

# Fire detection and fire alarm systems —

## Part 7: Smoke detectors — Point detectors using scattered light, transmitted light or ionization

The European Standard EN 54-7:2000, with the incorporation of amendments A1:2002 and A2:2006, has the status of a British Standard

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## National foreword

This British Standard is the official English language version of EN 54-7:2000, including amendments A1:2002 and A2:2006. It supersedes BS 5445-7:1984 and BS 5445-9:1984 which are withdrawn. It is one of a series of standards for fire detection and fire alarm systems (see BS EN 54-1 for a full list of current and proposed standards).

The start and finish of text introduced or altered by amendment is indicated in the text by tags  $\boxed{A_1}$   $\langle A_1 \rangle$ . Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by  $\boxed{A_1}$   $\langle A_1 \rangle$ .

The UK participation in its preparation was entrusted by Technical Committee FSH/12, Fire detection and alarm systems, to Subcommittee FSH/12/2, Fire detectors, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

### Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

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This British Standard, having been prepared under the direction of the Health and Environment Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 March 2001

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English version

**Fire detection and fire alarm systems — Part 7:  
Smoke detectors — Point detectors using scattered light,  
transmitted light or ionization**

Systèmes de détection et d'alarme incendie — Partie 7:  
DéTECTEURS DE FUMÉE — DéTECTEURS PONCTUELS FONCTIONNANT  
suivant le principe de la diffusion de la lumière, de la  
transmission de la lumière ou de l'ionisation

Brandmeldeanlagen — Teil 7: Rauchmelder —  
Punkförmige Melder nach dem Streulicht-, Durchlicht- oder  
Ionisationsprinzip

This European Standard was approved by CEN on 2 June 2000. Amendment A1 was approved by CEN on 5 April 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION  
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## **Foreword**

This European Standard has been prepared by Technical Committee CEN/TC 72, Fire detection and fire alarm systems, the Secretariat of which is held by BSI.

This European Standard replaces EN 54-7:1982, EN 54-7:1982/A1:1988, EN 54-9:1982.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2001, and conflicting national standards shall be withdrawn at the latest by June 2003. For products which have complied with the relevant national standard before the date of withdrawal (dow), as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until June 2006.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

This standard has been prepared in cooperation with the CEA (Comité Européen des Assurances) and with EURALARM (Association of European Manufacturers of Fire and Intruder Alarm Systems).

The significant differences from EN 54-7:1982+A1:1988 include:

- changes in the title of the EN 54 series and in the title of this part;
- the incorporation of the full descriptions of the test fires for fire sensitivity into the standard;  
NOTE: These descriptions were previously given in part 9 of the standard.
- the introduction of requirements for the limitation of the effects of *drift compensation* on the response to slowly developing fires;
- the introduction of requirements for protection against ingress of foreign bodies;
- changes in the environmental test procedures to use IEC tests where possible, to harmonize with test procedures applied to other types of detectors and to include EMC immunity tests;
- the requirement for an integral alarm indication.

EN 54-9:1982 and its amendments will all be withdrawn on publication of this revision.

Information on the relationship between this European Standard and other standards of the EN 54 series is given in annex A of EN 54-1:1996.

## **Foreword to amendment A1**

This document EN 54-7:2000/A1:2002) has been prepared by Technical Committee CEN/TC 72, Fire detection and fire alarm systems, the Secretariat of which is held by BSI.

This amendment to the European Standard EN 54-7:2000 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2002, and conflicting national standards shall be withdrawn at the latest by June 2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Construction Products Directive (89/106/EEC)..

For relationship with the EU Construction Products Directive, see information annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

## **Foreword to amendment A2**

This document (EN 54-7:2000/A2:2006) has been prepared by Technical Committee CEN/TC 72 "Fire detection and fire alarm systems", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2007, and conflicting national standards shall be withdrawn at the latest by July 2009.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationships with the EU Construction Products Directive, see informative annex ZA, which is an integral part of this document.

Amendment 2 to this standard adds additional requirements for smoke detectors with more than one smoke sensor.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

## **Introduction**

This amendment is intended to introduce additional requirements for smoke detectors with more than one smoke sensor.

## 1 Scope

This European Standard specifies requirements, test methods and performance criteria for point smoke detectors that operate using scattered light, transmitted light or ionization, for use in fire detection and fire alarm systems for buildings (see EN 54-1:1996). <sup>A2</sup> This European Standard includes point smoke detectors that incorporate more than one smoke sensor operating on these principles, and additional requirements and test methods for such detectors are given in Annex N. <sup>A2</sup>

For other types of smoke detector, or smoke detectors working on different principles, this standard should only be used for guidance. Smoke detectors with special characteristics and developed for specific risks are not covered by this standard.

NOTE: Certain types of detector contain radioactive materials. The national requirements for radiation protection differ from country to country and they are not specified in this standard.

## 2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

<u>ISO/IEC Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD Publication</u>	<u>Year</u>
-	-	<i>Fire detection and fire alarm systems — Part 1: Introduction.</i>	EN 54-1	1996
-	-	<i>Alarm Systems — Part 4: Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder and social alarm systems, +A1:1998.</i>	EN 50130-4	1995
IEC 60068-1	1988	<i>Environmental testing — Part 1: General and guidance, +A1:1992.</i>	EN 60068-1	1994
IEC 60068-2-1	1990	<i>Environmental testing — Part 2: Tests — Tests A: Cold, +A1:1993, A2:1994.</i>	EN 60068-2-1	1993
IEC 60068-2-3	1969	<i>Basic environmental testing procedures — Part 2: Tests — Test Ca: Damp heat, steady state, +A1:1984.</i>	HD 323.2.3 S2	1987

<u>ISO/IEC Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD Publication</u>	<u>Year</u>
IEC 60068-2-6	1995	<i>Environmental testing — Part 2: Tests — Test Fc. Vibration (sinusoidal), +Corr.:1995.</i>	EN 60068-2-6	1995
IEC 60068-2-27	1987	<i>Basic environmental testing procedures — Part 2: Tests — Test Ea &amp; Guidance: Shock.</i>	EN 60068-2-27	1993
IEC 60068-2-42	1982	<i>Basic environmental testing procedures — Part 2: Tests — Test Kc: Sulfur dioxide test for contacts and connections.</i>	-	-
IEC 60068-2-56	1988	<i>Environmental testing — Part 2: Tests — Test Cb: Damp heat steady state, primarily for equipment.</i>	HD 323.2.56 S1	1990
ISO 209-1	1989	<i>Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition.</i>	-	-

### 3 Terms and definitions

For the purposes of this standard, the following term and definition and those given in EN 54-1:1996 apply:

#### 3.1

##### **response threshold value**

aerosol density in the proximity of the specimen at the moment that it generates an alarm signal, when tested as described in 5.1.5

NOTE: 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 standard the detector shall meet the requirements of this clause, which shall be verified by visual inspection or engineering assessment, shall be tested as described in clause 5  $\overline{A_2}$  and, for detectors with more than one smoke sensor, Annex N  $\overline{A_2}$  and shall meet the requirements of the tests.

#### 4.2 Individual alarm indication

Each detector shall be provided with an integral red visual indicator, by which the individual detector, which released an alarm, can be identified until the alarm condition is reset. Where other conditions of the detector can be visually indicated, they shall be clearly distinguishable from the alarm indication, except when the detector is switched into a service mode. For detachable detectors the indicator may be integral with the base or the detector head. The visual indicator shall be visible from a distance of 6 m directly below the detector, in an ambient light intensity up to 500 lux.

#### 4.3 Connection of ancillary devices

Where the detector provides for connections to ancillary devices (e.g. remote indicators, control relays), open- or short-circuit failures of these connections shall not prevent the correct operation of the detector.

#### 4.4 Monitoring of detachable detectors

For detachable detectors, a means shall be provided for a remote monitoring system (e.g. the 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

If there is provision for on-site adjustment of the response behaviour of the detector then:

- 1) for each setting at which the manufacturer claims compliance with this standard, the detector shall comply with the requirements of this standard, and access to the adjustment means shall only be possible by the use of a code or special tool or by removing the detector from its base or mounting;
- 2) any setting(s) at which the manufacturer does not claim compliance with this standard shall only be accessible by the use of a code or special tool, and it shall be clearly marked on the detector or in the associated data, that if these setting(s) are used, the detector does not comply with the standard.

NOTE: These adjustments may be carried out at the detector or at the control and indicating equipment.

