage  $V_R$  with  $R_A$  plus 10% resistance in series is applied, record the occurrence of a battery fault warning.

For radio frequency linked multi-sensor fire alarms, test the specimen to determine if the interlink is operational.

*NOTE This can be a simple functional test to determine the response time of the interlink function.*

## 4.2.8 Battery fault warning

### 4.2.8.1 Requirement

The battery fault warning shall be expressed in accordance with [Table 12](#), applying the assessment method in [4.2.8.2](#).

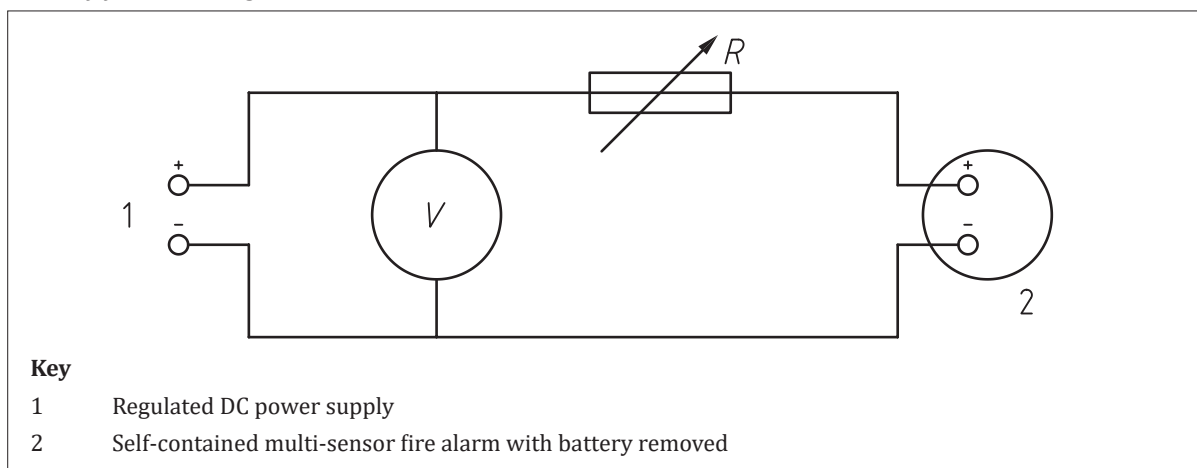
**Table 12** — *Battery fault warning*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>At supply voltage <math>V_E</math></p> <p>AND</p> <p>At supply voltage <math>V_R</math> with series resistance <math>R_A</math> AND</p> <p>At supply voltage <math>0.5 \cdot (V_R - V_E) + V_E</math> with a series resistance <math>R_B</math>:</p> <p>The multi-sensor fire alarm has a low battery audible fault warning before the battery prevents correct operation</p> <p>AND</p> <p>Where there is a smoke sensor:</p> <ul style="list-style-type: none"> <li>the ratio of smoke response values <math>\leq 1.6</math> AND</li> <li><math>m_{\min} \geq 0.05</math> dB/m</li> </ul> <p>AND</p> <p>Where there is a CO sensor:</p> <ul style="list-style-type: none"> <li>the ratio of CO response values <math>\leq 1.6</math> AND</li> <li><math>S_{\min} \geq 25</math> µl/l;</li> </ul> <p>AND</p> <p>Where there is a heat sensor, the ratio of heat response values <math>\leq 1.3</math></p> <p>AND</p> <p>Where the battery powers a radio, the radio is capable of both sending and receiving alarm messages</p> <p>AND</p> <p>As the battery voltage reduces to 0 V, the multi-sensor fire alarm does not falsely indicate an alarm</p> <p>AND</p> <p>Where a multi-sensor fire alarm transmits battery fault messages to other alarms to help ensure early identification of malfunctions, the audible and visual fault signal at the receiving alarm is distinguishable from the alarm signal and the fault warning signal from the originating multi-sensor fire alarm device, and is repeated periodically.</p> |

### 4.2.8.2 Assessment method

#### 4.2.8.2.1 Connection of the multi-sensor fire alarm device

Connect the multi-sensor fire alarm device as shown in [Figure 1](#).

**Figure 1** — Battery fault warning test circuit

Before conditioning and applying a supply voltage of  $V_R$ , measure:

- a) the smoke response value of one specimen in accordance with 4.1.5;
- b) the CO response value of the specimen in accordance with 4.1.6; and
- c) the heat response value of the specimen in accordance with 4.1.7 at a rate of rise of air temperature of 20 K/min,

and if radio interconnect is used, check that the device can both send and receive an alarm signal correctly.

#### 4.2.8.2.2 Battery fault warning at a voltage, $V_E$

With the series resistor,  $R$ , set to 0  $\Omega$ , decrease the supply voltage,  $V$ , from 10% above the declared low battery voltage in stages of maximum 1% of the declared nominal voltage,  $V_R$ , at intervals not less than the time declared by the manufacturer to achieve the fault warning until the fault warning is given.

Record the supply voltage at which the fault warning is given as  $V_E$ .

After the conditioning, measure the smoke response value of the specimen in accordance with 4.1.5. Designate the greater of the smoke response values measured before the conditioning and that after the conditioning as  $m_{\max}$  and the lesser as  $m_{\min}$ . Calculate the ratio of the smoke response values as  $m_{\max} : m_{\min}$ .

