INTERNATIONAL STANDARD

**ISO 7240-22**

Second edition
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# Fire detection and alarm systems —

## Part 22: Smoke-detection equipment for ducts

*Systèmes de détection et d'alarme d'incendie —*

*Partie 22: Équipement de détection des fumées dans les conduits*



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# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

This second edition cancels and replaces the first edition (ISO 7240-22:2007), which has been technically revised.

The main changes compared to the previous edition are as follows:

— in 5.16 (electromagnetic compatibility immunity tests), EN 50130-4 has been replaced by IEC 62599-2;

— marking has been moved to a new Clause 7;

— data and software requirements have been moved to Clause 8.

A list of all parts in the ISO 7240 series can be found in the ISO website.

# Introduction

Smoke-detection equipment for ducts (SDED) is used as part of a fire detection system to sample the environment within air ducts of a building. Detection of smoke releases a signal to the connected control and indicating equipment and can be used as a signal to an air-handling system to prevent the spread of smoke within the building.

SDED is required to function satisfactorily not only in the event of a fire, but also during and after exposure to conditions likely to be met in practice such as corrosion, vibration, direct impact, indirect shock and electromagnetic interference. Some tests specified are intended to assess the performance of the SDED under such conditions.

The performance of SDED is assessed from results obtained in specific tests. This document is not intended to place any other restrictions on the design and construction of such equipment.

# Fire detection and alarm systems —

# Part 22: Smoke-detection equipment for ducts

## 1 Scope

This document specifies requirements, test methods and performance criteria for smoke-detection equipment for ducts (SDED) for use in fire detection and alarm systems installed in buildings (see ISO 7240-1).

The SDED samples the air from a duct and detects smoke in the sample.

NOTE 1 A common method of operation is to use differential pressure arising from airflow in the duct.

The SDED can use smoke detectors complying with ISO 7240-7 or other detectors complying with tests specified in this document.

A common application for SDED is to detect visible smoke, for which detectors using scattered light or transmitted light can be more suitable. However, requirements for detectors using ionization are also included in this document for use in applications where detection of less visible fire aerosols is desired.

For the testing of other types of smoke detectors or smoke detectors working on different principles, this document can be used for guidance. Smoke detectors with special characteristics, developed for specific risks, are not covered.

NOTE 2 Certain types of detectors contain radioactive materials. The national requirements for radiation protection differ from country to country and are not specified in this document.

## 2 Normative references

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

ISO 209, *Aluminium and aluminium alloys — Chemical composition*

ISO 7240-1, *Fire detection and alarm systems — Part 1: General and definitions*

ISO 7240-7:2011, *Fire detection and alarm systems — Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

IEC 60068-1, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing — Part 2: Tests. Tests A: Cold*

IEC 60068-2-2, *Environmental testing — Part 2: Tests. Tests B: Dry heat*

IEC 60068-2-6, *Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27, *Environmental testing — Part 2: Test Ea and guidance: Shock*

IEC 60068-2-42, *Environmental testing — Part 2-42: Tests. Tests Kc: Sulphur dioxide tests for contacts and connections*

IEC 60068-2-78, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*



IEC 62599-2, *Alarm systems — Part 2: Electromagnetic compatibility — Immunity requirements for components of fire and security alarm systems*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7240-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

**3.1**
**response threshold value**
$A_{th}$
aerosol density in the proximity of the specimen at the moment that it generates an alarm signal, when tested as specified in 5.1.5

Note 1 to entry: The response threshold value may depend on signal processing in the detector and in the control and indicating equipment.

## 4 Requirements

### 4.1 Compliance

In order to comply with this document, the SDED shall:

a) meet the requirements of Clause 4, which shall be verified by visual inspection or engineering assessment;

b) be tested as specified in Clause 5, and shall meet the requirements of the tests;

c) meet the requirements of Clauses 7 and 8, which shall be verified by visual inspection.

### 4.2 Visual alarm indication

**4.2.1** Each SDED shall be provided with a red visual indicator, by which the SDED can be identified when the associated detector releases an alarm and which remains illuminated until the alarm condition is reset. Where other conditions of the SDED can be visually indicated, they shall be clearly distinguishable from the alarm indication, except when the SDED is switched into a service mode. The alarm indicator may be the smoke detector indicator provided the indicator is visible when the detector is *in situ* as part of the SDED.

**4.2.2** The visual indicator shall be visible from a distance of 6 m in an ambient light intensity up to 500 lx at an angle of up to

a) 5° from the axis of the detector in any direction, and

b) 45° from the axis of the detector in at least one direction.

### 4.3 Connection of ancillary devices

The SDED may provide for connections to ancillary devices (remote indicators, control relays, etc.), but open- or short-circuit failures of these connections shall not prevent the correct operation of the SDED.

## 4.4 Monitoring of detachable detectors

For detachable detectors, a means shall be provided for a remote monitoring system (e.g. the fire detection control and indicating equipment) to detect the removal of the head from the base, in order to give a fault signal.

## 4.5 Manufacturer's adjustments

It shall not be possible to change the manufacturer's settings except by special means (e.g. the use of a special code or tool) or by breaking or removing a seal.

## 4.6 On-site adjustment of response behaviour

**4.6.1** If there is provision for on-site adjustment of the response behaviour of the SDED, then

a) for all of the settings at which the manufacturer claims compliance with this document, the SDED shall comply with the requirements of this document and access to the adjustment means shall be possible only by the use of a code or special tool or by removing the SDED from its base or mounting;

b) any setting(s) at which the manufacturer does not claim compliance with this document shall be accessible only by the use of a code or special tool, and it shall be clearly marked on the SDED or in the associated data that if these setting(s) are used, the SDED does not comply with this document.

**4.6.2** These adjustments may be carried out at the SDED, the detector or the control and indicating equipment.

## 4.7 Requirements for software-controlled smoke-detection equipment for ducts

### 4.7.1 General

The requirements of 4.7.2 and 4.7.3 shall be met for SDED that rely on software control in order to fulfil the requirements of this document.

### 4.7.2 Software design

In order to ensure the reliability of the SDED, the following requirements for software design shall apply.

a) The software shall have a modular structure.

b) The design of the interfaces for manually and automatically generated data shall not permit invalid data to cause an error in the program operation.

c) The software shall be designed to avoid the occurrence of deadlock of the program flow.

### 4.7.3 Storage of programs and data

**4.7.3.1** The program necessary to comply with this document and any preset data, such as manufacturer's settings, shall be held in non-volatile memory. Writing to areas of memory containing this program and data shall be possible only by the use of some special tool or code and shall not be possible during normal operation of the detector.

**4.7.3.2** Site-specific data shall be held in memory that retains data for at least two weeks without external power to the SDED, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.

# 5 Tests

## 5.1 General

### 5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as described in IEC 60068-1 as follows:

— temperature: (15 to 35) °C;

— relative humidity: (25 to 75) %;

— air pressure: (86 to 106) kPa.

The temperature and humidity shall be substantially constant for each environmental test where the standard atmospheric conditions are applied.

### 5.1.2 Mounting arrangements

Mount the specimen by its normal means of attachment in accordance with the manufacturer's instructions. If these instructions describe more than one method of mounting, then the method considered to be least favourable shall be chosen for each test.

### 5.1.3 Operating conditions for tests

**5.1.3.1** If a test method requires a specimen to be operational, then the specimen shall be connected to suitable supply and monitoring equipment with characteristics as required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value or the mean of the specified range. If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices (e.g. through wiring to an end-of-line device for collective detectors) to allow a fault signal to be recognized.

**5.1.3.2** The details of the supply and monitoring equipment and the alarm criteria used shall be given in the test report (Clause 6).

### 5.1.4 Tolerances

**5.1.4.1** Unless otherwise stated, the tolerances for the environmental test parameters shall be as given in the basic reference standards for the test (e.g. the relevant part of IEC 60068).

**5.1.4.2** If a specific tolerance or deviation limit is not specified in a requirement or test procedure, then a tolerance of ±5 % shall be applied.

### 5.1.5 Response threshold value

**5.1.5.1** Install the specimen for which the response threshold value, $A_{th}$, is being measured in the smoke tunnel described in Annex A, in its normal operating position, by its normal means of attachment.

NOTE This measurement can be taken only where the sampling apparatus of the SDED can fit inside the smoke tunnel. Where the sampling apparatus is too large, it will be necessary to agree on other arrangements with the manufacturer.



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

**5.1.5.3** Unless otherwise specified in the test procedure, the air temperature in the tunnel shall be (23 ± 5) °C and shall not vary by more than 5 K for all the measurements on a particular SDED type.

**5.1.5.4** Connect the specimen to its supply and monitoring equipment as specified in 5.1.3, and allow it to stabilize for a period of at least 15 min, unless otherwise specified by the manufacturer.