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

The detector shall be so designed that a sphere of diameter  $(1,3 \pm 0,05)$  mm cannot pass into the sensor chamber(s).

NOTE: This requirement is intended to restrict the access of insects into the sensitive parts of the detector. It is known that this requirement is not sufficient to prevent the access of all insects, however it is considered that extreme restrictions on the size of access holes may introduce the danger of clogging by dust etc. It may therefore be necessary to take other precautions against false alarms due to the entry of small insects.

#### 4.8 Response to slowly developing fires

The provision of "drift compensation" (e.g. to compensate for sensor drift due to the build-up of dirt in the detector), shall not lead to a significant reduction in the detector's sensitivity to slowly developing fires.

Since it is not practical to make tests with very slow increases in smoke density, an assessment of the detector's response to slow increases in smoke density shall be made by analysis of the circuit/software, and/or physical tests and simulations.

The detector shall be deemed to meet the requirements of this clause if this assessment shows that:

- a) for any rate of increase in smoke density  $R$ , which is greater than  $A/4$  per hour (where  $A$  is the detector's initial uncompensated response threshold value), the time for the detector to give an alarm does not exceed  $1,6 \times A/R$  by more than 100 s; and
- b) the range of compensation is limited such that, throughout this range, the compensation does not cause the response threshold value of the detector to exceed its initial value by a factor greater than 1,6.

NOTE: Further information about the assessment of these requirements is given in annex L.

## **4.9 Marking**

Each detector shall be clearly marked with the following information:

- a) the number of this standard (i.e. EN 54-7);
- b) the name or trademark of the manufacturer or supplier;
- c) the model designation (type or number);
- d) the 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 detector.

For detachable detectors, the detector head shall be marked with a), b), c) and e), and the base shall be marked with at least c) (i.e. its own model designation) and d).

Where any marking on the device uses symbols or abbreviations not in common use then these shall be explained in the data supplied with the device.

The marking shall be visible during installation of the detector and shall be accessible during maintenance.

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

## **4.10 Data**

Detectors shall either be supplied with sufficient technical, installation and maintenance data to enable their correct installation and operation<sup>1)</sup> or, if all of these data are not supplied with each detector, reference to the appropriate data sheet shall be given on, or with, each detector.

NOTE: Additional information may be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this standard.

## **4.11 Additional requirements for software controlled detectors**

### **4.11.1 General**

For detectors which rely on software control in order to fulfil the requirements of this standard, the requirements of 4.11.2, 4.11.3 and 4.11.4 shall be met.

### **4.11.2 Software documentation**

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

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

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<sup>1)</sup> To enable correct operation of the detectors, these data should describe the requirements for the correct processing of the signals from the detector. This may be in the form of a full technical specification of these signals, a reference to the appropriate signalling protocol or a reference to suitable types of control and indicating equipment etc.

- 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;
  - 5) the way in which the modules are called, including any interrupt processing.
- b) a description of which areas of memory are used for the various purposes (e.g. the program, site specific data and running data);
- c) a designation, by which the software and its version can be uniquely identified.

**4.11.2.2** The manufacturer shall have available detailed design documentation, which only needs to be provided if required by the testing authority. It shall comprise at least the following:

- a) an overview of the whole system configuration, including all software and hardware components;
- b) a description of each module of the program, containing at least:
  - 1) the name of the module;
  - 2) a description of the tasks performed;
  - 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).

#### **4.11.3 Software design**

In order to ensure the reliability of the detector, 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 error in the program operation;
- c) the software shall be designed to avoid the occurrence of deadlock of the program flow.

#### **4.11.4 The storage of programs and data**

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

Site-specific data shall be held in memory which will retain data for at least two weeks without external power to the detector, 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 60068-1:1988+A1:1992 as follows:

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

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

#### 5.1.2 Operating conditions for tests

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 conventional detectors) to allow a fault signal to be recognized.

NOTE: The details of the supply and monitoring equipment and the alarm criteria used should be given in the test report.

#### 5.1.3 Mounting arrangements

The specimen shall be mounted 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 most unfavorable shall be chosen for each test.

#### 5.1.4 Tolerances

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).

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

#### 5.1.5 Measurement of response threshold value

The specimen for which the response threshold value is to be measured shall be installed in the smoke tunnel, described in annex A, 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, unless otherwise specified in the test procedure.

Before commencing each measurement the smoke tunnel shall be purged 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  $(0,2 \pm 0,04) \text{ m s}^{-1}$  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 detector type.

The specimen shall be connected to its supply and monitoring equipment as described in 5.1.2, and shall be allowed to stabilize for a period of at least 15 min, unless otherwise specified by the manufacturer.

The test aerosol, as described in annex B, shall be introduced into the tunnel such that the rate of increase of aerosol density is as follows:

$$0,015 \leq \frac{\Delta m}{\Delta t} \leq 0,1 \text{ dB m}^{-1} \text{ min}^{-1}$$

for detectors using scattered or transmitted light; or

$$0,05 \leq \frac{\Delta y}{\Delta t} \leq 0,3 \text{ min}^{-1}$$

for detectors using ionization.

NOTE 1: These ranges are intended to allow the selection of a convenient rate, depending upon the detector's sensitivity, to get a response in a reasonable time.

NOTE 2: The equations for  $m$  and  $y$  are given in annex C.

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

The aerosol density at the moment that the specimen gives an alarm shall be recorded as  $m$  ( $\text{dB m}^{-1}$ ) for detectors using scattered or transmitted light, or as  $y$  for detectors using ionization (see annex C). This shall be taken as the response threshold value.

**A<sub>2</sub>** NOTE 3: For further information about measuring the response threshold value of detectors with more than one smoke sensor, see N.2. **A<sub>2</sub>**

### 5.1.6 Provision for tests

The following shall be provided for testing compliance with this standard:

- a) for detachable detectors: twenty detector heads and bases;  
for non-detachable detectors: twenty specimens;
- b) the data required in 4.10.

NOTE 1: Detachable detectors comprise at least two parts; a base (socket) and a head (body). If the specimens are detachable detectors, then the two, or more, parts together are regarded as a complete detector.

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

NOTE 2: This implies that the mean response threshold value of the twenty specimens found in the reproducibility test should also represent the production mean, and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

## 5.1.7 Test schedule

The specimens shall be tested according to the following test schedule (see Table 1). After the reproducibility test, the four least sensitive specimens (i.e. those with the highest response thresholds) shall be numbered 17 to 20, and the others shall be numbered 1 to 16 arbitrarily.

Table 1 — Test schedule

Test	Clause	Specimen No(s)
Repeatability	5.2	one chosen arbitrarily
Directional dependence	5.3	one chosen arbitrarily
Reproducibility	5.4	all specimens
Variation in supply parameters	5.5	1
Air movement	5.6	2
Dazzling <sup>1)</sup>	5.7	3
Dry heat (operational)	5.8	4
Cold (operational)	5.9	5
Damp heat, steady state (operational)	5.10	6
Damp heat, steady state (endurance)	5.11	7
Sulfur dioxide (SO <sub>2</sub> ) corrosion (endurance)	5.12	8
Shock (operational)	5.13	9
Impact (operational)	5.14	10
Vibration, sinusoidal (operational)	5.15	11
Vibration, sinusoidal (endurance)	5.16	11
Electrostatic discharge (operational)	5.17	12 <sup>2)</sup>
Radiated electromagnetic fields (operational)	5.17	13 <sup>2)</sup>
Conducted disturbances induced by electromagnetic fields (operational)	5.17	14 <sup>2)</sup>
Fast transient bursts (operational)	5.17	15 <sup>2)</sup>
Slow high energy voltage surge (operational)	5.17	16 <sup>2)</sup>
Fire sensitivity	5.18	17, 18, 19 and 20
<sup>1)</sup> This test only applies to detectors using scattered or transmitted light. <sup>2)</sup> In the interests of test economy, it is permitted to use the same specimen for more than one EMC test. In that case, intermediate functional test(s) on the specimen(s) used for more than one test may be deleted, and the functional test conducted at the end of the sequence of tests. However, it should be noted that in the event of a failure, it may not be possible to identify which test exposure caused the failure (see clause 4 of EN 50130-4:1995+A1:1998).		

## 5.2 Repeatability

### 5.2.1 Object

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

### 5.2.2 Test procedure

The response threshold value of the specimen to be tested shall be measured as described in 5.1.5 six times.

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

The maximum response threshold value shall be designated  $y_{\max}$  or  $m_{\max}$ , the minimum value shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.2.3 Requirements

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

The lower response threshold value  $y_{\min}$  shall be not less than 0,2, or  $m_{\min}$  shall not be less than 0,05 dB m<sup>-1</sup>.