Measure the CO response value in accordance with 4.1.6. Designate the greater of the CO response values measured before the conditioning and that measured after the conditioning as  $S_{\max}$  and the lesser as  $S_{\min}$ . Calculate the ratio of the CO response values as  $S_{\max} : S_{\min}$ .

Test the heat response value of the specimen in accordance with 4.1.7 at a rate of rise of air temperature of 20 K/min. Designate the greater of the heat response values measured before the conditioning and that measured after the conditioning as  $t_{\max}$  and the lesser as  $t_{\min}$ . Calculate the ratio of the heat response values as  $t_{\max} : t_{\min}$ .

If the battery is used for radio interconnection, check that the device can both send and receive an alarm signal correctly.

**4.2.8.2.3 Battery fault warning signal at a resistance,  $R_A$** 

With the supply voltage,  $V$ , set at  $V_R$ , increase the resistance of the series resistor,  $R$ , from 0 in increments of:

- a) 1  $\Omega$  for multi-sensor fire alarms powered with a supply greater than 5 V; and
- b) 0.5  $\Omega$  for multi-sensor fire alarms powered with a supply of 5 V or less,

at intervals not less than the time declared by the manufacturer to achieve the fault warning until the fault warning is given.

Record the resistance of the series resistor at which the fault warning is given as  $R_A$ .

After the conditioning, measure the smoke response value of the specimen in accordance with 4.1.5. Designate the greater of the smoke response values measured before the conditioning and that after the conditioning as  $m_{\max}$  and the lesser as  $m_{\min}$ . Calculate the ratio of the smoke response values as  $m_{\max} : m_{\min}$ .

Measure the CO response value in accordance with 4.1.6. Designate the greater of the CO response value measured before the conditioning and that measured after the conditioning as  $S_{\max}$  and the lesser as  $S_{\min}$ . Calculate the ratio of the CO response values as  $S_{\max} : S_{\min}$ .

Measure the heat response value of the specimen in accordance with 4.1.7 at a rate of rise of air temperature of 20 K/min. Designate the greater of the heat response values measured before the conditioning and that measured after the conditioning as  $t_{\max}$  and the lesser as  $t_{\min}$ . Calculate the ratio of the heat response values as  $t_{\max} : t_{\min}$ .

If the battery is used for radio interconnection, check that the device can both send and receive an alarm signal correctly.

**4.2.8.2.4 Battery fault warning signal at a resistance  $R_B$** 

With the supply voltage,  $V$ , determined in accordance with equation (2):

$$V = 0.5 \cdot (V_R - V_E) + V_E \quad (2)$$

increase the resistance of the series resistor,  $R$ , from 0 in increments of:

- a) 1  $\Omega$  for multi-sensor fire alarms powered with a supply greater than 5 V; and
- b) 0.5  $\Omega$  for multi-sensor fire alarms powered with a supply of 5 V or less,

at intervals not less than the time declared by the manufacturer to achieve the fault warning until the fault warning is given.

Record the resistance of the series resistor at which the fault warning is given as  $R_B$ .

After the conditioning, measure the smoke response value of the specimen in accordance with 4.1.5. Designate the greater of the smoke response values measured before the conditioning and that after the conditioning as  $m_{\max}$  and the lesser as  $m_{\min}$ . Calculate the ratio of the smoke response values as  $m_{\max} : m_{\min}$ .

Measure the CO response value in accordance with 4.1.6. Designate the greater of the CO response value measured before the conditioning and that measured after the conditioning as  $S_{\max}$  and the lesser as  $S_{\min}$ . Calculate the ratio of the CO response values as  $S_{\max} : S_{\min}$ .

Test the heat response value of the specimen in accordance with 4.1.7 at a rate of rise of air temperature of 20 K/min. Designate the greater of the heat response values measured before the conditioning and that measured after the conditioning as  $t_{\max}$  and the lesser as  $t_{\min}$ . Calculate the ratio of the heat response values as  $t_{\max} : t_{\min}$ .

If the battery is used for radio interconnection, check that the device can both send and receive an alarm signal correctly.

#### 4.2.8.2.5 Reduction of supply voltage to 0 V

Reduce the supply voltage from the voltage at which the low battery warning is given ( $V_E$ ) in increments of  $0.1 V_{\min}^{-1}$  down to a supply voltage of 0 V.

Carry out a technical assessment to verify conformity to [4.2.8.1](#).

#### 4.2.8.3 Remote transmission of battery fault warning

Carry out a visual inspection and a technical assessment to verify conformity to [4.2.8.1](#).

### 4.2.9 Routine test facility

#### 4.2.9.1 Requirement

The provision of a routine test facility, by which the function of the alarm can be tested, shall be expressed in accordance with [Table 13](#), applying the assessment method in [4.2.9.2](#).

**Table 13** — Routine test facility

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2      | <p>The device is not interconnected AND</p> <p>The device has a manually operated test facility that is accessible from outside the alarm when installed as specified in the installation instructions AND</p> <p>Operation of the test facility checks that all sensors used for the detection of fire phenomena are functioning correctly AND</p> <p>The test facility checks that the alarm signal processing circuitry is functioning correctly AND</p> <p>Provided the alarm is functioning correctly, the test facility emits an audible alarm signal (a lower sound output level than that required in <a href="#">4.2.11</a> is allowed).</p> |
| 1      | <p>The device is interconnectable with other devices AND:</p> <ul style="list-style-type: none"> <li>• meets all the criteria for devices that are not interconnected (Option 2) AND</li> <li>• all interconnected alarms emit an audible or visual signal.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                |

#### 4.2.9.2 Assessment method

Activate the routine test facility on the multi-sensor fire alarm.