**5.1.5.5** Introduce the test aerosol, as specified in Annex B, into the tunnel such that the rate of increase of aerosol density is as follows:

— for SDED incorporating detectors using scattered or transmitted light, in decibels per metre per minute, as shown in Formula (1):

$$0{,}015 < \frac{\Delta m}{\Delta t} < 0{,}1 \tag{1}$$

— for SDED incorporating detectors using ionization, per minute, as shown in Formula (2):

$$0{,}05 < \frac{\Delta y}{\Delta t} < 0{,}3 \tag{2}$$

NOTE These ranges are intended to allow the selection of a convenient rate, depending upon the sensitivity of the SDED, so that a response can be obtained in a reasonable time.

**5.1.5.6** The rate of increase in aerosol density shall be similar for all measurements on a particular SDED type.

**5.1.5.7** Conduct tests on the SDED specimen at each of the following air velocities:

a) the minimum specified by the manufacturer;

b) the maximum specified by the manufacturer;

c) the mean of the minimum and maximum.

**5.1.5.8** The response threshold value is the aerosol density (in terms of $m$ or $y$) at the moment that the specimen gives an alarm at each air velocity. This shall be recorded as $m$, expressed in decibels per metre, for detectors using scattered or transmitted light, or as $y$ for detectors using ionization (as specified in Annex C).

**5.1.5.9** Designate the greater of the response threshold value as $y_{max}$ or $m_{max}$ for each air velocity; the lesser as $y_{min}$ or $m_{min}$ for each air velocity.

### 5.1.6 Provision for tests

**5.1.6.1** The following shall be provided for testing compliance with this document:

a) 13 SDED specimens;

b) data required in Clause 8.

**5.1.6.2** The specimens submitted shall be deemed representative of the manufacturer's normal production with regard to their construction and calibration. This implies that the mean response threshold value of the 12 specimens found in the reproducibility test (5.3) should also represent the

production mean, and that the limits specified in the response threshold value test should also be applicable to the manufacturer's production.

### 5.1.7 Test schedule

The specimens shall be tested according to the test schedule given in Table 1. After the reproducibility test, number the two least sensitive specimens (i.e. those with the highest response thresholds) 12 and 13, and the others 1 to 11 arbitrarily.

**Table 1 — Test schedule**

| Test | Subclause | Specimen number(s) |
|---|---|---|
| Repeatability | 5.2 | One chosen arbitrarily |
| Reproducibility | 5.3 | All specimens |
| Variation of supply parameters[a] | 5.4 | 1 |
| Dazzling[b] | 5.5 | 2 |
| Dry heat (operational) | 5.6 | 3 |
| Cold (operational) | 5.7 | 4 |
| Damp heat, steady-state (operational) | 5.8 | 5 |
| Damp heat, steady-state (endurance) | 5.9 | 6 |
| Sulfur dioxide, $SO_2$, corrosion (endurance) | 5.10 | 7 |
| Shock (operational) | 5.11 | 8 |
| Impact (operational) | 5.12 | 9 |
| Vibration, sinusoidal (operational) | 5.13 | 10 |
| Vibration, sinusoidal (endurance) | 5.14 | 10 |
| Air leakage[c] | 5.15 | 7, 10 |
| Electromagnetic compatibility (EMC), Immunity tests (operational) | 5.16 | 11 |
| Fire sensitivity | 5.17 | 12, 13 |

[a] This test duplicates a test undertaken as part of the assessment of point type smoke detectors for conformance to ISO 7240-7. Where the SDED includes a smoke detector conforming to ISO 7240-7 and does not include any additional active electronic components, this test may be omitted.

[b] This test only applies to detectors using scattered or transmitted light principle of operation. Where the SDED includes a smoke detector conforming to ISO 7240-7 or the sensing element is mounted within an opaque enclosure, this test may be omitted.

[c] Air leakage test is undertaken after the corrosion test and the vibration tests.

### 5.1.8 Test report

The test results shall be reported in accordance with Clause 6.

## 5.2 Repeatability

### 5.2.1 Object of test

To show that the SDED has stable behaviour with respect to its sensitivity even after a number of alarm conditions.

### 5.2.2 Test procedure

**5.2.2.1** Mount the specimen to be tested as specified in 5.1.2 and connect to the supply and monitoring equipment specified in 5.1.3.



**5.2.2.2** Measure the response threshold value of the specimen to be tested six times for each air velocity as specified in 5.1.5.

**5.2.2.3** Designate the maximum response threshold value as $y_{max}$ or $m_{max}$ for each air velocity, the minimum value as $y_{min}$ or $m_{min}$ for each air velocity.

### 5.2.3 Requirements

**5.2.3.1** The ratio of the response threshold values, $y_{max} : y_{min}$ or $m_{max} : m_{min}$, shall not be greater than 1,6 for each air velocity.

**5.2.3.2** The lower response threshold value, $y_{min}$, shall not be less than 0,2, or $m_{min}$ shall not be less than 0,05 dB/m.

## 5.3 Reproducibility

### 5.3.1 Object of test

To show that the sensitivity of the SDED does not vary unduly from specimen to specimen and to establish response threshold value data for comparison with the response threshold values measured after the environmental tests.

### 5.3.2 Test procedure

**5.3.2.1** Mount the specimen to be tested as specified in 5.1.2 and connect to the supply and monitoring equipment specified in 5.1.3.

**5.3.2.2** Measure the response threshold value of each of the test specimens for each air velocity as specified in 5.1.5.

**5.3.2.3** Calculate the mean of these response threshold values for each air velocity, which shall be designated as $\overline{y}$ or $\overline{m}$.

**5.3.2.4** Designate the maximum response threshold value as $y_{max}$ or $m_{max}$ and the minimum value as $y_{min}$ or $m_{min}$ for each air velocity.

### 5.3.3 Requirements

**5.3.3.1** The ratio of the response threshold values, $y_{max} : \overline{y}$ or $m_{max} : \overline{m}$, shall not be greater than 1,33 for each air velocity, and the ratio of the response threshold values, $\overline{y} : y_{min}$ or $\overline{m} : m_{min}$, shall not be greater than 1,5 for each air velocity.

**5.3.3.2** The lower response threshold value, $y_{min}$, shall not be less than 0,2, or $m_{min}$ shall not be less than 0,05 dB/m.

## 5.4 Variation in supply parameters

### 5.4.1 Object of test

To show that, within the specified range(s) of the supply parameters (e.g. voltage), the sensitivity of the SDED is not unduly dependent on these parameters.

### 5.4.2 Test procedure

**5.4.2.1** Mount the specimen to be tested as specified in 5.1.2 and connect to the supply and monitoring equipment specified in 5.1.3.

**5.4.2.2** At the mean air velocity specified in 5.1.5, measure the response threshold value of the specimen as specified in 5.1.5, at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

**5.4.2.3** Designate the greater of the response threshold value as $y_{max}$ or $m_{max\ and}$ the lesser as $y_{min}$ or $m_{min}$.

NOTE For non-addressable detectors, the supply parameter is the DC voltage applied to the detector. For other types of detector (e.g. analogue addressable), it can be necessary to consider signal levels and timing. If necessary, the manufacturer can be requested to provide suitable supply equipment to allow the supply parameters to be changed as required.

### 5.4.3 Requirements

**5.4.3.1** The ratio of the response threshold values, $y_{max} : y_{min}$ or $m_{max} : m_{min}$, shall not be greater than 1,6.

**5.4.3.2** The lower response threshold value, $y_{min}$, shall not be less than 0,2, or $m_{min}$ shall not be less than 0,05 dB/m.

## 5.5 Dazzling

### 5.5.1 Object of test

To show that the sensitivity of the SDED is not unduly influenced by the close proximity of artificial light sources. This test is applied only to SDED with detectors using scattered light or transmitted light, as detectors using ionization are considered unlikely to be influenced.

### 5.5.2 Test procedure

**5.5.2.1** Mount the specimen as specified in 5.1.2 and connect it to supply and monitoring equipment as specified in 5.1.3. Install the dazzling apparatus (specified in Annex D) over the portion of the specimen mounted outside the duct, such that the smoke-sensing element and housing are fully enclosed by the apparatus. Perform the following procedure at the mean air velocity specified in 5.1.5.

a) Measure the response threshold value as specified in 5.1.5.

b) Switch the five lamps ON simultaneously for 10 s and then OFF for 10 s. Repeat this for 10 times.

c) Switch the five lamps ON again and, after at least 1 min, measure the response threshold value as specified in 5.1.5, with the lamps ON.

d) Switch the five lamps OFF.

**5.5.2.2** Designate the maximum response threshold value as $m_{max}$ and the minimum response threshold value as $m_{min}$.

### 5.5.3 Requirements

**5.5.3.1** During the periods when the lamps are being switched ON and OFF, and when the lamps are ON before the response threshold value is measured, the specimen shall not emit either an alarm or a fault signal.

**5.5.3.2** The ratio of the response thresholds, $m_{max} : m_{min}$, shall be not greater than 1,6.

## 5.6 Dry heat (operational)

### 5.6.1 Object of test

To demonstrate the ability of the SDED to function correctly at high ambient temperatures that may occur for short periods in the service environment.