## 5.3 Directional dependence

### 5.3.1 Object

To confirm that the sensitivity of the detector is not unduly dependent on the direction of airflow around the detector.

### 5.3.2 Test procedure

The response threshold value of the specimen to be tested shall be measured eight times as described in 5.1.5, the specimen being rotated 45° about its vertical axis between each measurement, so that the measurements are taken for eight different orientations relative to the direction of air flow.

The maximum response threshold value shall be designated  $y_{\max}$  or  $m_{\max}$ , the minimum value shall be designated  $y_{\min}$  or  $m_{\min}$ .

The orientations for which the maximum and minimum response threshold values were measured shall be noted.

In the following tests the orientation for which the maximum response threshold was measured is referred to as the least sensitive orientation, and the orientation for which the minimum response threshold was measured is referred to as the most sensitive orientation.

### 5.3.3 Requirements

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

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<sup>-1</sup>.

## 5.4 Reproducibility

### 5.4.1 Object

To show that the sensitivity of the detector 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.

### 5.4.2 Test procedure

The response threshold value of each of the test specimens shall be measured as described in 5.1.5.

The mean of these response threshold values shall be calculated and shall be designated  $\bar{y}$  or  $\bar{m}$ .

The maximum response threshold value shall be designated  $y_{\max}$  or  $m_{\max}$ ; the minimum value shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.4.3 Requirements

The ratio of the response threshold values  $y_{\max} : \bar{y}$  or  $m_{\max} : \bar{m}$  shall not be greater than 1,33, and the ratio of the response threshold values  $\bar{y} : y_{\min}$  or  $\bar{m} : m_{\min}$  shall not be greater than 1,5.

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<sup>-1</sup>.

## 5.5 Variation in supply parameters

### 5.5.1 Object

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

### 5.5.2 Test procedure

The response threshold value of the specimen shall be measured as described in 5.1.5, at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

The maximum response threshold value shall be designated  $y_{\max}$  or  $m_{\max}$  and the minimum value shall be designated  $y_{\min}$  or  $m_{\min}$ .

NOTE: For conventional detectors the supply parameter is the dc voltage applied to the detector. For other types of detector (e.g. analogue addressable) signal levels and timing may need to be considered. If necessary, the manufacturer may be requested to provide suitable supply equipment to allow the supply parameters to be changed as required.

### 5.5.3 Requirements

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

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<sup>-1</sup>.

## 5.6 Air movement

### 5.6.1 Object

To show that the sensitivity of the detector is not unduly affected by the rate of the air flow, and that it is not unduly prone to false alarms in draughts or in short gusts.

### 5.6.2 Test Procedure

The response threshold value of the specimen to be tested shall be measured as described in 5.1.5 in the most and least sensitive orientations, and shall be appropriately designated  $y_{(0,2)\max}$  and  $y_{(0,2)\min}$  or  $m_{(0,2)\max}$  and  $m_{(0,2)\min}$ .

These measurements shall then be repeated but with an air velocity, in the proximity of the detector, of  $(1 \pm 0,2) \text{ m s}^{-1}$ . The response threshold values in these tests shall be designated  $y_{(1,0)\max}$  and  $y_{(1,0)\min}$  or  $m_{(1,0)\max}$  and  $m_{(1,0)\min}$ .

Additionally, for detectors using ionization, the specimen to be tested shall be subjected, in its most sensitive orientation, to an aerosol-free air flow at a velocity of  $(5 \pm 0,5) \text{ m s}^{-1}$  for a period of not less than 5 min and not more than 7 min, and then at least 10 min later to a gust at a velocity of  $(10 \pm 1) \text{ m s}^{-1}$  for a period of not less than 2 s and not more than 4 s. The specimen shall be monitored during the exposure to aerosol-free air to detect any alarm or fault signals.

NOTE: These exposures can be generated by plunging the specimen to be tested into an airflow with the appropriate velocity for the required time.

### 5.6.3 Requirements

For detectors using ionization the following shall apply:

$$0,625 \leq \frac{y_{(0,2)\max} + y_{(0,2)\min}}{y_{(1,0)\max} + y_{(1,0)\min}} \leq 1,6$$

and the detector shall emit neither a fault signal nor an alarm signal during the test with aerosol-free air.

For detectors using scattered or transmitted light the following shall apply:

$$0,625 \leq \frac{m_{(0,2)\max} + m_{(0,2)\min}}{m_{(1,0)\max} + m_{(1,0)\min}} \leq 1,6$$

## 5.7 Dazzling

### 5.7.1 Object

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

### 5.7.2 Test procedure

The dazzling apparatus, described in annex D, is installed in the smoke tunnel described in annex A. The specimen is installed in the dazzling apparatus in the least sensitive orientation and connected to its supply and monitoring equipment. The following test procedure is then applied:

The response threshold value is measured as described in 5.1.5.

The four lamps are switched simultaneously ON for 10 s and then OFF for 10 s, ten times.

The four lamps are then switched ON again and after at least 1 min the response threshold value is measured, as described in 5.1.5, with the lamps ON.

The four lamps are then switched OFF.

The above procedure is then repeated but with the detector rotated 90° in one direction (either direction can be chosen), from the least sensitive orientation.

For each orientation, the maximum response threshold value shall be designated  $m_{\max}$  and the minimum response threshold value shall be designated  $m_{\min}$ .

### 5.7.3 Requirements

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 emit neither an alarm nor a fault signal.

For each orientation, the ratio of the response thresholds  $m_{\max} : m_{\min}$  shall not be greater than 1,6.

## 5.8 Dry heat (operational)

### 5.8.1 Object

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

### 5.8.2 Test procedure

The specimen to be tested shall be installed in the smoke tunnel described in annex A in its least sensitive orientation, with an initial air temperature of  $(23 \pm 5) ^\circ\text{C}$ , and shall be connected to its supply and monitoring equipment.

The air temperature in the smoke tunnel shall then be increased to  $(55 \pm 2) ^\circ\text{C}$  at a rate not exceeding  $1 \text{ K min}^{-1}$ , and maintained at this temperature for 2 h.

The response threshold value shall then be measured as described in 5.1.5 but with the temperature at  $(55 \pm 2) ^\circ\text{C}$ .

The greater of the response threshold values measured in this test and that measured for the same specimen in the reproducibility test, shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.8.3 Requirements

No alarm or fault signal 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.

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 Cold (operational)

### 5.9.1 Object

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

### 5.9.2 Test procedure

#### 5.9.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-1:1990+A1:1993+A2:1994 Test Ab, and as described below.

#### 5.9.2.2 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 and shall be connected to supply and monitoring equipment as described in 5.1.2.

#### 5.9.2.3 Conditioning

The following conditioning shall be applied:

Temperature:	$(-10 \pm 3) ^\circ\text{C}$ .
Duration:	16 h.

NOTE: Test Ab specifies rates of change of temperature of  $\leq 1 \text{ K min}^{-1}$  for the transitions to and from the conditioning temperature.

#### 5.9.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any alarm or fault signals.

#### 5.9.2.5 Final measurements

After a recovery period of at least 1 h at the standard laboratory conditions, the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold values measured in this test and that measured for the same specimen in the reproducibility test, shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.9.3 Requirements

No alarm or fault signal shall be given during the transition to the conditioning temperature or during the period at the conditioning temperature.

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 Damp heat, steady state (operational)

### 5.10.1 Object

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

### 5.10.2 Test procedure

#### 5.10.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-56:1988 Test Cb and as described below.

#### 5.10.2.2 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 and shall be connected to supply and monitoring equipment as described in 5.1.2.

#### 5.10.2.3 Conditioning

The following conditioning shall be applied:

Temperature:	$(40 \pm 2) \text{ }^\circ\text{C}$ .
Relative Humidity:	$(93 \pm 3) \%$ .
Duration:	4 days.

#### 5.10.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any alarm or fault signals.

#### 5.10.2.5 Final measurements

After a recovery period of at least 1 h at the standard laboratory conditions, the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.10.3 Requirements

No alarm or fault signal shall be given during the conditioning.

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 Damp heat, steady state (endurance)

### 5.11.1 Object

To demonstrate the ability of the detector 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, etc.).

### 5.11.2 Test procedure

#### 5.11.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-56:1988 Test Cb or IEC 60068-2-3:1969+A1:1984 Test Ca, and as described below.