Carry out an assessment based on the manufacturer's description of the routine test facility operation to verify conformity to [4.2.9.1](#).

With a fault induced on one or more of the sensors within the multi-sensor fire alarm being routinely tested, activate the routine test facility on the multi-sensor fire alarm to check whether the multi-sensor fire alarm emits an audible alarm signal.

If interconnection means are provided, connect the alarm under test with the maximum number of multi-sensor fire alarms allowed in the manufacturer's instructions.

*NOTE If more than five alarms can be interconnected, a minimum of five alarms may be interconnected and the remainder simulated by an equivalent electrical load.*

#### 4.2.10 Audible fire alarm signal

##### 4.2.10.1 Requirement

The audible alarm signal emitted in the event of the detection of a fire shall be expressed in accordance with [Table 14](#), applying the assessment method in [4.2.10.2](#).

**Table 14** — *Fire alarm signal*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>The audible alarm signal consists of a modulated sound with any off period not more than 2 s in duration AND</p> <p>The audible alarm signal takes precedence over any other audible signal, even when such other signal is initiated first AND</p> <p>The audible alarm signal is distinctive from any other audible non-fire alarm signals which can be produced by the alarm.</p> |

**4.2.10.2 Assessment**

Activate an alarm signal on the multi-sensor fire alarm and measure the OFF-duration of the audible signal to verify conformity to [4.2.10.1](#).

Initiate signals other than alarm (e.g. low battery signal, sensor fault) and then induce an alarm event. Verify conformity to [4.2.10.1](#).

**4.2.11 Sound output****4.2.11.1 Requirement**

The alarm signal emitted in the event of a fire shall be expressed in accordance with [Table 15](#), applying the assessment method in [4.2.11.2](#).

**Table 15** — *Sound output*

| Option                                                                                                                                                                                                                                              | Criteria                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                                                                                                                                                                                                                                                   | <p>The sounder is stimulated by a single or multiple frequency(ies) AND these frequencies do not exceed 3.5 kHz.<sup>A)</sup> AND</p> <p>The sound output level is at least 85 dB(A) at 3 m in one direction directly in front of the multi-sensor fire alarm or at an angle within 45° of this.</p> |
| <p><sup>A)</sup> In the case of a sound pattern with a swept frequency or a spread of frequencies, the centre frequency should not exceed 3.5 kHz and the maximum frequency of a sweep, or the maximum frequency should not exceed 3.5 kHz +5%.</p> |                                                                                                                                                                                                                                                                                                      |

**4.2.11.2 Assessment method**

Test two samples. Test any multi-sensor fire alarm intended additionally for wired multiple-station interconnection in that configuration with the maximum line resistance and maximum number of networked alarms, with the sound output measured on the multi-sensor fire alarm subject to the smoke or equivalent. Test mains-powered multi-sensor fire alarms when connected to a source of rated voltage and frequency. For rechargeable or primary batteries, use a stabilized power supply set to  $V_E$  with the specified battery still in position but disconnected. Test mains-powered multi-sensor fire alarms incorporating a stand-by power source both as mains and battery powered.

*NOTE 1 If more than five alarms can be interconnected, a minimum of five alarms may be interconnected and the remainder simulated by an equivalent electrical load.*

Mount the multi-sensor fire alarm on a board made of plywood with dimensions of  $(1.2 \pm 0.02)$  m by  $(1.2 \pm 0.02)$  m and thickness of  $(20 \pm 3)$  mm.

Use a sound pressure level meter conforming to BS EN 61672-1:2013, class 2 or better, to measure and record the A-weighted sound pressure level in dB(A), using the F (Fast) (0.125 s) and maximum hold multi-sensor fire alarm indicator characteristic.

Take the measurement indoors in a simulated free-field condition satisfying the following condition: the sound pressure level varies with the distance from a point according to a  $1/r^2$ -law within

tolerances of  $\pm 1$  dB for the sound pressure level, in a  $(200 \times 200 \times 200)$  mm volume around the position to be occupied by the microphone during the measurement.

*NOTE 2 An anechoic chamber is regarded as being a free-field environment.*

*NOTE 3 The sound pressure level may be measured at 1 m and the value at 3 m calculated by subtracting 9.54 dB from the reading at 1 m.*

The ambient noise level shall be at least 10 dB(A) below the measured level produced by the alarm.

Measure the frequency with an oscilloscope or spectrum analyser to identify the maximum driving frequency.

#### 4.2.12 Sounder durability

##### 4.2.12.1 Requirement

The durability of the multi-sensor fire alarm's sounder shall be expressed in accordance with [Table 16](#), applying the assessment method in [4.2.12.2](#).

**Table 16** — *Sounder durability*

| Option | Criteria                                                                                       |
|--------|------------------------------------------------------------------------------------------------|
| 1      | The sound output of the alarm is within 3 dB of the sound output prior to prolonged operation. |

##### 4.2.12.2 Assessment method

###### *COMMENTARY ON 4.2.12.2*

*The objective of this test is to determine whether the sound pressure level changes significantly after prolonged operation of the sounder.*

Connect the specimen to its power source in accordance with [4.1.2](#). For a battery-operated multi-sensor fire alarm, use a stabilized supply adjusted to the specified voltage.