### 5.6.2 Test procedure

#### 5.6.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Bb, and in 5.6.2.2 to 5.6.2.5.

#### 5.6.2.2 State of specimen during conditioning

Mount the specimen being tested as specified in 5.1.2 in the smoke tunnel (see Annex A) and connect it to its supply and monitoring equipment as specified in 5.1.3.

#### 5.6.2.3 Conditioning

Apply the following conditioning:

— tunnel air velocity: maximum is specified by the manufacturer;

— temperature: starting at an initial air temperature of (23 ± 5) °C, increase the air temperature in the smoke tunnel to (55 ± 2) °C;

— duration: maintain this temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of <1 °C/min for the transitions to and from the conditioning temperature.

#### 5.6.2.4 Measurements during conditioning

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

#### 5.6.2.5 Final measurements

**5.6.2.5.1** Measure the response threshold value at the maximum air velocity as specified in 5.1.5, but at a temperature of (55 ± 2) °C.

**5.6.2.5.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.

### 5.6.3 Requirements

**5.6.3.1** No alarm or fault signals shall be given during the period that the temperature is increasing to the conditioning temperature or during the conditioning period until the response threshold value is measured.

**5.6.3.2** The ratio of the response threshold values, $y_{max} : y_{min}$ or $m_{max} : m_{min}$, shall not be greater than 1,6.

## 5.7 Cold (operational)

### 5.7.1 Object of test

To demonstrate the ability of the SDED to function correctly at low ambient temperatures appropriate to the anticipated service environment.

### 5.7.2 Test procedure

#### 5.7.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1, Test Ab, and in 5.7.2.2 to 5.7.2.5.

#### 5.7.2.2 State of specimen during conditioning

Mount the specimen as specified in 5.1.2 and connect it to supply and monitoring equipment as specified in 5.1.3.

#### 5.7.2.3 Conditioning

Apply the following conditioning:

— tunnel air velocity: maximum is specified by the manufacturer;

— temperature: starting at an initial temperature of (23 ± 5) °C, decrease the air temperature in the smoke tunnel to (–10 ± 3) °C;

— duration: 16 h.

NOTE Test Ab specifies rates of change of temperature of <1 °C/min for the transitions to and from the conditioning temperature.

#### 5.7.2.4 Measurements during conditioning

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

#### 5.7.2.5 Final measurements

**5.7.2.5.1** After a recovery period of at least 1 h at the standard atmospheric conditions, measure the response threshold value at the mean air velocity specified in 5.1.5.

**5.7.2.5.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.



#### 5.7.3 Requirements

**5.7.3.1** No alarm or fault signals shall be given during the transition to or the period of the conditioning temperature.

**5.7.3.2** The ratio of the response threshold values, $y_{max}$ : $y_{min}$ or $m_{max}$ : $m_{min}$, shall not be greater than 1,6.

### 5.8 Damp heat, steady-state (operational)

#### 5.8.1 Object of test

To demonstrate the ability of the SDED to function correctly at high relative humidity (without condensation), which can occur for short periods in the anticipated service environment.

#### 5.8.2 Test procedure

##### 5.8.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab, and in 5.8.2.2 to 5.8.2.5.

##### 5.8.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.2 and connect it to supply and monitoring equipment as specified in 5.1.3.

##### 5.8.2.3 Conditioning

Apply the following conditioning:

— tunnel air velocity: maximum specified by the manufacturer;

— temperature: (40 ± 2) °C in the smoke tunnel;

— relative humidity: (93 ± 3) % in the smoke tunnel;

— duration: 4 d.

##### 5.8.2.4 Measurements during conditioning

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

##### 5.8.2.5 Final measurements

**5.8.2.5.1** After a recovery period of at least 1 h at the standard atmospheric conditions, measure the response threshold value at the mean air velocity as specified in 5.1.5.

**5.8.2.5.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.

#### 5.8.3 Requirements

**5.8.3.1** No alarm or fault signals shall be given during the conditioning.

**5.8.3.2** The ratio of the response threshold values, $y_{max}$ : $y_{min}$ or $m_{max}$ : $m_{min}$, shall not be greater than 1,6.

## 5.9 Damp heat, steady-state (endurance)

### 5.9.1 Object of test

To demonstrate the ability of the SDED to withstand the long-term effects of humidity in the service environment (e.g. changes in electrical properties of materials, chemical reactions involving moisture, galvanic corrosion).

### 5.9.2 Test procedure

#### 5.9.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab, and in 5.9.2.2 to 5.9.2.4.

#### 5.9.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.2. Do not supply it with power during the conditioning.

NOTE As power is not supplied to the specimen during conditioning, it is not necessary to mount the specimen in the smoke tunnel, but it can be mounted on a plate simulating the smoke tunnel wall.

#### 5.9.2.3 Conditioning

Apply the following conditioning to the whole of the SDED, including any portion that might not normally be mounted inside a duct:

— temperature: (40 ± 2) °C;

— relative humidity: (93 ± 3) %;

— duration: 21 d.

#### 5.9.2.4 Final measurements

**5.9.2.4.1** After a recovery period of at least 1 h in standard atmospheric conditions, measure the response threshold value at the mean air velocity as specified in 5.1.5.

**5.9.2.4.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.

### 5.9.3 Requirements

**5.9.3.1** No fault signal attributable to the endurance conditioning shall be given on the reconnection of the specimen.

**5.9.3.2** The ratio of the response threshold values, $y_{max}$ : $y_{min}$ or $m_{max}$ : $m_{min}$, shall not be greater than 1,6.



## 5.10 Sulfur dioxide, $SO_2$, corrosion (endurance)

### 5.10.1 Object of test

To demonstrate the ability of the SDED to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

### 5.10.2 Test procedure

#### 5.10.2.1 Reference

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-42, Test Kc, but carry out the conditioning as specified in 5.10.2.3.

#### 5.10.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.2. Do not supply it with power during the conditioning, but equip it with untinned copper wires, of the appropriate diameter, connected to sufficient terminals to allow the final measurement to be made, without making further connections to the specimen.

NOTE As power is not supplied to the specimen during conditioning, it is not necessary to mount the specimen in the smoke tunnel and it can be mounted on a plate simulating the smoke tunnel wall.

#### 5.10.2.3 Conditioning

Apply the following conditioning to the whole of the SDED, including any portion that may not normally be mounted inside a duct:

— temperature:(25 ± 2) °C;

— relative humidity: (93 ± 3) %;

— $SO_2$ concentration: (25 ± 5) µl/l;

— duration: 21 d.

#### 5.10.2.4 Final measurements

**5.10.2.4.1** Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, ⊣ 50 % RH, followed by a recovery period of at least 1 h at the standard atmospheric conditions. After this, mount the specimen as specified in 5.1.3 and measure the response threshold value at the mean air velocity as specified in 5.1.5.

**5.10.2.4.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.

### 5.10.3 Requirements

**5.10.3.1** No fault signal, attributable to the endurance conditioning, shall be given on reconnection of the specimen.

**5.10.3.2** The ratio of the response threshold values, $y_{max} : y_{min}$ or $m_{max} : m_{min}$, shall not be greater than 1,6.

## 5.11 Shock (operational)

### 5.11.1 Object of test

To demonstrate the immunity of the SDED to mechanical shocks that are likely to occur, albeit infrequently, in the anticipated service environment.

### 5.11.2 Test procedure

#### 5.11.2.1 Reference

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-27, Test Ea, but carry out the conditioning as specified in 5.11.2.3.

#### 5.11.2.2 State of specimen during conditioning

Mount the specimen as specified in 5.1.2 to a rigid fixture, and connect it to its supply and monitoring equipment as specified in 5.1.3.

#### 5.11.2.3 Conditioning

**5.11.2.3.1** For specimens with a mass $M < 4{,}75$ kg, apply the following conditioning:

— shock pulse type: half sine;

— pulse duration: 6 ms;

— peak acceleration: $10 \times (100 - 20M)$ m/s$^2$ (where $M$ is the mass of the specimen in kilograms);

— number of directions: 6;

— pulses per direction: 3.

**5.11.2.3.2** Do not test specimens with a mass $M > 4{,}75$ kg.

#### 5.11.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any alarm or fault signals.

#### 5.11.2.5 Final measurements

**5.11.2.5.1** After the conditioning, mount the specimen as specified in 5.1.2 and measure the response threshold value at the mean air velocity as specified in 5.1.5.

**5.11.2.5.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$, and the lesser as $y_{min}$ or $m_{min}$.

### 5.11.3 Requirements

**5.11.3.1** No alarm or fault signals shall be given during the conditioning period or the additional 2 min.

**5.11.3.2** The ratio of the response threshold values, $y_{max} : y_{min}$ or $m_{max} : m_{min}$, shall not be greater than 1,6.



## 5.12 Impact (operational)

### 5.12.1 Object of test

To demonstrate the immunity of the SDED to mechanical impacts upon its exposed surface that it can sustain in the normal shipping, installation and service environments, and which it can reasonably be expected to withstand.