#### 5.11.2.2 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 but shall not be supplied with power during the conditioning.

#### 5.11.2.3 Conditioning

The following conditioning shall be applied:

Temperature:	(40 ± 2) °C.
Relative Humidity:	(93 ± 3) %.
Duration:	21 days.

#### 5.11.2.4 Final measurements

After a recovery period of at least 1 h in standard laboratory conditions, the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.11.3 Requirements

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

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 Sulfur dioxide (SO<sub>2</sub>) corrosion (endurance)

### 5.12.1 Object

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

### 5.12.2 Test procedure

#### 5.12.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-42:1982 Test Kc, except that the conditioning shall be as described below.

#### 5.12.2.2 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3. It shall not be supplied with power during the conditioning, but it shall have untinned copper wires, of the appropriate diameter, connected to sufficient terminals, to allow the final measurement to be made without making further connections to the specimen.

#### 5.12.2.3 Conditioning

The following conditioning shall be applied:

Temperature:	(25 ± 2) °C.
Relative humidity:	(93 ± 3) %.
SO <sub>2</sub> concentration:	(25 ± 5) ppm (by volume).
Duration:	21 days.

#### 5.12.2.4 Final measurements

Immediately after the conditioning, the specimen shall be subjected 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 laboratory conditions. After this, the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

#### 5.12.3 Requirements

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

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 Shock (operational)

#### 5.13.1 Object

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

#### 5.13.2 Test procedure

##### 5.13.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-27:1987 Test Ea, except that the conditioning shall be as described below.

##### 5.13.2.2 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to a rigid fixture, and shall be connected to its supply and monitoring equipment as described in 5.1.2.

### 5.13.2.3 Conditioning

For specimens with a mass  $\leq 4,75$  kg the following conditioning shall be applied:

Shock pulse type:	Half sine.
Pulse duration:	6 ms.
Peak acceleration:	$10 \times (100 - 20M) \text{ m s}^{-2}$ (Where $M$ is the specimen's mass in kg).
Number of directions:	6.
Pulses per direction:	3.

No test is applied to specimens with a mass  $> 4,75$  kg.

### 5.13.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for a further 2 min to detect any alarm or fault signals.

### 5.13.2.5 Final measurements

After the conditioning the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.13.3 Requirements

No alarm or fault signal shall be given during the conditioning period or the additional 2 min.

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 Impact (operational)

### 5.14.1 Object

To demonstrate the immunity of the detector to mechanical impacts upon its surface, which it may sustain in the normal service environment, and which it can reasonably be expected to withstand.

### 5.14.2 Test procedure

#### 5.14.2.1 Apparatus

The test apparatus shall consist of a swinging hammer incorporating a rectangular-section aluminium alloy head (aluminium alloy Al Cu<sub>4</sub> Si Mg complying with ISO 209-1:1989, solution treated 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  $(50 \pm 2,5)$  mm high,  $(76 \pm 3,8)$  mm wide and  $(80 \pm 4)$  mm long at mid height as shown in Figure E.1. A suitable apparatus is described in annex E.

#### 5.14.2.2 State of the specimen during conditioning

The specimen shall be rigidly mounted to the apparatus by its normal mounting means and shall be positioned so that it is struck by the upper half of the impact face when the hammer is in the vertical position (i.e. when the hammer head is moving horizontally). The azimuthal direction and position of impact relative to the specimen shall be chosen as that most likely to impair the normal functioning of the specimen. The specimen shall be connected to its supply and monitoring equipment as described in 5.1.2.

### 5.14.2.3 Conditioning

The following conditioning shall be applied:

Impact energy:	$(1,9 \pm 0,1)$ J.
Hammer velocity:	$(1,5 \pm 0,13)$ m s <sup>-1</sup> .
Number of impacts:	1.

### 5.14.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for a further 2 min to detect any alarm or fault signals.

### 5.14.2.5 Final measurements

After the conditioning the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.14.3 Requirements

No alarm or fault signal shall be given during the conditioning period or the additional 2 min.

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 Vibration, sinusoidal (operational)

### 5.15.1 Object

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

### 5.15.2 Test procedure

#### 5.15.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-6:1995+Corr.:1995 Test Fc, and as described below.

#### 5.15.2.2 State of the specimen during conditioning

The specimen shall be mounted on a rigid fixture as described in 5.1.3 and shall be connected to its supply and monitoring equipment as described in 5.1.2. The vibration shall be applied in each of three mutually perpendicular axes, in turn. The specimen shall be mounted so that one of the three axes is perpendicular to its normal mounting plane.

### 5.15.2.3 Conditioning

The following conditioning shall be applied:

Frequency range:	(10 to 150) Hz.
Acceleration amplitude:	5 m s <sup>-2</sup> ( $\approx 0,5 g_n$ ).
Number of axes:	3.
Sweep rate:	1 octave min <sup>-1</sup> .
Number of sweep cycles:	1 per axis.

NOTE: 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. Only one final measurement need be made.

### 5.15.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any alarm or fault signals.

### 5.15.2.5 Final measurements

The final measurements, as specified in 5.16.2.4, are normally made after the vibration endurance test and only need be made here if the operational test is conducted in isolation.

### 5.15.3 Requirements

No alarm or fault signal shall be given during the conditioning.

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

## 5.16 Vibration, sinusoidal (endurance)

### 5.16.1 Object

To demonstrate the ability of the detector to withstand the long-term effects of vibration at levels appropriate to the service environment.

### 5.16.2 Test procedure

#### 5.16.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-6:1995+Corr.:1995 Test Fc, and as described below.

#### 5.16.2.2 State of the specimen during conditioning

The specimen shall be mounted on a rigid fixture as described in 5.1.3, but shall not be supplied with power during conditioning. The vibration shall be applied in each of three mutually perpendicular axes, in turn. The specimen shall be mounted so that one of the three axes is perpendicular to its normal mounting axis.

### 5.16.2.3 Conditioning

The following conditioning shall be applied:

Frequency range:	(10 to 150) Hz.
Acceleration amplitude:	10 m s <sup>-2</sup> ( $\approx 1,0 g_n$ ).
Number of axes:	3.
Sweep rate:	1 octave min <sup>-1</sup> .
Number of sweep cycles:	20 per axis.

NOTE: 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. Only one final measurement need be made.

### 5.16.2.4 Final measurements

After the conditioning the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

### 5.16.3 Requirements

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

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

## 5.17 Electromagnetic compatibility (EMC), immunity tests (operational)

The following EMC immunity tests shall be carried out, as described in EN 50130-4:1995+A1:1998:

- a) electrostatic discharge;
- b) radiated electromagnetic fields;
- c) conducted disturbances induced by electromagnetic fields;
- d) fast transient bursts;
- e) slow high energy voltage surges.

For these tests the criteria for compliance specified in EN 50130-4:1995+A1:1998 and the following shall apply:

- 1) The functional test, called for in the initial and final measurements, shall be as follows:

The response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated  $y_{\max}$  or  $m_{\max}$ , and the lesser shall be designated  $y_{\min}$  or  $m_{\min}$ .

- 2) The required operating condition shall be as described in 5.1.2.
- 3) The acceptance criterion for the functional test after the conditioning shall be as follows:

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

## 5.18 Fire sensitivity

### 5.18.1 Object

To show that the detector has adequate sensitivity to a broad spectrum of smoke types as required for general application in fire detection systems for buildings.

### 5.18.2 Principle

The specimens are mounted in a standard fire test room and are exposed to a series of test fires designed to produce smoke, representative of a wide spectrum of types of smoke and smoke flow conditions.

### 5.18.3 Test procedure

#### 5.18.3.1 Fire test room

The fire sensitivity tests shall be conducted in a rectangular room with a flat horizontal ceiling, and the following dimensions:

Length:	9 m to 11 m.
Width:	6 m to 8 m.
Height:	3,8 m to 4,2 m.

The fire test room shall be equipped with the following measuring instruments arranged as indicated in annex F:

- Measuring ionization chamber (MIC).
- Obscuration meter.
- Temperature probe.

#### 5.18.3.2 Test Fires

The specimens shall be subjected to the four test fires TF2 to TF5 (see NOTE and annexes G to J). The type, quantity and arrangement of the fuel and the method of ignition are described in annexes G to J for each test fire, along with the end of test condition and the required profile curve limits.