Operate the specimen for 8 h of alternate 5 min of energization, followed by 5 min of de-energization in the alarm conditions.

After the conditioning, measure the sound output of the multi-sensor fire alarm in accordance with [4.2.11.2](#), only at the  $(0^\circ, 0^\circ)$  angle.

#### 4.2.13 Protection against the ingress of foreign bodies

##### 4.2.13.1 Requirement

###### *COMMENTARY ON 4.2.13.1*

*This requirement is intended to restrict the access of insects into the sensitive parts of the multi-sensor fire alarm. It is known that a 1.3 mm diameter limit is not sufficient to prevent the access of all insects, but it is considered that extreme restrictions on the size of access holes could introduce the danger of clogging by dust, etc. It might therefore be necessary to take other precautions against false alarms due to the entry of small insects.*

The protection of the multi-sensor fire alarm against the ingress of foreign bodies shall be expressed in accordance with [Table 17](#), applying the assessment method in [4.2.13.2](#).

**Table 17** — *Protection against ingress of foreign bodies*

| Option | Criteria                                                                                                                                                                                                                                                  |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | A sphere with a diameter $(1.3 \pm 0.05)$ mm cannot pass into the smoke sensor chamber(s) AND<br>A rectangular probe with a cross-section of $(1.0 \pm 0.05)$ mm by $(2.0 \pm 0.05)$ mm cannot pass beyond the outer surface of the smoke sensor chamber. |

#### 4.2.13.2 Assessment method

Assess one specimen to determine if:

- a) a sphere of diameter  $(1.3 \pm 0.05)$  mm can pass into the smoke sensor chamber(s); or
- b) a rectangular probe with a cross-section of  $(1.0 \pm 0.05)$  mm by  $(2.0 \pm 0.05)$  mm can pass beyond the outer surface of the smoke sensor chamber.

#### 4.2.14 Software-controlled multi-sensor fire alarms

##### 4.2.14.1 Requirement

For a multi-sensor fire alarm which relies on software control, the design of the software to ensure the reliability of the multi-sensor fire alarm shall be expressed in accordance with [Table 18](#), applying the assessment method in [4.2.14.2](#).

**Table 18** — *Software controlled multi-sensor fire alarms*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>The multi-sensor fire alarm relies on software control AND</p> <p>The software has a modular structure AND</p> <p>The design of the interfaces for manually and automatically generated data does not permit invalid data to cause error in the program operation AND</p> <p>The software is designed to avoid the occurrence of deadlock of the program flow AND</p> <p>The program and pre-set data are held in non-volatile memory AND</p> <p>Writing to areas of memory containing the program and data is only possible by use of a special tool or code and is not possible during normal operation of the multi-sensor fire alarm AND</p> <p>Site-specific data are held in memory which retains data for at least two weeks without external power to the multi-sensor fire alarm, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.</p> |
| X      | The multi-sensor fire alarm does not rely on software control.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

##### 4.2.14.2 Assessment method

Assess the manufacturer software documentation to determine whether:

- a) the software documentation is sufficiently detailed for the design to be inspected and includes at least the following:
  - 1) a functional description of the main program flow (e.g. as a flow diagram or structogram), including:
    - i) a brief description of the modules and the functions they perform;
    - ii) the way in which the modules interact;
    - iii) the overall hierarchy of the program;
    - iv) the way in which the software interacts with the hardware of the multi-sensor fire alarm;

- v) the way in which the modules are called, including any interrupt processing;
- 2) a description of which areas of memory are used for the various purposes (e.g. the program, site-specific data and running data);
- 3) a designation by which the software and its version can be uniquely identified; and
- b) where the design overview is not sufficiently detailed for the assessment, additional documentation is provided by the manufacturer if requested by the testing authority, comprising at least the following:
  - 1) an overview of the whole system configuration, including all software and hardware components;
  - 2) a description of each module of the program, containing at least:
    - i) the name of the module;
    - ii) a description of the tasks performed;
    - iii) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data;
  - 3) full source code listings, as hard copy or in machine-readable form [e.g. American Standard Code for Information Interchange (ASCII) code], including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized; and
  - 4) details of any software tools used in the design and implementation phase [e.g. computer-aided software engineering (CASE) tools, compilers].

#### **4.2.15 Inter-connectable multi-sensor fire alarms**

##### **4.2.15.1 Requirement**

Where provision is made for the interconnection of multi-sensor fire alarms to give a general audible alarm signal, this shall be expressed in accordance with [Table 19](#), applying the assessment method in [4.2.15.2](#).

##### **4.2.15.2 Assessment methods**

###### **4.2.15.2.1 Assessment of interconnection response time**

Connect the multi-sensor fire alarms under test with the maximum number of multi-sensor fire alarms allowed in the manufacturer's instructions.

*NOTE 1 If more than five alarms can be interconnected, a minimum of five alarms may be interconnected and the remainder simulated by an equivalent electrical load.*

If multi-sensor fire alarms are interconnected using radio frequency links, place the devices in the same room at a distance less than the maximum range.