### 5.12.2 Test procedure

#### 5.12.2.1 Apparatus

The test apparatus (specified in Annex E) shall consist of a swinging hammer incorporating a rectangular-section aluminium alloy head (aluminium alloy Al $Cu_4SiMg$ complying with ISO 209, solution- and precipitation-treated condition) with the plane-impact face chamfered to an angle of 60° to the horizontal when in the striking position (i.e. when the hammer shaft is vertical). The hammer head shall be (50 ± 2,5) mm high, (76 ± 3,8) mm wide and (80 ± 4) mm long at mid-height.

#### 5.12.2.2 State of specimen during conditioning

Mount the specimen rigidly to the apparatus by its normal mounting means and position it so that the portion of the SDED that is not mounted within the duct (e.g. the detector housing) is struck by the upper half of the impact face when the hammer is in the vertical position (i.e. when the hammerhead is moving horizontally). Choose the azimuthal direction and the position of impact relative to the specimen as that most likely to impair the normal functioning of the specimen. Connect the specimen to its supply and monitoring equipment as specified in 5.1.3.

#### 5.12.2.3 Conditioning

Use the following test parameters during the conditioning:

— impact energy: (1,9 ± 0,1) J;

— hammer velocity: (1,5 ± 0,13) m/s;

— number of impacts: 1.

#### 5.12.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any alarm or fault signals.

#### 5.12.2.5 Final measurements

**5.12.2.5.1** After the conditioning, mount the specimen as specified in 5.1.2 and measure the response threshold value at the mean air velocity as specified in 5.1.5.

**5.12.2.5.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.

### 5.12.3 Requirements

**5.12.3.1** No alarm or fault signals shall be given during the conditioning period or the additional 2 min.

**5.12.3.2** The impact shall not detach the SDED from the mounting.

**5.12.3.3** The ratio of the response threshold values, $y_{max}$ : $y_{min}$ or $m_{max}$ : $m_{min}$, shall not be greater than 1,6.

## 5.13 Vibration, sinusoidal (operational)

### 5.13.1 Object of test

To demonstrate the immunity of the SDED to vibration at levels considered appropriate to the normal service environment.

### 5.13.2 Test procedure

#### 5.13.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.13.2.2 to 5.13.2.5.

#### 5.13.2.2 State of specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.2 and connect it to its supply and monitoring equipment as specified in 5.1.3. Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

#### 5.13.2.3 Conditioning

Apply the following conditioning:

— frequency range: (10 to 150) Hz;

— acceleration amplitude: 5 m/s$^2$ (approximately 0,5 $g_n$);

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 1/axis.

The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. It is necessary to make only one final measurement.

#### 5.13.2.4 Measurements during conditioning

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

#### 5.13.2.5 Final measurements

**5.13.2.5.1** After the conditioning, visually inspect the specimen for mechanical damage, both internally and externally. Then mount the specimen as specified in 5.1.2 and measure the response threshold value at the mean air velocity as specified in 5.1.5.

NOTE The final measurements are normally made after the vibration endurance test and it is necessary to make them here only if the operational test is conducted in isolation.

**5.13.2.5.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.



### 5.13.3 Requirements

**5.13.3.1** No alarm or fault signals shall be given during the conditioning. No mechanical damage either internally or externally shall result.

**5.13.3.2** The ratio of the response threshold values, $y_{max}$ : $y_{min}$ or $m_{max}$ : $m_{min}$, shall not be greater than 1,6.

## 5.14 Vibration, sinusoidal (endurance)

### 5.14.1 Object of test

To demonstrate the ability of the SDED to withstand the long-term effects of vibration at levels appropriate to the shipping, installation and service environment.

### 5.14.2 Test procedure

#### 5.14.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and 5.14.2.2 to 5.14.2.4.

#### 5.14.2.2 State of specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.2, but do not supply it with power during conditioning. Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting axis of the specimen.

#### 5.14.2.3 Conditioning

Apply the following conditioning:

— frequency range: (10 to 150) Hz;

— acceleration amplitude: 10 m/s$^2$ (approximately 1,0 $g_n$);

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 20/axis.

The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. It is necessary to make only one final measurement.

#### 5.14.2.4 Final measurements

**5.14.2.4.1** After the conditioning, mount the specimen as specified in 5.1.2 and measure the response threshold value at the mean air velocity as specified in 5.1.5.

**5.14.2.4.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.

### 5.14.3 Requirements

**5.14.3.1** No fault signal, attributable to the endurance conditioning, shall be given on reconnection of the specimen.

**5.14.3.2** The ratio of the response threshold values, $y_{max} : y_{min}$ or $m_{max} : m_{min}$, shall not be greater than 1,6.

## 5.15 Air leakage

### 5.15.1 Object of test

**5.15.1.1** To demonstrate the ability of the SDED to remain sealed and thereby ensure minimum leakage to or from the sampled environment.

**5.15.1.2** In the case where the SDED is installed completely within the volume of the duct, it is not necessary to satisfy this test. However, installation instructions should include a clear method of installation such that the duct remains sealed. The instructions should also specify that other components of the SDED are physically separated (independent from duct pressure) and only electrically connected.

### 5.15.2 Test procedure

#### 5.15.2.1 State of specimen during conditioning

Mount each specimen as specified in 5.1.2 in a test apparatus that can be evacuated and pressurized (see Annex F). Do not supply it with power during conditioning.

#### 5.15.2.2 Conditioning

Apply the following conditioning to each specimen.

— vacuum: Evacuate the SDED to a differential pressure of –1,13 kPa.

— duration: 10 min.

— pressurize: Pressurize the SDED to +3,0 kPa.

— duration: 10 min.

#### 5.15.2.3 Final measurements

Measure the differential pressure for the evacuate test and the pressure test.

### 5.15.3 Requirements

The air leakage for the SDED shall be not more than that amount in Table 2.

**Table 2 — Maximum leakage**

| Differential pressure after 10 min | |
|---|---|
| –1,13 kPa initial vacuum | +3,0 kPa initial pressure |
| ≤–0,75 kPa | ≥2,0 kPa |

## 5.16 Electromagnetic compatibility (EMC) immunity tests (operational)

### 5.16.1 Object of test

To demonstrate immunity to sources of electro-magnetic radiation likely to occur, albeit infrequently, in the anticipated service environment.

### 5.16.2 Test procedure

#### 5.16.2.1 Reference

Use the test apparatus and the test procedures shall be as described in IEC 62599-2 and in 5.16.2.2 to 5.16.2.5.

#### 5.16.2.2 State of specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.2 and connect it to its supply and monitoring equipment as specified in 5.1.3.

#### 5.16.2.3 Conditioning

Conduct the following EMC immunity tests as specified in IEC 62599-2:

a) electrostatic discharge;

b) radiated electromagnetic fields;

c) conducted disturbances induced by electromagnetic fields;

d) fast transient bursts at a repetition rate of 100 kHz;

e) slow high-energy voltage surges.

#### 5.16.2.4 Measurements during conditioning

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

**5.16.2.4.2** The functional test called for in the initial measurements shall be the response threshold value test as specified in 5.1.5.

#### 5.16.2.5 Final measurements

**5.16.2.5.1** The functional test called for in the final measurements shall be the response threshold value test as specified in 5.1.5.

**5.16.2.5.2** Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as $y_{max}$ or $m_{max}$ and the lesser as $y_{min}$ or $m_{min}$.

### 5.16.3 Requirements

**5.16.3.1** No alarm or fault signals shall be given during the conditioning period.

**5.16.3.2** The ratio of the response threshold, $y_{max} : y_{min}$ or $m_{max} : m_{min}$, shall not be greater than 1,6.

## 5.17 Fire sensitivity

### 5.17.1 Object of test

To show that the SDED has adequate sensitivity to visible smoke types required for general applications in fire detection systems for buildings.

### 5.17.2 Test procedure

#### 5.17.2.1 Principle of test

The specimens are mounted in a duct leading from a standard fire-test room (specified in Annex A) and exposed to two test fires designed to produce smoke representative of the type that can impair visibility in a building, at two duct air velocities.

#### 5.17.2.2 Test fires

Subject the specimens to the two test fires, TF2 and TF4. The type, quantity and arrangement of the fuel and the method of ignition for each test fire are specified in Annexes G and H, respectively, along with the end-of-test condition and the test validity criteria.

It is permissible, and can be necessary, to adjust the quantity, condition (e.g. moisture content) and arrangement of the fuel to obtain valid test fires.

#### 5.17.2.3 Mounting of specimens

**5.17.2.3.1** Mount the specimen as specified in 5.1.2 in the smoke tunnel (see Annex A).

**5.17.2.3.2** Where the tube length specified by the manufacturer exceeds or is less than the width of the test tunnel, the sampling tube length should be adjusted to equal the width of the test tunnel. The adjusted tube length should provide the same number and size of equally spaced holes, as per the manufacturer's longest or shortest tube, whichever is appropriate.