In order to be a valid test fire, the development of the fire shall be such that the profile curves of  $m$  against  $y$  and  $m$  against time, fall within the specified limits, up to the time when all of the specimens have generated an alarm signal or the end of test condition is reached, whichever is the earlier. If these conditions are not met then the test is invalid and shall be repeated. It is permissible, and may be necessary, to adjust the quantity, condition (e.g. moisture content) and arrangement of the fuel to obtain valid test fires.

NOTE: The test fire (TF) numbers have been retained from EN 54-9:1982 to avoid confusion.

#### 5.18.3.3 Mounting of the specimens

The four specimens (Nos. 17, 18, 19 and 20) shall be mounted on the fire test room ceiling in the designated area (see annex F). The specimens shall be mounted in accordance with the manufacturer's instructions, such that they are in the least sensitive orientation, relative to an assumed air flow from the centre of the room to the specimen.

Each specimen shall be connected to its supply and monitoring equipment, as described in 5.1.2, and shall be allowed to stabilize in its quiescent condition before the start of each test fire.

NOTE: Detectors which dynamically modify their sensitivity in response to varying ambient conditions, may 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.

#### 5.18.3.4 Initial conditions

Before each test fire the room shall be ventilated with clean air until it is free from smoke, and so that the conditions listed below can be obtained.

The ventilation system shall then be switched off and all doors, windows and other openings shall be closed. The air in the room shall then be allowed to stabilize, and the following conditions shall be obtained before the test is started:

Air temperature $T$ :	$(23 \pm 5) \text{ }^\circ\text{C}$ .
Air movement:	negligible.
Smoke density (ionization):	$y \leq 0,05$ .
Smoke density (optical):	$m \leq 0,02 \text{ dB m}^{-1}$ .

NOTE: The stability of the air and temperature affects the smoke flow within the room. This is particularly important for the test fires, which produce low thermal lift for the smoke (e.g. TF2 and TF3). It is therefore recommended that the difference between the temperature near the floor and the ceiling is  $< 2 \text{ K}$ , and that local heat sources that can cause convection currents (e.g. lights and heaters) should be avoided. 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.

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

During each test fire the following fire parameters shall be recorded continuously or at least once per second.

Parameter	Symbol	Units
Temperature change	$\Delta T$	K
Smoke density (ionization)	$y$	dimensionless
Smoke density (optical)	$m$	$\text{dB m}^{-1}$

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.

The time of response of each specimen shall be recorded along with the fire parameters  $y_a$  and  $m_a$ , at the moment of response.

#### 5.18.4 Requirements

All four specimens shall generate an alarm signal, in each test fire, before the specified end of test condition is reached.

## Annex A (normative)

### Smoke tunnel for response threshold value measurements

The following specifies those properties of the smoke tunnel which are of primary importance for making repeatable and reproducible measurements of response threshold values of smoke detectors. However, since it is not practical to specify and measure all parameters which can influence the measurements, the background information in annex K should be carefully considered and taken into account when a smoke tunnel is designed and used to make measurements in accordance with this standard.

The smoke tunnel shall have a horizontal working section containing a working volume. The working volume is a defined 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 detector to be tested and the sensing parts of the measuring equipment. The working section shall be designed to allow the dazzling apparatus described in annex D to be inserted. The detector to be tested shall be mounted in its normal operating position on the underside of a flat board aligned with the airflow in the working volume. The board shall be of such dimensions that the edge(s) of the board are at least 20 mm from any part of the detector. The detector mounting arrangement shall not unduly obstruct the air flow between the board and the tunnel ceiling.

Means shall be provided for creating an essentially laminar air flow at the required velocities (i.e.  $(0,2 \pm 0,04) \text{ m s}^{-1}$  or  $(1,0 \pm 0,2) \text{ m s}^{-1}$ ) through the working volume. It shall be possible to control the temperature at the required values and to increase the temperature at a rate not exceeding  $1 \text{ K min}^{-1}$  to  $55 \text{ }^\circ\text{C}$ .

Both aerosol density measurements,  $m$  and  $y$ , shall be made in the working volume in the proximity of the detector.

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

Only one detector shall be mounted in the tunnel, unless it has been demonstrated that measurements made simultaneously on more than one detector are in close agreement with measurements made by testing detectors 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

A polydisperse aerosol shall be used as the test aerosol. The maximum of the aerosol mass distribution shall correspond to particle diameters between 0,5  $\mu\text{m}$  and 1  $\mu\text{m}$  with the refractive index of the aerosol particles of approximately 1,4.

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.

NOTE 1: One possible method to ensure that the aerosol is stable is to measure and monitor the stability of the ratio  $m : y$ .

NOTE 2: It is recommended that an aerosol generator producing a paraffin oil mist is used (e.g. using pharmaceutical grade paraffin oil).

## Annex C (normative)

### Smoke measuring instruments

#### C.1 Obscuration meter

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

The absorbance index is designated  $m$  and given the units of decibels per metre ( $\text{dB m}^{-1}$ ). The absorbance index  $m$  is given by the following equation:

$$m = \frac{10}{d} \log \left( \frac{P_0}{P} \right) \text{ dB m}^{-1}$$

where:

- $d$  is the distance, 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.

For all aerosol or smoke concentrations up to  $2 \text{ dB m}^{-1}$ , the measuring error of the obscuration meter shall not exceed  $0,02 \text{ dB m}^{-1} + 5 \%$  of the measured aerosol or smoke concentration.

The optical system shall be arranged so that any light scattered by more than  $3^\circ$  by the test aerosol or smoke is disregarded by the light detector.

The effective radiated power<sup>2)</sup> of the light beam shall be as follows:

- a) at least 50 % shall be within a wavelength range from 800 nm to 950 nm;
- b) not more than 1 % shall be in the wavelength range below 800 nm; and
- c) not more than 10 % shall be in the wavelength range above 1 050 nm.

#### C.2 Measuring ionization chamber (MIC)

##### C.2.1 General

The response threshold of detectors 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 detector, at the moment that it generates an alarm signal.

---

<sup>2)</sup> 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.2.2 Operating method and basic construction

The mechanical construction of the measuring ionization chamber is shown in annex M.

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.

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.

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 by the aerosol or smoke particles in a known manner. The relative variation in the current of ions is used as a measurement of the aerosol or smoke concentration.

The measuring chamber is so dimensioned and operated that the following relationships apply:

$$Z \times \bar{d} = \eta \times y \quad \text{and} \quad y = \left(\frac{I_0}{I}\right) - \left(\frac{I}{I_0}\right)$$

where:

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

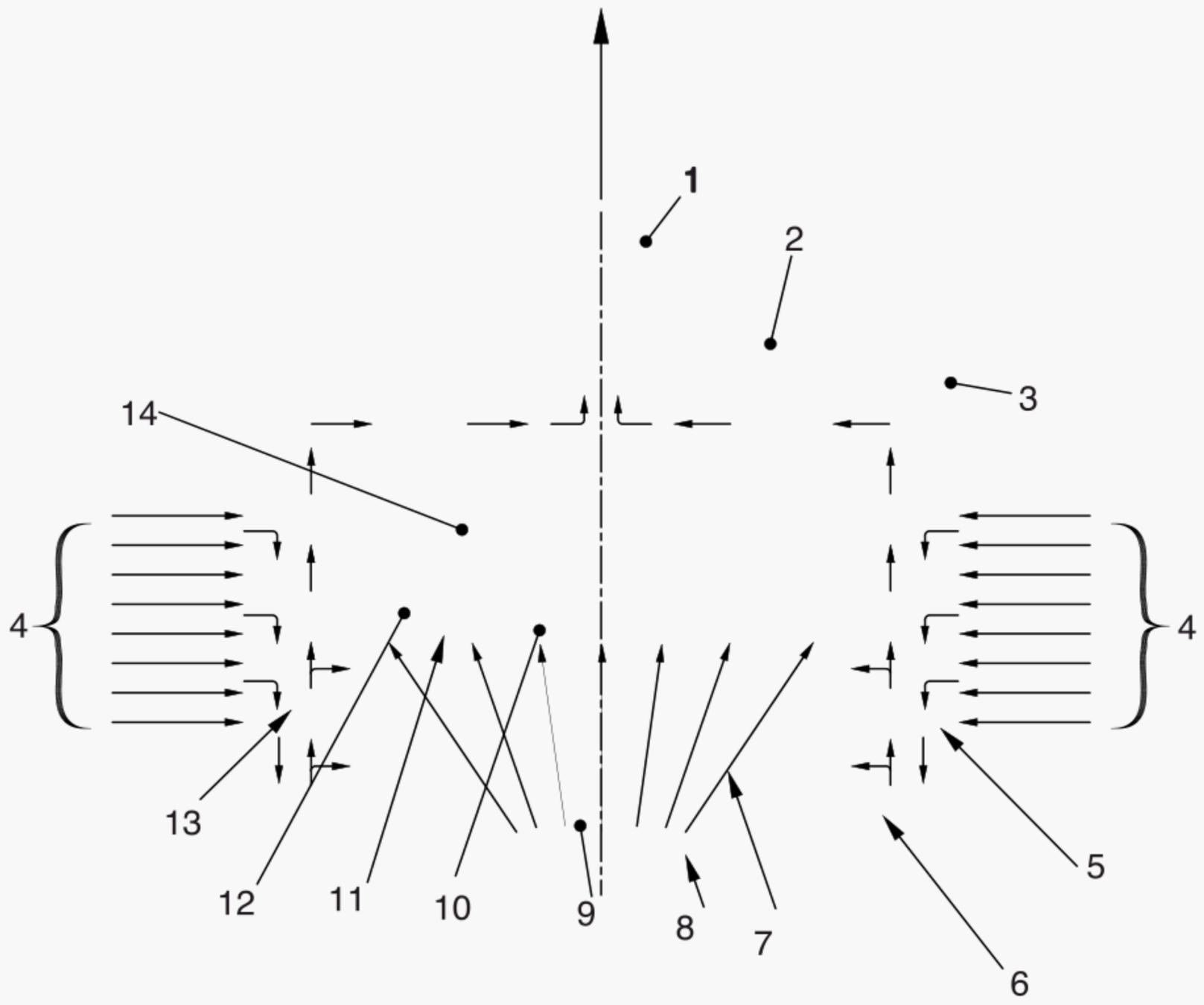
$I$  is the chamber current in air with test aerosol or smoke;