Trigger one multi-sensor fire alarm into the alarm condition and check all the interconnected alarms to verify that the audible alarm signal starts within 30 s of the initial alarm signal.

*NOTE 2 This test can be carried out using suitable field test equipment.*

**Table 19** — *Inter-connectable multi-sensor fire alarms*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>The multi-sensor fire alarm includes the provision for interconnection to give a general audible alarm signal AND</p> <p>An audible signal is emitted from all interconnected multi-sensor fire alarms within 30 s of the fire being detected by any one or more of these multi-sensor fire alarms AND</p> <p>An open circuit of the transmission path (open-circuit of wiring or disruption of radio link) does not jeopardize the functioning of the individual multi-sensor fire alarms and does not result in an alarm condition AND</p> <p>A short circuit of a wired transmission path does not result in an alarm condition AND</p> <p>With a short circuit of a wired transmission path the sounder output does not decrease by more than 3 dBA AND</p> <p>With a short circuit of a wired transmission path, if a smoke sensor is included in the multi-sensor fire alarm, the ratio of smoke response values is <math>\leq 1.6</math> AND <math>m_{\min} \geq 0.05</math> dB/m AND</p> <p>With a short circuit of a wired transmission path, if a heat sensor is included in the multi-sensor fire alarm, the ratio of heat response values is <math>\leq 1.3</math> AND</p> <p>With a short circuit of a wired transmission path, if a CO sensor is included in the multi-sensor fire alarm, the ratio of CO response values is <math>\leq 1.6</math> AND (<math>S_{\min} \geq 25</math> µl/l).</p> |
| X      | The alarm does not include the provision for interconnection to give a general audible alarm signal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

**4.2.15.2.2 Assessment of function with open circuit**

Apply an open circuit between the interconnecting leads or disrupt, via means provided by the manufacturer, the radio transmission between two radio frequency-linked multi-sensor fire alarms and monitor all multi-sensor fire alarms for at least 1 min, then:

- verify that none of the interconnected alarms has indicated an alarm condition; and
- trigger all the multi-sensor fire alarms into the alarm condition individually, to verify that they still operate correctly.

*NOTE* This test can be carried out using suitable field test equipment.

**4.2.15.2.3 Assessment of function with short circuit**

Apply a short circuit between the interconnecting multi-sensor fire alarms and monitor all multi-sensor fire alarms for at least 1 min, and verify that none of these has indicated an alarm condition.

*NOTE* This test is not applicable for multi-sensor fire alarms that are interconnected using radio frequency links.

With the short circuit still in place, carry out the following.

- Repeat the sound output tests in accordance with 4.2.11 on one of the multi-sensor fire alarms, ensuring that the other interconnected multi-sensor fire alarms are sufficiently screened or distanced so that their audible alarm signals do not influence the measurement. Designate the sound output measured in this test as  $L_{00int}$  and that measured in the same direction for the same specimen in the sound output test as  $L_{00}$ . Calculate the decrease in sound output by  $L_{00} - L_{00int}$ .
- If the multi-sensor fire alarm includes a smoke sensor, measure the smoke response value in accordance with 4.1.5. Designate the greater of the smoke response values measured in this test and that measured for the same specimen in the reproducibility test as  $m_{\max}$ , and the lesser as  $m_{\min}$ . Calculate the ratio of the smoke response values as  $m_{\max} : m_{\min}$ .

- c) If the multi-sensor fire alarm includes a CO sensor, measure the CO response value in accordance with 4.1.6. Designate the greater of the CO response values measured in this test and that measured for the same specimen in the reproducibility test as  $S_{\max}$  and the lesser as  $S_{\min}$ . Calculate the ratio of the CO response values as  $S_{\max} : S_{\min}$ .
- d) If the multi-sensor fire alarm includes a heat sensor, measure the heat response value in accordance with 4.1.7 at a rate of rise of air temperature of 20 K/min. Designate the greater of the heat response values measured in this test and that measured for the same specimen in the reproducibility test as  $t_{\max}$  and the lesser as  $t_{\min}$ . Calculate the ratio of the heat response values as  $t_{\max} : t_{\min}$ .

## 4.2.16 Multi-sensor fire alarms using radio frequency links

### 4.2.16.1 Radio frequency (RF) link range

#### 4.2.16.1.1 Requirement

##### COMMENTARY ON 4.2.16.1.1

*This subclause specifies performance requirements for multi-sensor fire alarms using radio frequency links for interconnection. There is no requirement for permanent monitoring of the transmission path.*

The minimum free-field range of a radio multi-sensor fire alarm shall be expressed in accordance with Table 20, applying the assessment method in 4.2.16.1.2.

**Table 20** — Radio frequency link range

| Option | Criteria                                                                                                                                        |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Multi-sensor fire alarm includes an RF link which communicates the alarm status within 30 s and has a minimum free-field range of $\geq 100$ m. |
| X      | The multi-sensor fire alarm does not include an RF link.                                                                                        |

#### 4.2.16.1.2 Assessment method

##### 4.2.16.1.2.1 RF range

Determine the transmission power of each specimen in the most unfavourable transmission direction according to the manufacturer's specification. This may be measured, for example, in an RF anechoic chamber or under free-field conditions. Where the units use different frequencies, make the measurement at the highest frequency.

Identify the specimen with the lowest transmission power and mark it as "S1".