**5.17.2.3.3** Connect the specimen to its supply and monitoring equipment, as specified in 5.1.3, and allow it to stabilize in its quiescent condition before the start of each test fire.

**5.17.2.3.4** Detectors that dynamically modify their sensitivity in response to varying ambient conditions can require special reset procedures and/or stabilization times. The manufacturer's guidance should be sought in such cases to ensure that the state of the detectors at the start of each test is representative of their normal quiescent state.

#### 5.17.2.4 Initial conditions

**IMPORTANT — The stability of the air and temperature affects the smoke flow within the room. This is particularly important for the test fires that produce low thermal lift for the smoke (e.g. TF2). If it is necessary for people to be in the room at the beginning of a test fire, they should leave as soon as possible, taking care to produce the minimum disturbance to the air.**

**5.17.2.4.1** Before each test fire, ventilate the room and duct with clean air until it is free from smoke, so that the conditions given below can be obtained.

**5.17.2.4.2** Switch off the ventilation system and close all doors, windows and other openings. Then, allow the air in the room to stabilize and the following conditions to be obtained before the test is started:

— air temperature, $T$: (23 ± 5) °C;

— airflow in the duct: adjusted to the minimum air velocity as specified by the manufacturer in 5.1.5;

— smoke density (ionization): $y \leq 0{,}05$;

— smoke density (optical): $m \leq 0{,}02$ dB/m.

#### 5.17.2.5 Recording of the fire parameters and response values

**5.17.2.5.1** During each test fire, record the fire parameters in Table 3 as a function of time from the start of the test. Record each parameter continuously or at least once per second.

**Table 3 — Fire parameters**

| Parameter | Symbol | Units |
|---|---|---|
| Temperature change | $\Delta T$ | °C |
| Smoke density (ionization) | $y$ | (dimensionless) |
| Smoke density (optical) | $m$ | dB/m |

**5.17.2.5.2** The alarm signal given by the supply and monitoring equipment shall be taken as the indication that a specimen has responded to the test fire.

**5.17.2.5.3** Record the time of response (alarm signal) of each specimen, along with $\Delta T_a$, $y_a$ and $m_a$, the fire parameters at the moment of response. A response of the SDED after the end of test condition is ignored.

#### 5.17.2.6 Repeat test

Repeat each test fire test, but at the maximum air velocity as specified by the manufacturer in 5.1.5.

### 5.17.3 Requirements

Both specimens shall generate an alarm signal, in each test fire, at each velocity, before the specified end-of-test condition is reached.

## 6 Test report

The test report shall contain, as a minimum, the following information:

a) the name and address of the testing organization;

b) the name of manufacturer or agent;

c) the identification of the SDED tested;

d) a reference to this document, i.e. ISO 7240-22;

e) a list of the information to meet the requirements of 5.1.7;

f) the date of tests;

g) the conditioning period and the conditioning atmosphere;

h) the temperature and the relative humidity in the test room throughout the test;

i) the details of the supply and monitoring equipment and the alarm criteria;

j) the results of the test: the individual response threshold values and the minimum, maximum and arithmetic mean values where appropriate;

k) the air velocities where the SDED passed the tests in this document;

l) the details of any deviation from this document or from the International Standards to which reference is made, and details of any operations regarded as optional;

m) any limitations of use;

n) a statement indicating whether or not the SDED complied with this document.

# 7 Marking

**7.1** Each SDED shall be clearly marked with the following information:

a) number of this document (i.e. ISO 7240-22);

b) name or trademark of the manufacturer or supplier;

c) model designation (type or number);

d) wiring-terminal designations;

e) some mark(s) or code(s) (e.g. serial number or batch code), by which the manufacturer can identify at least the date or batch and place of manufacture, and the version number(s) of any software contained within the SDED.

**7.2** Where any marking on the SDED uses symbols or abbreviations not in common use, then these should be explained in the data supplied with the device.

**7.3** The marking shall be visible during the installation of the SDED and shall be accessible during the maintenance.

**7.4** The markings shall not be placed on screws or other easily removable parts.

# 8 Data

## 8.1 Hardware documentation

Either the SDED shall be supplied with sufficient technical, installation and maintenance data to enable correct installation and operation or, if all of this data are not supplied with each SDED unit, reference to the appropriate data sheet shall be given on, or with, each SDED unit. These data shall include

— the range of operating differential pressures between the inlet and outlet sampling tubes and the recommended method for measuring the pressures;

— the range of operating duct air velocities;

— the range of applicable duct sizes for specific sampling tube lengths; and

— the models of point smoke detectors for which the SDED meets the requirements of this document.

NOTE Additional information can be required by organizations certifying that SDED units produced by a manufacturer conform to the requirements of this document.

## 8.2 Software documentation

**8.2.1** The manufacturer shall submit documentation that gives an overview of the software design. This documentation shall be in sufficient detail for the design to be inspected for compliance with this document and shall include at least the following:

a) functional description of the main program flow (e.g. as a flow diagram or structogram) including

   1) a brief description of the modules and the functions that they perform,

   2) the way in which the modules interact,

   3) the overall hierarchy of the program,

   4) the way in which the software interacts with the hardware of the detector, and

   5) the way in which the modules are called, including any interrupt processing;

b) description of which areas of memory are used for the various purposes (e.g. the program, site-specific data and running data);

c) designation by which the software and its version can be uniquely identified.

**8.2.2** The manufacturer shall prepare and maintain detailed design documentation. This shall be available for inspection in a manner that respects the manufacturers' rights for confidentiality. It shall comprise at least the following:

a) overview of the whole system configuration, including all software and hardware components;

b) description of each module of the program, containing at least

   1) the name of the module,

   2) a description of the tasks performed, and

   3) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data;

c) full source-code listings, as hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized;

d) details of any software tools used in the design and implementation phase (e.g. CASE-Tools, Compilers, etc.).

This detailed design documentation may be reviewed at the manufacturers' premises.

# Annex A
(normative)

# Smoke tunnel and fire test room arrangement for response measurements

**A.1** This annex specifies those properties of the smoke tunnel that are of primary importance for making repeatable and reproducible measurements of response threshold values of SDED and the response of the SDED to the test fires.

**A.2** The smoke tunnel shall have a horizontal working section containing a working volume. The working volume is defined as the part of the working section where the air temperature and air flow are within the required test conditions. Conformance with this requirement shall be regularly verified under static conditions, by measurements at an adequate number of points distributed within and on the imaginary boundaries of the working volume. The working volume shall be large enough to fully enclose the sampling portion of SDED being tested and the sensing parts of the measuring equipment. The SDED being tested shall be mounted in its normal operating position with the air flow in the working volume.

**A.3** The smoke tunnel shall be located close to the fire-test room so as to minimize changes that can occur in the smoke characteristics of the fire (see Annex I). The test fire room shall be as specified in ISO 7240-7:2011, Annex F. An arrangement shall be made to transfer unfiltered smoke from the fire test room to the duct. Air from the duct shall be drawn and replaced back into the test fire room in such a way so as to minimize the disturbance to the air in the test fire room. The duct smoke tunnel shall operate so as to draw air from the test fire room at the start and during the test fire.

**A.4** It shall be possible to control the temperature at the required values, to increase the temperature in the working volume of the smoke tunnel at a rate not exceeding 1 K/min to 55 °C and decrease the temperature in the working volume of the smoke tunnel at a rate not exceeding 1 K/min to −10 °C.

**A.5** It shall be possible to control the relative humidity at the required values to increase the relative humidity in the smoke tunnel to 93 %.

**A.6** Both aerosol density measurements, m in dB/m for detectors using scattered or transmitted light and y (dimensionless) for detectors using ionization, shall be made in the working volume in the proximity of the sensing apparatus.

**A.7** Means shall be provided for the introduction of the test aerosol such that a homogeneous aerosol density is obtained in the working volume.

**A.8** Means shall be provided for creating a constant airflow, variable from (1 ± 0,2) m/s to (20 ± 4,0) m/s, throughout the working volume.

**A.9** Only one SDED specimen shall be mounted in the tunnel, unless it has been demonstrated that measurements made simultaneously on more than one specimen are in close agreement with measurements made by testing specimens individually. In the event of a dispute, the value obtained by individual testing shall be accepted.

# Annex B
(normative)

# Test aerosol for response threshold value measurements

**B.1** A polydispersive aerosol shall be used as the test aerosol to measure the response threshold values. The bulk of the particles comprising the aerosol shall have a particle diameter between 0,5 µm and 1 µm and a refractive index of approximately 1,4.

**B.2** The test aerosol shall be reproducible and stable with regard to the following parameters:

— particle mass distribution;

— optical constants of the particles;

— particle shape;

— particle structure.

**B.3** The stability of the aerosol should be ensured. One possible method to do this is to measure and monitor the stability of the ratio, $m : y$.

**B.4** It is recommended that an aerosol generator using pharmaceutical-grade paraffin oil be used to generate the test aerosol.