$\eta$  is the chamber constant;

$Z$  is the particle concentration in particles per m<sup>3</sup>;

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

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 response threshold value for smoke detectors using ionization.



**Key**

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

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

**C.2.3 Technical data**

## a) Radiation source:

Isotope:	Americium Am <sup>241</sup> .
Activity:	130 kBq (3,5 μCi) ± 5 %.
Average α energy:	4,5 MeV ± 5 %.
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 vs voltage characteristic of the chamber in its linear region (chamber current ≤ 100 pA)) shall be  $1,9 \times 10^{11} \Omega \pm 5 \%$ , when measured in aerosol- and smoke-free air at:

pressure:	(101,3 ± 1) kPa;
temperature:	(25 ± 2) °C;
relative humidity:	(55 ± 20) %;

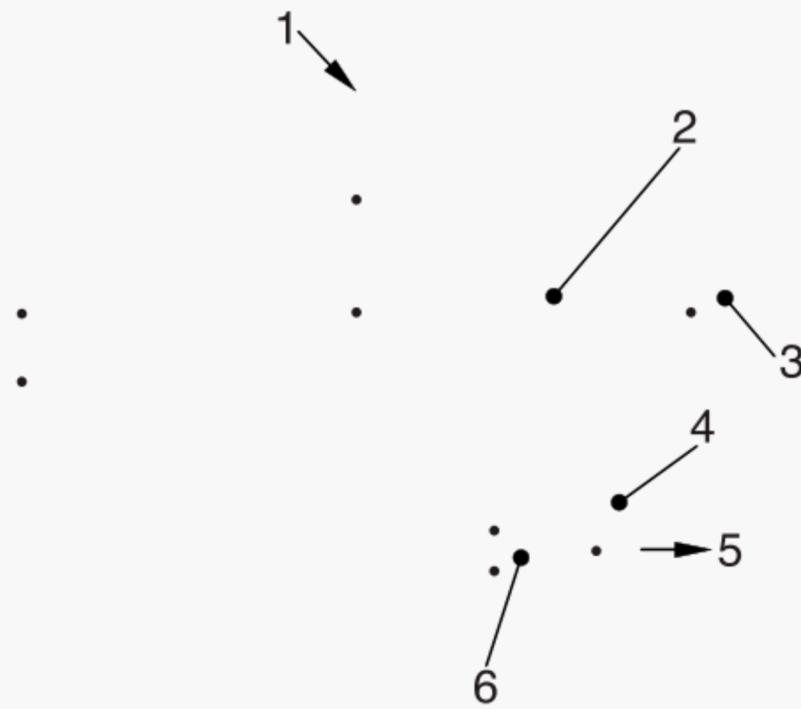
with the potential of the guard ring within ± 0,1 V of the voltage of the measuring electrode.

## 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  $< 10^9 \Omega$ .

## d) Suction system:

The suction system shall draw air through the device at a continuous steady flow of  $30 \text{ l min}^{-1} \pm 10 \%$  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,  $Z_{in} < 10^9 \Omega$

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

**Annex D**  
 (normative)

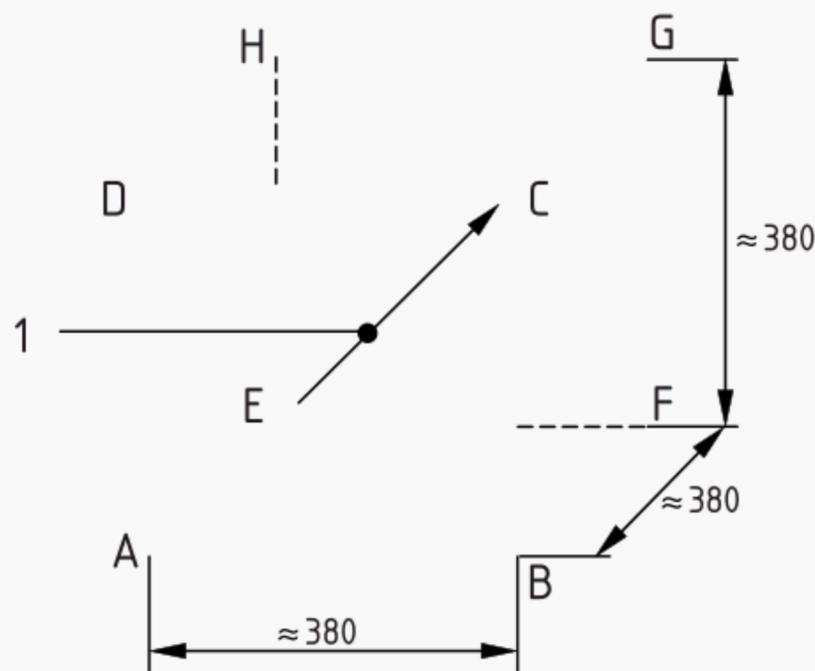
**Apparatus for dazzling test**

The apparatus (see Figure D.1) shall be constructed so that it can be inserted in the working section of the smoke tunnel. Four of the cube faces shall be closed and lined on the inside with high gloss aluminium foil; two opposing cube faces shall be open so that the test aerosol can flow through the device. Circular fluorescent lamps (32 W) with a diameter of approximately 30 cm shall be fitted to the closed surfaces of the cube.

The detector to be tested shall be installed within the cube (see Figure D.1) so that light can play on it from above, below and from two sides.

NOTE: Care should be taken with the electrical connections to the fluorescent lamps to avoid electrical interference with the detection system.

Dimensions in millimetres



Sides ABCD and EFGH shall be open to allow for the flow of aerosol.

Sides ABFE, AEHD, BFGC and DCGH shall have lamps mounted as shown below:



**Key**

- 1 stream of aerosol
- 2 fluorescent lamp

**Figure D.1 — Dazzling apparatus**

## **Annex E** (informative)

### **Apparatus for impact test**

The apparatus (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.

The striker is of dimensions 76 mm wide, 50 mm high and 94 mm long (overall dimensions) and is manufactured from aluminium alloy (Al Cu<sub>4</sub> Si Mg to ISO 209-1:1989), solution treated and precipitation treated condition. It has a plane impact face chamfered at  $(60 \pm 1)^\circ$  to the long axis of the head. The tubular steel shaft has an outside diameter of  $(25 \pm 0,1)$  mm with walls  $(1,6 \pm 0,1)$  mm thick.

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

Diametrically opposite the hammer shaft are two steel counter balance arms, each 20 mm in outside diameter and 185 mm long. These arms are screwed into the boss so that a 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 is mounted a 12 mm wide  $\times$  150 mm diameter aluminium alloy pulley and round this an inextensible cable is wound, one end being fixed to the pulley. The other end of the cable supports the operating weight.