In the same frequency band or channel used, test the receiver sensitivity of all the specimens (apart from "S1") under free-field conditions using "S1" as the transmitter, orientated such that its most unfavourable transmitting direction faces the receiver. Position each of the other specimens, in turn, at a distance of 100 m or more, orientated such that the least sensitive direction faces the transmitter. Then transmit an alarm signal by "S1" and measure the time taken for the receiver to generate an audible alarm.

*NOTE It is accepted that the least sensitive receiver direction is the same as the most unfavourable transmission direction.*

##### 4.2.16.1.2.2 Alternative RF range

Details of how an alternative RF range is measured shall be obtained from the latest edition of BS EN 50291-1 or any post-2020 edition of BS EN 14604 which defines an RF range test.

*NOTE The challenge of measuring RF range in free air is complex and is currently under review; hence this allowance to use an alternative RF range assessment method.*

#### 4.2.16.2 Identification codes verification

##### 4.2.16.2.1 Requirements

Radio multi-sensor fire alarms shall have a coding scheme sufficient to prevent interference with other nearby multi-sensor fire alarm systems, for example, by triggering alarms or receiving alarms from nearby systems operating within the same radio range, applying the assessment method in [4.2.16.2.2](#).

*NOTE* These other multi-sensor fire alarm systems could come from the same manufacturer or could be technically similar multi-sensor fire alarms from another manufacturer.

There shall be a minimum of 65 000 identification codes or, alternatively, the manufacturer shall provide means to the user on site to choose the identification code with a minimum of 256 codes to ensure that a multi-sensor fire alarm does not interfere with other nearby systems.

##### 4.2.16.2.2 Assessment method

*COMMENTARY ON 4.2.16.2.2*

*The objective of this test is to demonstrate the ability of the multi-sensor fire alarm to distinguish between the required amount of identification codes.*

Carry out a technical assessment of the documentation describing how the coding operates to verify conformity to [4.2.16.2.1](#).

#### 4.2.16.3 Environmental requirements for radio frequency interconnected multi-sensor fire alarms

##### 4.2.16.3.1 Requirement

Multi-sensor fire alarms interconnected by radio frequency shall not generate or transmit an alarm or no-fault signal when subjected to the environmental tests and the endurance tests, applying the assessment method in [4.2.16.3.2](#).

##### 4.2.16.3.2 Assessment method

*COMMENTARY ON 4.2.16.3.2*

*The objective of this test is to show that multi-sensor fire alarms interconnected by radio frequency, including radio modules, do not change significantly after environmental conditioning.*

Subject the multi-sensor fire alarms, including their radio modules, to the environmental tests.

After conditioning:

- trigger the conditioned multi-sensor fire alarm into the alarm condition and check that one interconnected sample goes into alarm as specified in [4.2.16.3.1](#); and
- trigger the unconditioned multi-sensor fire alarm into the alarm condition and check that the conditioned multi-sensor fire alarm goes into alarm as specified in [4.2.16.3.1](#).

Carry out a technical assessment to verify conformity to [4.2.16.3.1](#).

#### 4.2.17 Temporary disablement facility

##### 4.2.17.1 Requirement

Where provision is made for temporary disablement of a multi-sensor fire alarm while in its normal condition, this shall be expressed in accordance with [Table 21](#), applying the assessment method in [4.2.17.2](#).

**Table 21** — *Temporary disablement facility*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>The multi-sensor fire alarm is not interconnected AND</p> <p>The initiation of the temporary disablement period is possible at least by operation of a manual control on the alarm (this control may be the same as the manual control provided for routine testing) AND</p> <p>The operation of the temporary disablement control disables or desensitizes the alarm for at least 5 min up to maximum 15 min AND</p> <p>The normal operation of the alarm automatically restores after this time AND</p> <p>Continuous operation of the temporary disablement control (e.g. stuck test button) does not lead to the alarm being disabled for more than 15 min:</p> <ul style="list-style-type: none"> <li>• without an audible warning signal being emitted by the alarm (alarm or fault warning) for as long as the control is held on;</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• without restoration of the alarm to normal operation</li> </ul> <p>AND</p> <p>When restored to normal operation, the ratio of response of all sensors before and after the temporary disablement period is not less than 0.625 and not greater than 1.6.</p> |
| 2      | <p>The multi-sensor fire alarm is interconnected AND</p> <p>Meets the criteria for devices that are not interconnected (Option 1) AND</p> <p>Temporary disablement of a specific alarm does not lead to disablement of any interconnected multi-sensor fire alarm devices AND</p> <p>A disabled alarm is capable of indicating an alarm signal received from an interconnected alarm.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 3      | <p>The multi-sensor fire alarm meets all criteria stated in Option 1</p> <p>AND</p> <p>A remote-control device can be used to activate the temporary disablement facility AND</p> <p>The remote control works exclusively from a position in line of sight of the alarm in the same room to the assigned multi-sensor fire alarm device AND</p> <p>The technical manual and the user manual state that the remote control is to be used in line of sight of the multi-sensor fire alarm.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 4      | <p>The multi-sensor fire alarm meets all criteria stated in Option 2</p> <p>AND</p> <p>A remote-control device can be used to activate the temporary disablement facility AND</p> <p>The remote control works exclusively from a position in line of sight of the alarm in the same room as the assigned multi-sensor fire alarm device AND</p> <p>The technical manual and the user manual state that the remote control is to be used in line of sight of the multi-sensor fire alarm.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| X      | The alarm does not provide a temporary disablement facility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

**4.2.17.2 Assessment method**

For assessment of the temporary disablement facility, follow the manufacturer's instructions for application of fire phenomena during the assessment.