# Annex C
(normative)

# Smoke-measuring instruments

## C.1 Obscuration meter

**C.1.1** The response threshold of SDED using scattered light or transmitted light is characterized by the absorbance index (extinction module) of the test aerosol, measured in the proximity of the alarm, at the moment that it generates an alarm signal.

**C.1.2** The absorbance index is designated, *m*, and expressed in decibels per metre (dB/m). The absorbance index, *m*, is given by Formula (C.1):

$$m = \frac{10}{d} \log\left(\frac{P_0}{P}\right) \tag{C.1}$$

where

*d* is the distance, expressed in metres, travelled by the light in the test aerosol or smoke, from the light source to the light receiver;

$P_0$ is the radiated power received without test aerosol or smoke;

*P* is the radiated power received with test aerosol or smoke.

**C.1.3** For all aerosol or smoke concentrations corresponding to an attenuation of up to 2 dB/m, the measuring error of the obscuration meter shall not exceed 0,02 dB/m + 5 % of the measured attenuation of the aerosol or smoke concentration.

**C.1.4** The optical system shall be arranged so that any light scattered more than 3° by the test aerosol or smoke is disregarded by the light detector.

The effective radiated power of the light beam shall be:

— at least 50 % within a wavelength range from 800 nm to 950 nm,

— not more than 1 % in the wavelength range below 800 nm, and

— not more than 10 % in the wavelength range above 1 050 nm.

NOTE The effective radiated power in each wavelength range is the product of the power emitted by the light source, the transmission level of the optical measuring path in clean air and the sensitivity of the receiver within this wavelength range.

## C.2 Measuring ionization chamber (MIC)

### C.2.1 General

The response threshold of SDED using ionization is characterized by a non-dimensional quantity, *y*, which is derived from the relative change of the current flowing in a measuring ionization chamber, and which is related to the particle concentration of the test aerosol measured in the proximity of the alarm at the moment that it generates an alarm condition.



### C.2.2 Operating method and basic construction

**C.2.2.1** The mechanical construction of the measuring ionization chamber is given in Annex J.

**C.2.2.2** The measuring device consists of a measuring chamber, an electronic amplifier and a method of continuously sucking in a sample of the aerosol or smoke to be measured.

**C.2.2.3** The principle of operation of the measuring ionization chamber is shown in Figure C.1. The measuring chamber contains a measuring volume and a suitable means by which the sampled air is sucked in and passes the measuring volume in such a way that the aerosol/smoke particles diffuse into this volume. This diffusion is such that the flow of ions within the measuring volume is not disturbed by air movements.

**C.2.2.4** The air within the measuring volume is ionized by alpha radiation from an americium radioactive source, such that there is a bipolar flow of ions when an electrical voltage is applied between the electrodes. This flow of ions is affected in a known manner by the aerosol or smoke particles. The ratio of the current in the aerosol-free chamber to that in the presence of an aerosol is a known function of the aerosol or smoke concentration. Thus, the non-dimensional quantity, $y$, which is approximately proportional to the particle concentration for a particular type of aerosol or smoke, is used as a measure of the response threshold value for smoke detector using ionization.

**C.2.2.5** The measuring chamber is dimensioned and operated such that Formulae (C.2) and (C.3) apply:

$$Z \times \bar{d} = \eta \times y \tag{C.2}$$

$$y = \left(\frac{I_0}{I}\right) - \left(\frac{I}{I_0}\right) \tag{C.3}$$

where

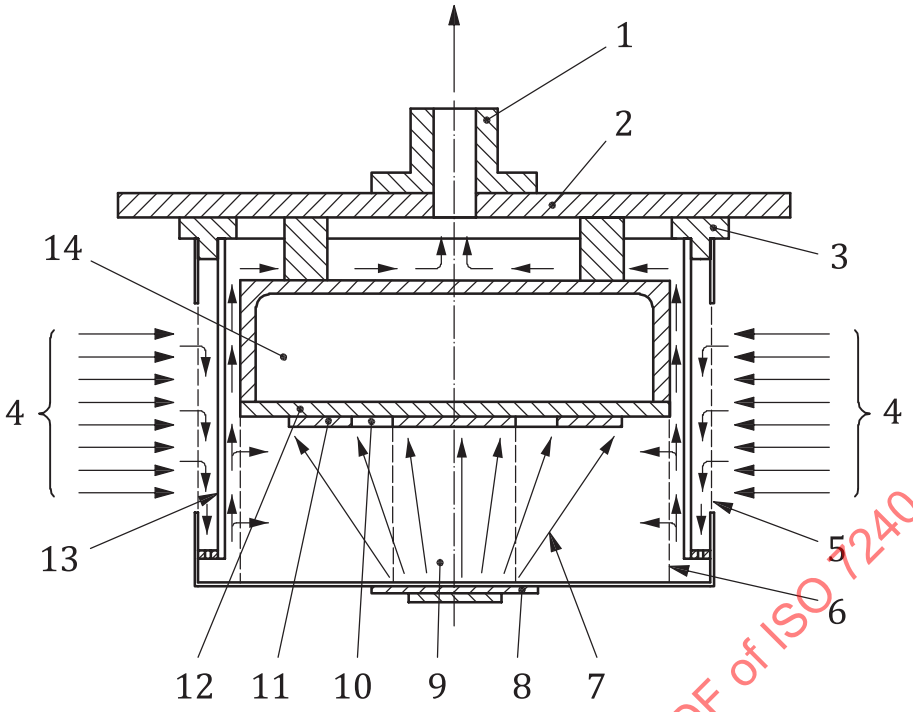
$I_0$ is the chamber current in air without test aerosol or smoke;

$I$ is the chamber current in air with test aerosol or smoke;

$\eta$ is the chamber constant;

$Z$ is the particle concentration in particles per cubic metre;

$\bar{d}$ is the average particle diameter.




**Key**

| | | | |
|---|---|---|---|
| 1 | suction nozzle | 8 | $\alpha$ source |
| 2 | assembly plate | 9 | measuring volume |
| 3 | insulating ring | 10 | measuring electrode |
| 4 | air/smoke entry | 11 | guard ring |
| 5 | outer grid | 12 | insulating material |
| 6 | inner grid | 13 | windshield |
| 7 | $\alpha$ rays | 14 | electronics |

**Figure C.1 — Measuring ionization chamber — Method of operation**

### C.2.3 Technical data

a) Radiation source:

— isotope: americium, $^{241}$Am;

— activity: (130 ± 6,5) kBq;

— average energy: (4,5 ± 0,225) MeV;

— mechanical construction: americium oxide embedded in gold between two layers of gold, covered with a hard gold alloy. The source is in the form of a circular disc with a diameter of 27 mm, which is mounted in a holder such that no cut edges are accessible.

b) Ionization chamber:

The chamber impedance (i.e. the reciprocal of the slope of the current versus voltage characteristic of the chamber in its linear region where the chamber current is ≤100 pA) shall be (1,9 ± 0,095) × $10^{11}$ Ω, when measured in aerosol- and smoke-free air at the following conditions:

— pressure: (101,3 ± 1) kPa;

— temperature: (25 ± 2) °C;

— relative humidity: (55 ± 20) %;

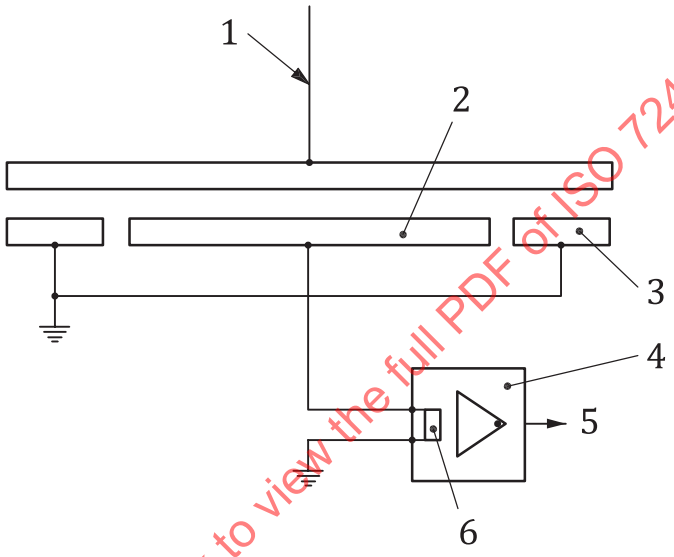
with the potential of the guard ring within ±0,1 V of the voltage of the measuring electrode.

c) Current measuring amplifier:

The chamber is operated in the circuit shown in Figure C.2, with the supply voltage such that the chamber current between the measuring electrodes, is 100 pA in aerosol- or smoke-free air. The input impedance of the current measuring device shall be $<10^9$ Ω.

d) Suction system:

The suction system shall draw air through the device at a continuous steady flow of (30 ± 3) l/min at atmospheric pressure.