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

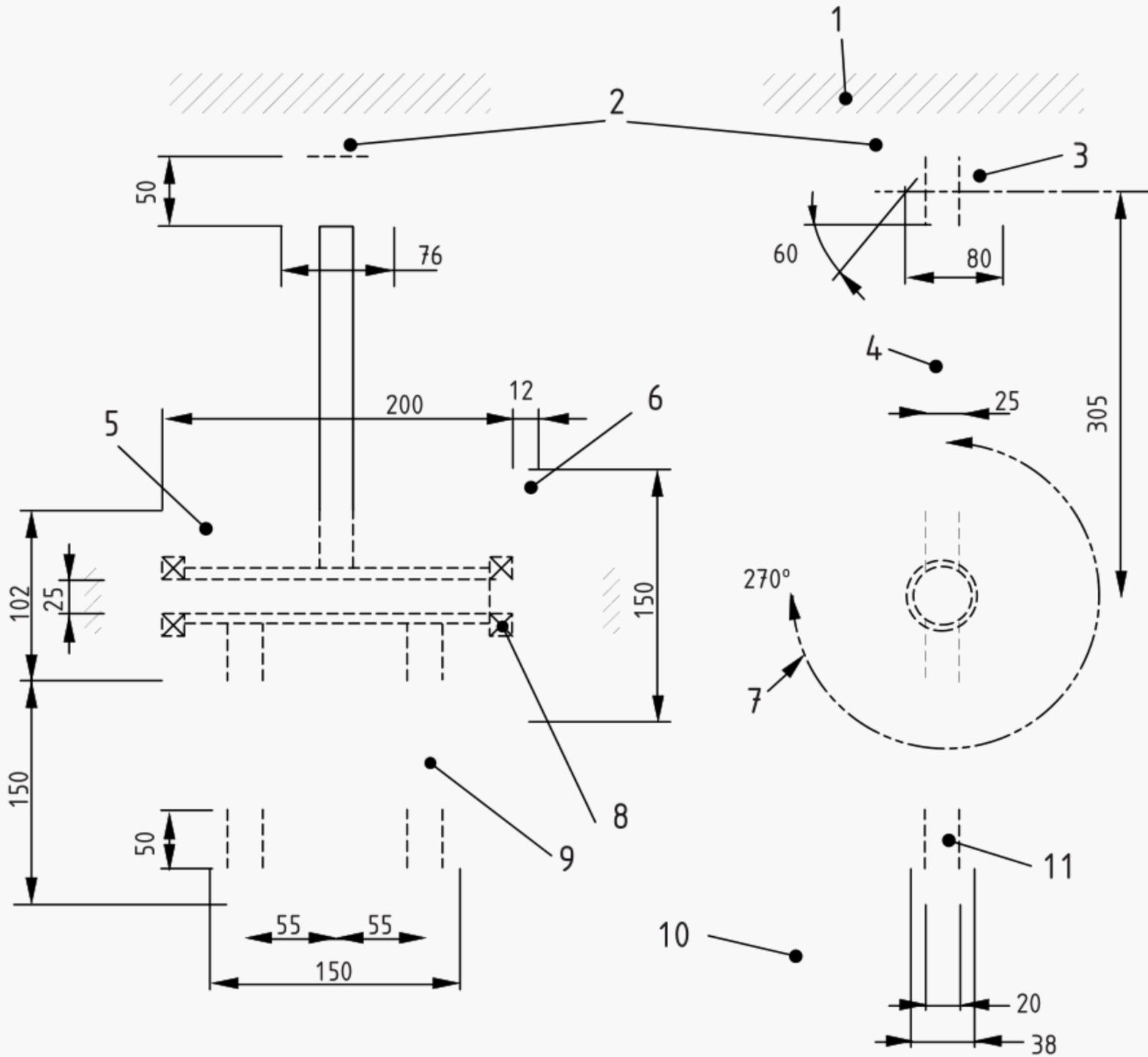
To operate the apparatus, the position of the specimen and the mounting board is first adjusted as shown in Figure E.1 and the mounting board is then secured rigidly to the frame. The hammer assembly is then balanced carefully by adjustment of the counter balance weight with the operating weight removed. 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 will spin the hammer and arm through an angle of  $3\pi/2$  radians to strike the specimen. The mass of the operating weight to produce the required impact energy of 1,9 J equals:

$$\frac{0,388}{3\pi r} \text{ kg}$$

where  $r$  is the effective radius of the pulley in metres. This equals approximately 0,55 kg for a pulley radius of 75 mm.

As the standard calls for a hammer velocity at impact of  $(1,5 \pm 0,13) \text{ m s}^{-1}$ , the mass of the hammer head will need to be reduced by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0,79 kg will be required to obtain the specified velocity, but this will have to be determined by trial and error.

Dimensions in millimetres



**Key**

- |                  |                          |
|------------------|--------------------------|
| 1 mounting board | 7 270° angle of movement |
| 2 detector       | 8 ball bearings          |
| 3 striker        | 9 counter balance arms   |
| 4 striker shaft  | 10 operating weight      |
| 5 boss           | 11 counterbalance weight |
| 6 pulley         |                          |

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

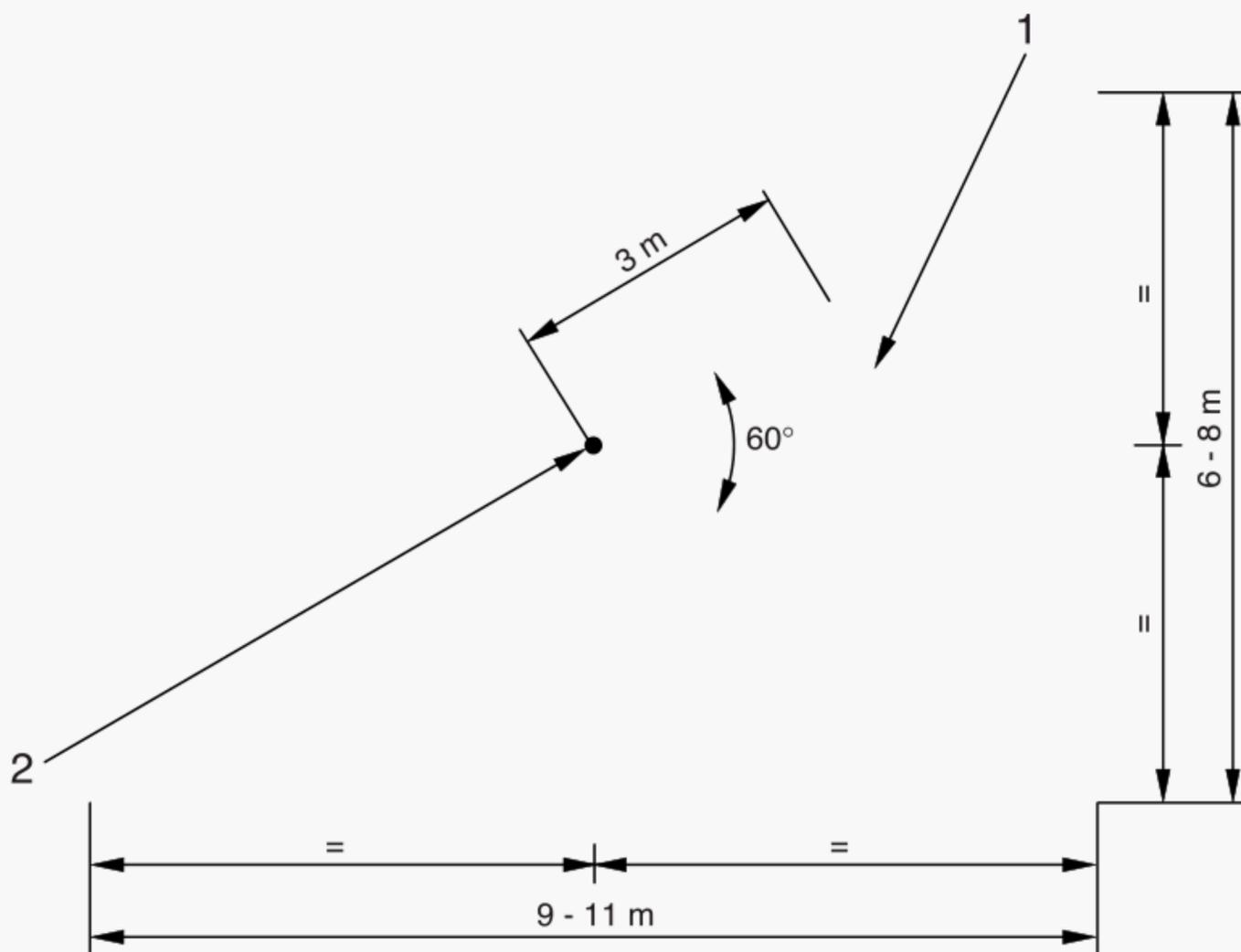
**Figure E.1 — Impact apparatus**

## Annex F (normative)

### Fire test room

The specimens to be tested, the MIC, the temperature probe and the measuring part of the obscuration meter shall all be located within the volume shown in Figures F.1 & F.2.