During all tests, supply the multi-sensor fire alarms with nominal supply voltage.

**Option 1:**

Operate the manual control for temporary disablement. For devices containing at least one optical sensor, generate smoke conditions up to three times greater than those required for alarm as measured in accordance with [4.1.5](#). For devices with no optical sensor, generate CO conditions greater than three times those required to produce an alarm in accordance with [4.1.6](#). Maintain these fire conditions for the duration of the test. Measure the time between the operation of the manual control for temporary disablement and the reoccurrence of the audible alarm signal to verify conformity to [4.2.17.1](#).

Repeat the test with the manual control facility for temporary disablement operated continuously and verify conformity to [4.2.17.1](#).

To verify that the multi-sensor fire alarm has returned to normal operation, place the multi-sensor fire alarm in clear air. Operate the manual control for the temporary disablement and wait for 900 s to 915 s before starting a measurement of the multi-sensor fire alarm's responses values in accordance with [4.1.5](#) and [4.1.6](#), as appropriate, and verify conformity to [4.2.17.1](#).

**Option 2:**

Conduct the assessment as for Option 1, then:

- a) interconnect an arbitrarily chosen multi-sensor fire alarm to the assigned specimen; and
- b) operate the manual control for the temporary disablement mode of the arbitrarily chosen multi-sensor fire alarm.

Measure the fire phenomena response of the interconnected specimen while the temporary disablement mode of the first alarm is in operation and verify conformity to [4.2.17.1.1](#), including that the first alarm, while in temporary disablement mode, gives an interconnected alarm response when the second specimen enters alarm.

**Option 3 or 4:**

Conduct the assessment as for Option 1 or Option 2 as applicable (see [Table 21](#)) on the manual control on the multi-sensor fire alarm. Repeat for the remote-control device and:

- a) for a wired remote-control device or fixed wireless remote-control device, visually inspect the installation manual to confirm that there is a clear requirement for the remote-control device to be installed in the immediate vicinity, e.g. situated in line of sight or up to 10 m from the assigned multi-sensor fire alarm(s); and
- b) for a portable wireless remote-control device, visually inspect the user manual to determine if there is a clear instruction for the remote-control device to be operated exclusively only after inspection has confirmed there is no fire in the immediate vicinity of the assigned multi-sensor fire alarm(s).

**4.2.18 Alarm muting facility****4.2.18.1 Requirement**

Where provision is made for temporarily muting an alarm signal after smoke has been detected, this shall be expressed in accordance with [Table 22](#), applying the assessment method in [4.2.18.2](#).

**Table 22** — *Alarm muting facility*

| Option | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | <p>The multi-sensor fire alarm is not interconnected AND</p> <p>The initiation of the alarm muting period is possible at least by operation of a manual control on the alarm (this control may be the same as the manual control provided for routine testing) AND</p> <p>The operation of the muting control disables or desensitizes the alarm for at least 5 min up to maximum 15 min AND</p> <p>The normal operation of the alarm automatically restores after this time AND</p> <p>Continuous operation of the temporary disablement control (e.g. stuck test button) does not lead to the alarm being muted for more than 15 min.</p>                                                                       |
| 2      | <p>The multi-sensor fire alarm is interconnected AND</p> <p>Meets the criteria for devices that are not interconnected (Option 3) AND</p> <p>Muting the multi-sensor fire alarm that detected a fire leads to alarm silence of any interconnected multi-sensor fire alarm devices which have not detected a fire AND</p> <p>Alarm silencing at an interconnected multi-sensor fire alarm not having detected a fire by itself can lead to alarm silence of any other interconnected multi-sensor fire alarm device, but not of the multi-sensor fire alarm that detected the fire AND</p> <p>Those silenced interconnected multi-sensor fire alarms are still capable of detecting fires and giving an alarm.</p> |
| 3      | <p>The alarm meets all criteria for Option 1</p> <p>AND</p> <p>A remote-control device can be used to activate the muting facility AND</p> <p>The remote control works exclusively from a position in line of sight of the alarm in the same room as the assigned multi-sensor fire alarm device AND</p> <p>The technical manual and the user manual state that the remote control is to be used in line of sight of the multi-sensor fire alarm.</p>                                                                                                                                                                                                                                                             |
| 4      | <p>The alarm meets all criteria for Option 2</p> <p>AND</p> <p>A remote-control device can be used to activate the muting facility AND</p> <p>The remote control works exclusively from a position in line of sight of the alarm in the same room as the assigned multi-sensor fire alarm device AND</p> <p>The technical manual and the user manual state that the remote control is to be used in line of sight of the multi-sensor fire alarm.</p>                                                                                                                                                                                                                                                             |
| X      | The alarm does not provide a muting facility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

**4.2.18.2 Assessment methods**

Follow the manufacturer's instructions for application of fire phenomena during the assessment.

During all tests, supply the multi-sensor fire alarms with nominal supply voltage.