**Key**

1 supply voltage
2 measuring electrode
3 guard ring
4 current measuring amplifier
5 output voltage proportional to chamber current
6 input impedance, $Z_{in} > 10^9$ Ω

**Figure C.2 — Measuring ionization chamber — Operating circuit**

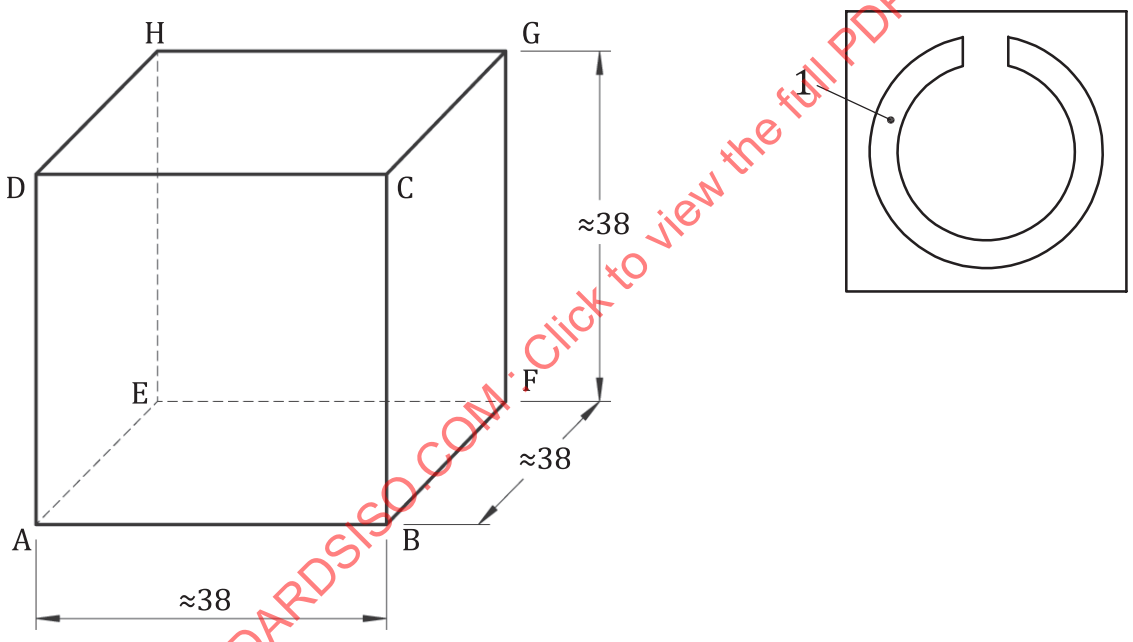
# Annex D
(normative)

# Apparatus for dazzling test

**D.1** The dazzling apparatus [see Figure D.1 a)] shall be constructed so that it can be mounted over the SDED sensing element. The apparatus is cube-shaped, with five of the cube faces (ABFE, AEHD, BFGC, EFGH and CDHG) closed and lined on the inside with high-gloss aluminium foil. The remaining cube face (ABCD) is open to allow the apparatus to be installed over the sensing element enclosure.

**D.2** A circular fluorescent lamp [32 W, "warm white", approximate colour temperature: 2 800 K; see Figure D.1 b)] with a diameter of approximately 30 cm is mounted on each of the five closed surfaces of the cube. To obtain a stable light output, the tubes should be aged for 100 h and discarded at 2 000 h.

Dimensions in millimetres




**a) Dazzling apparatus** **b) Lamp**

**Key**

1 fluorescent lamp

**Figure D.1 — Dazzling apparatus and lamp**

# Annex E
(normative)

# Apparatus for impact test

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

**E.2** The striker with overall dimensions of 76 mm (width) × 50 mm (depth) × 94 mm (length) and is manufactured from aluminium alloy (Al $Cu_4SiMg$ as specified in ISO 209), which has been solution- and precipitation-treated. It has a plane-impact face chamfered at (60 ± 1)° to the long axis of the head. The tubular steel shaft has an outside diameter of (25 ± 0,1) mm with a wall thickness of (1,6 ± 0,1) mm.

**E.3** The striker is mounted on the shaft so that its long axis is at a radial distance of 305 mm from the axis of rotation of the assembly, the two axes being mutually perpendicular. The central boss is 102 mm in outside diameter and 200 mm long, and is mounted coaxially on the fixed steel pivot shaft, which is approximately 25 mm in diameter; however, the precise diameter of the shaft depends on the bearings used.

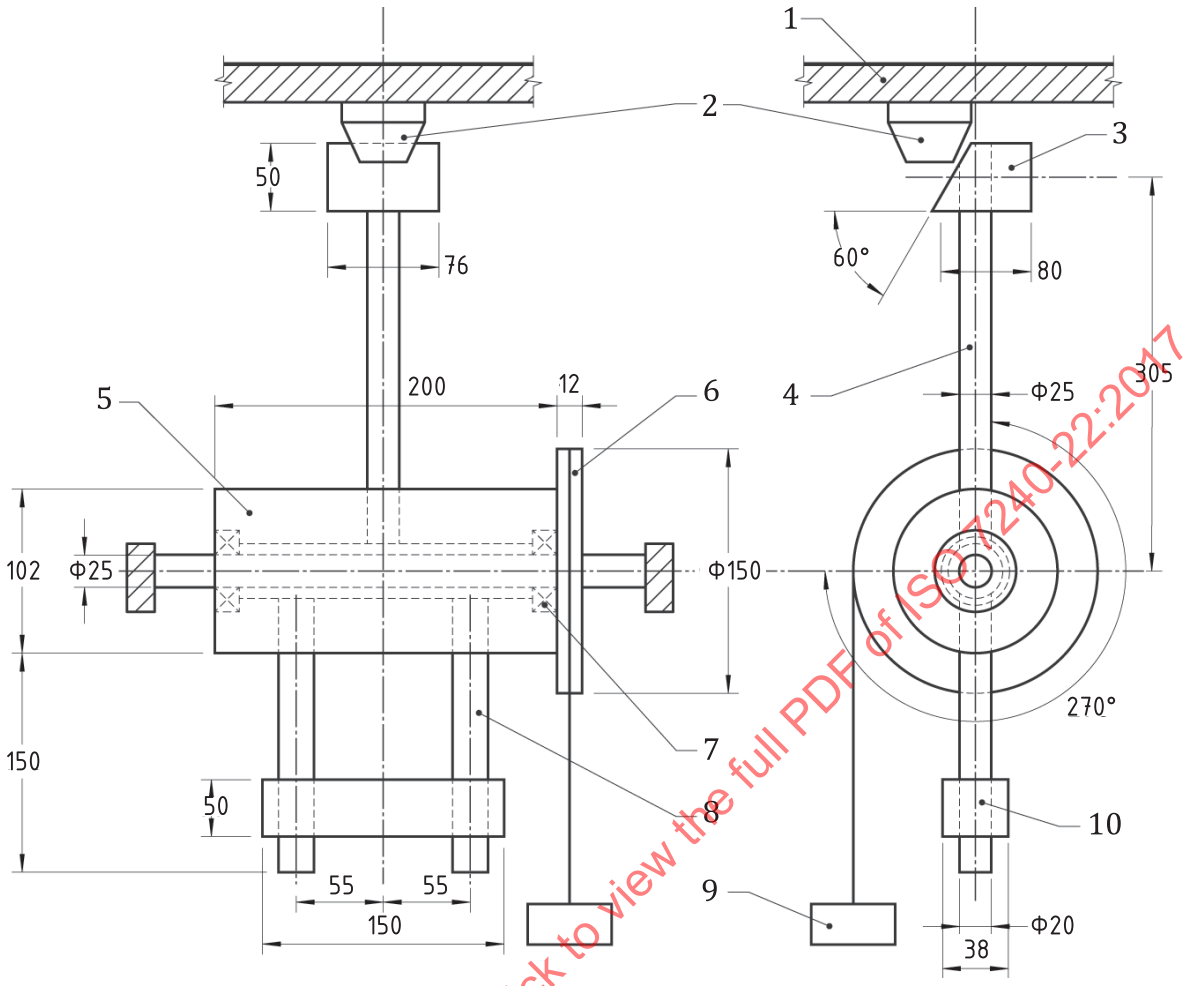
**E.4** Diametrically opposite the hammer shaft are two steel counter-balance arms, each 20 mm in outside diameter and 185 mm long. These arms are screwed into the boss so that the length of 150 mm protrudes. A steel counter-balance weight is mounted on the arms so that its position can be adjusted to balance the weight of the striker and arms, as in Figure E.1. On the end of the central boss, a 150 mm-diameter aluminium alloy pulley is mounted that is 12 mm wide. Around this is wound an inextensible cable with one end fixed to the pulley. The other end of the cable supports the operating weight.

**E.5** The rigid frame also supports the mounting board on which the specimen is mounted by its normal fixings. The mounting board is adjustable vertically so that the upper half of the impact face of the hammer strikes the specimen when the hammer is moving horizontally, as shown in Figure E.1.

**E.6** To operate the apparatus, first the position of the mounting board with the specimen is adjusted as shown in Figure E.1 and then the mounting board is secured rigidly to the frame. Next, the hammer assembly is balanced carefully by adjusting the counter-balance weight with the operating weight removed. The hammer arm is then drawn back to the horizontal position ready for release and the operating weight is reinstated. On release of the assembly, the operating weight spins the hammer and arm through an angle of $3\pi/2$ rad to strike the specimen. The mass, in kilograms, of the operating weight to produce the required impact energy of 1,9 J equals $0{,}388/(3\pi r)$ kg, where $r$ is the effective radius of the pulley, in metres. This equals approximately 0,55 kg for a pulley radius of 75 mm.

**E.7** As this document requires a hammer velocity at impact of (1,5 ± 0,13) m/s, it is necessary to reduce the mass of the hammer head by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0,79 kg is required to obtain the specified velocity, but it is necessary to determine this by trial and error.

Dimensions in millimetres




**Key**

| | | | |
|---|---|---|---|
| 1 | mounting board | 6 | pulley |
| 2 | exposed portion of SDED | 7 | ball bearings |
| 3 | striker | 8 | counter balance arms |
| 4 | striker shaft | 9 | operating weight |
| 5 | boss | 10 | counter balance weight |

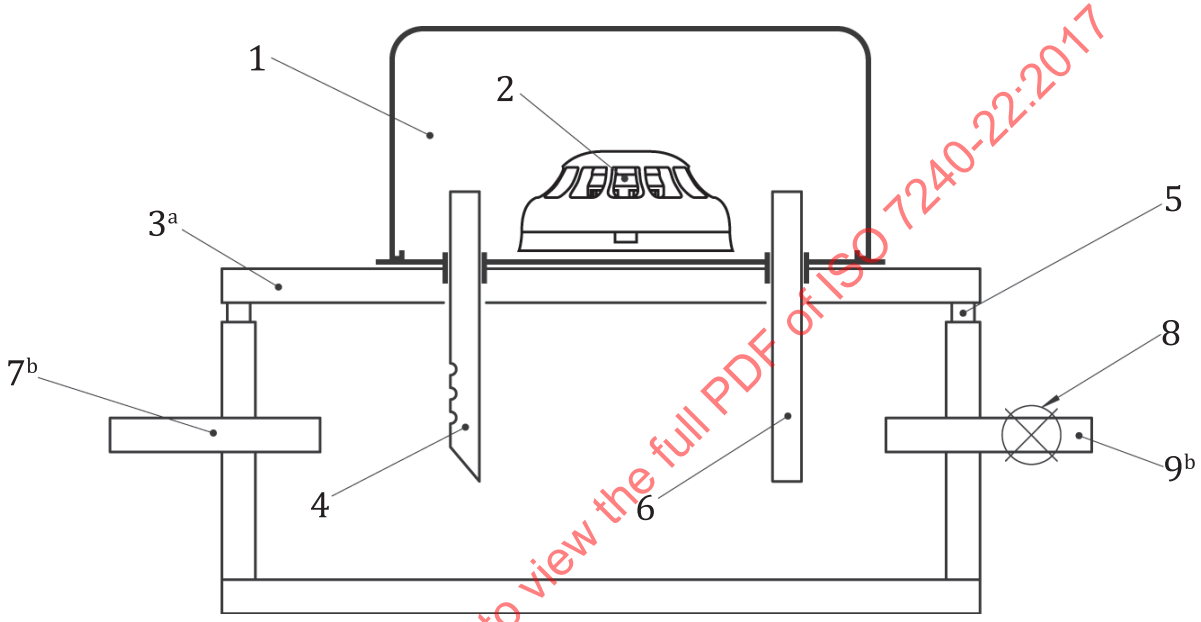
NOTE The dimensions, apart from those relating to the hammer head, are shown for guidance.

**Figure E.1 — Impact apparatus**

# Annex F
(informative)

# Air-leakage test apparatus

Figure F.1 shows an example of the apparatus and mounting method of SDED to measure the air leakage of the SDED when mounted on the side of a duct.




**Key**

1 smoke-detection equipment for ducts
2 smoke detector
3 flange plate
4 inlet sampling pipe
5 box seal
6 outlet sampling pipe
7 to pressure gauge
8 inlet valve
9 to pump

a The flange plate should be constructed from corrosion resistant material such as stainless steel.

b Outlets to the pump and the pressure gauge should be sealed at the entry point to the test apparatus.

**Figure F.1 — Section view of air leakage test apparatus**

# Annex G
(normative)

# Rapid smouldering (pyrolysis) wood fire (TF2)

## G.1 Fuel

Approximately 10 dried beechwood sticks, each stick having dimensions of 75 mm × 25 mm × 20 mm.

## G.2 Conditioning

Dry the sticks in a heating oven so the moisture content is approximately 5 %.

## G.3 Preparation

If necessary, transport the sticks from the oven in a closed plastic bag and open the bag just prior to laying out the sticks in the test arrangement.

## G.4 Hotplate

**G.4.1** The hotplate shall have a 220 mm diameter grooved surface with eight concentric grooves with a distance of 3 mm between grooves. Each groove shall be 2 mm deep and 5 mm wide, with the outer groove 4 mm from the edge. The hotplate shall have a rating of approximately 2 kW.

**G.4.2** The temperature of the hotplate shall be measured by a sensor attached to the fifth groove, counted from the edge of the hotplate, and secured to provide a good thermal contact.

## G.5 Arrangement

The sticks shall be arranged radially on the grooved hotplate surface, with the 20 mm side in contact with the surface such that the temperature probe lies between the sticks and is not covered, as shown in Figure G.1.

## G.6 Heating rate

Power the hotplate such that its temperature rises from ambient to 600 °C in approximately 11 min.

## G.7 Test validity criteria

**G.7.1** No flaming shall occur before the end-of-test condition has been reached. The development of the fire shall be such that the curves of $m$ against $y$, and $m$ against time, $t$, fall within the hatched areas shown in Figures G.2 and G.3, respectively. That is, $y < 0{,}5$ and $225 < t < 540$ at the end-of-test condition $m_E = 0{,}5$ dB/m.

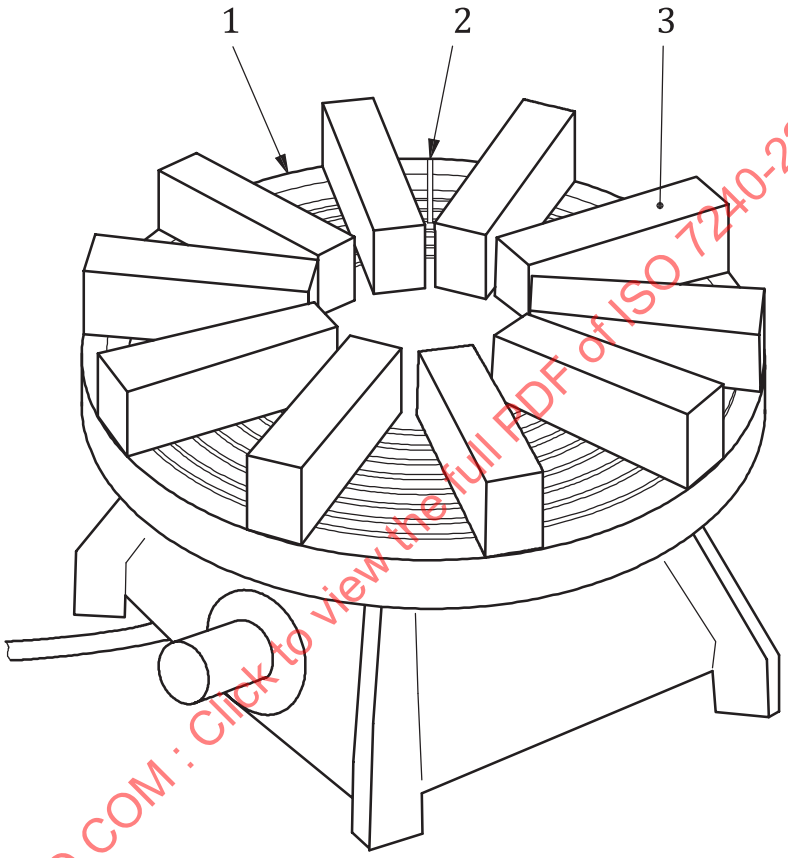
**G.7.2** The specimen shall generate an alarm signal before $m = 0{,}5$ dB/m in the duct-tunnel working section (see Figure I.2).

## G.8 Variables

The number of sticks, the rate of temperature increase of the hotplate and the degree of conditioning of the wood may be varied in order for the test fire to remain within the profile curve limits.

## G.9 End-of-test condition

The end-of-test condition, $m_E$, shall be when $m$ = 0,5 dB/m in the duct-tunnel working section (see Figure I.2) or the specimen has generated an alarm signal, whichever is the earlier.




**Key**

1 grooved hotplate
2 temperature sensor
3 wooden sticks

**Figure G.1 — Arrangement of sticks on hotplate**