**Option 1:**

For devices containing at least one optical sensor, generate smoke conditions up to three times greater than those required for alarm as measured in accordance with 4.1.5. For devices with no optical sensor, generate CO conditions up three times greater than those required to produce an alarm in accordance with 4.1.6. Maintain these fire conditions for the duration of the test. Place the multi-sensor fire alarm into these conditions and after the multi-sensor fire alarm has entered alarm

condition, operate the manual control for alarm muting. Measure the time between the operation of the manual control for alarm muting and the reoccurrence of the audible alarm signal to verify conformity to [4.2.18.1](#).

Repeat the test with the manual control facility for alarm muting operated continuously and verify conformity to [4.2.18.1](#).

#### Option 2:

Conduct the assessment as for Option 1, then:

- interconnect two arbitrarily chosen multi-sensor fire alarms to the assigned specimen;
- place the assigned specimen into alarm condition;
- operate the manual control for muting on the multi-sensor fire alarm that is in alarm and check that it mutes other devices;
- induce an alarm event on a silenced interconnected multi-sensor fire alarm to confirm it is not disabled;
- wait for 900 s, then place the assigned specimen into the alarm condition; and
- operate the manual control for muting on one of the arbitrarily chosen interconnected alarms, which is not detecting fire conditions and verify conformity to [4.2.18.1](#).

#### Option 3 or 4:

Conduct the assessment as for Option 1 or Option 2, as applicable (see [Table 22](#)), on the manual control on the multi-sensor fire alarm. Repeat for the remote-control device and:

- for a wired remote-control device or fixed wireless remote-control device, visually inspect the installation manual to confirm that there is a clear requirement for the remote-control device to be installed in the immediate vicinity, e.g. situated in line of sight or up to 10 m from the assigned multi-sensor fire alarm(s); and
- for a portable wireless remote-control device, visually inspect the user manual to determine if there is a clear instruction for the remote-control device to be operated exclusively only after inspection has confirmed there is no fire in the same room, in the immediate vicinity of the assigned multi-sensor fire alarm(s).

### 4.3 Nominal activation conditions/sensitivity

#### 4.3.1 Repeatability

##### 4.3.1.1 Requirement

The stability of the multi-sensor fire alarm with respect to its sensitivity to CO, even after the CO response value has been reached several times, shall conform to [Table 23](#), applying the assessment method in [4.3.1.2](#).

**Table 23** — *Repeatability of CO response*

| Option | Criteria                                                              |
|--------|-----------------------------------------------------------------------|
| 1      | Ratio of CO response value $\leq 1.6$ AND<br>$S_{\min} \geq 25$ ml/l. |

##### 4.3.1.2 Assessment method

Measure the CO response value of one specimen to be tested six times in accordance with [4.1.6](#), allowing a dwell period specified by the manufacturer.

The specimen's orientation relative to the direction of airflow is arbitrary, but it shall be the same for all six measurements.

Designate the maximum response threshold value as  $S_{\max}$  and the minimum value as  $S_{\min}$ . Calculate the ratio of the CO response values as  $S_{\max} : S_{\min}$ .

### 4.3.2 Directional dependence

#### 4.3.2.1 Directional dependence of smoke response

##### 4.3.2.1.1 Requirement

The dependence of the sensitivity of the multi-sensor fire alarm to smoke on the direction of airflow around the multi-sensor fire alarm shall be expressed in accordance with [Table 24](#), applying the assessment method in [4.3.2.1.2](#).

**Table 24** — *Directional dependence of smoke response*

| Option | Criteria                                                                   |
|--------|----------------------------------------------------------------------------|
| 1      | Ratio of smoke response value $\leq 1.6$ AND<br>$m_{\min} \geq 0.05$ dB/m. |
| X      | The multi-sensor fire alarm does not provide for an optional smoke sensor. |

##### 4.3.2.1.2 Assessment method

Measure the smoke response value of one specimen to be tested eight times in accordance with [4.1.5](#), the specimen being rotated  $45^\circ$  about its vertical axis between each measurement so that measurements are taken for eight different orientations relative to the direction of airflow.

Designate the maximum smoke response value as  $m_{\max}$  and the minimum value as  $m_{\min}$ . Calculate the ratio of the smoke response values as  $m_{\max} : m_{\min}$ .

Record the orientations for which the maximum and minimum smoke response values were measured.

*NOTE* For other tests in this British Standard, the orientation for which the maximum smoke response value was measured is referred to as the least sensitive orientation for smoke, and the orientation for which the minimum smoke response value was measured is referred to as the most sensitive orientation for smoke.

#### 4.3.2.2 Directional dependence of CO response

##### 4.3.2.2.1 Requirement

The dependence of the sensitivity of the multi-sensor fire alarm to CO on the direction of airflow around the multi-sensor fire alarm shall be expressed in accordance with [Table 25](#), applying the assessment method in [4.3.2.2.2](#).

**Table 25** — *Directional dependence of CO response*

| Option | Criteria                                                                |
|--------|-------------------------------------------------------------------------|
| 1      | Ratio of CO response value $\leq 1.6$ AND<br>$S_{\min} \geq 25$ ml/l.   |
| X      | The multi-sensor fire alarm does not provide for an optional CO sensor. |

##### 4.3.2.2.2 Assessment method

Measure the CO response value of one specimen to be tested eight times in accordance with [4.1.6](#), the specimen being rotated  $45^\circ$  about its vertical axis between each measurement so that the measurements are taken for eight different orientations relative to the direction of airflow.