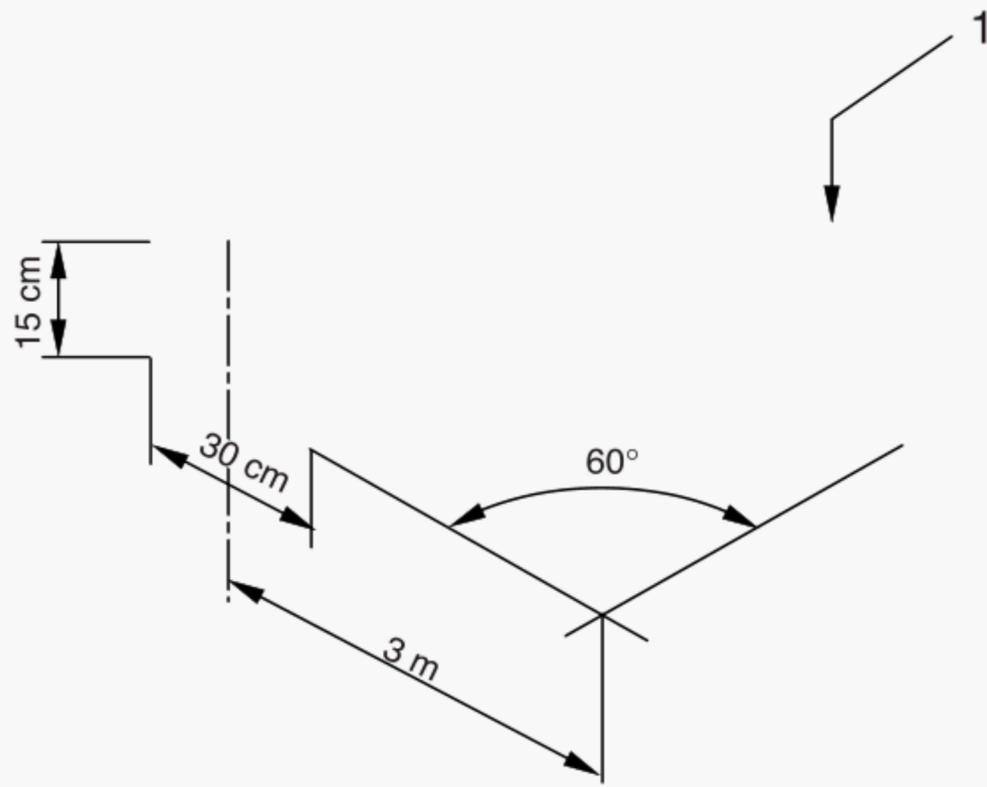
The specimens, the MIC and the mechanical parts of the obscuration meter shall be at least 100 mm apart, measured to the nearest edges. The centre line of the beam of the obscuration meter shall be at least 35 mm below the ceiling.



#### Key

- 1 specimens and measuring instruments (see Figure F.2)
- 2 position of test fire

Figure F.1 — Plan view of the fire test room



**Key**  
1 ceiling

Figure F.2 — Mounting position for specimens and measuring instruments

## Annex G (normative)

### Smouldering (pyrolysis) wood fire (TF2)

#### G.1 Fuel

Approximately 10 dried beechwood sticks (moisture content  $\approx 5\%$ ), each stick having dimensions of 75 mm  $\times$  25 mm  $\times$  20 mm.

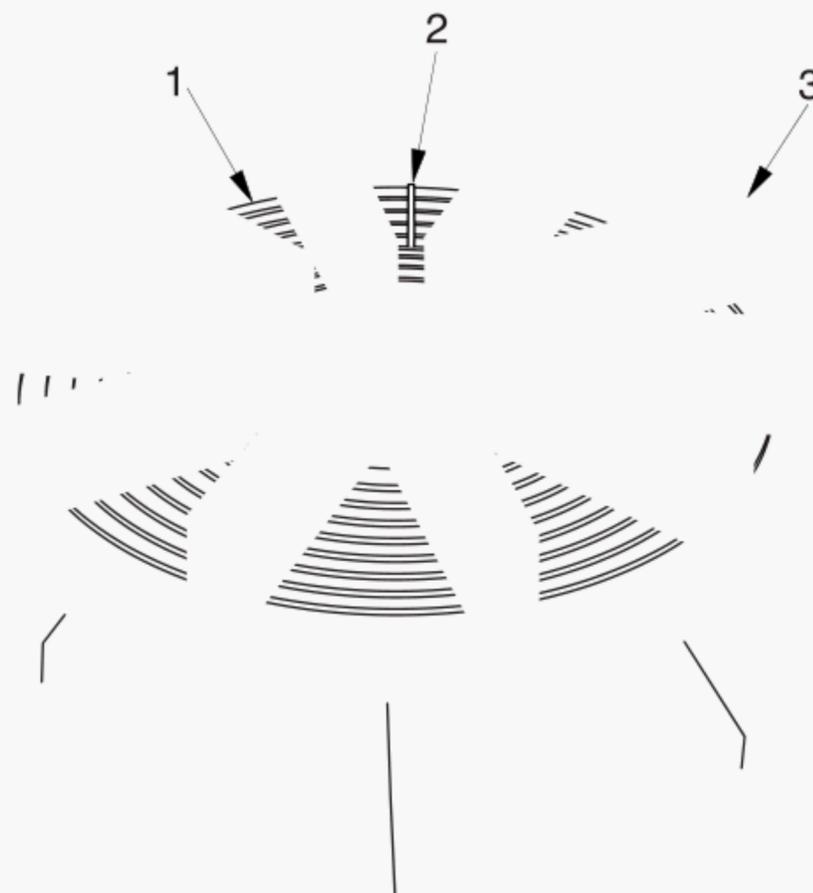
#### G.2 Hotplate

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

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.3 Arrangement

The sticks shall be arranged 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.



#### Key

- 1 grooved hotplate
- 2 temperature sensor
- 3 wooden sticks

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

**G.4 Heating rate**

The hotplate shall be powered such that its temperature rises from ambient to 600 °C in approximately 11 min.

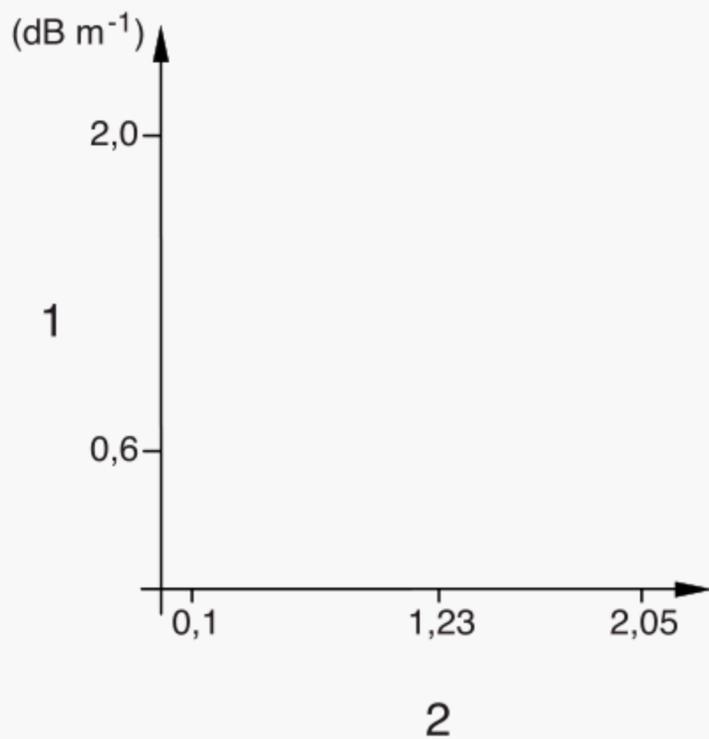
**G.5 End of test condition**

$$m_E = 2 \text{ dB m}^{-1}$$

**G.6 Test validity criteria**

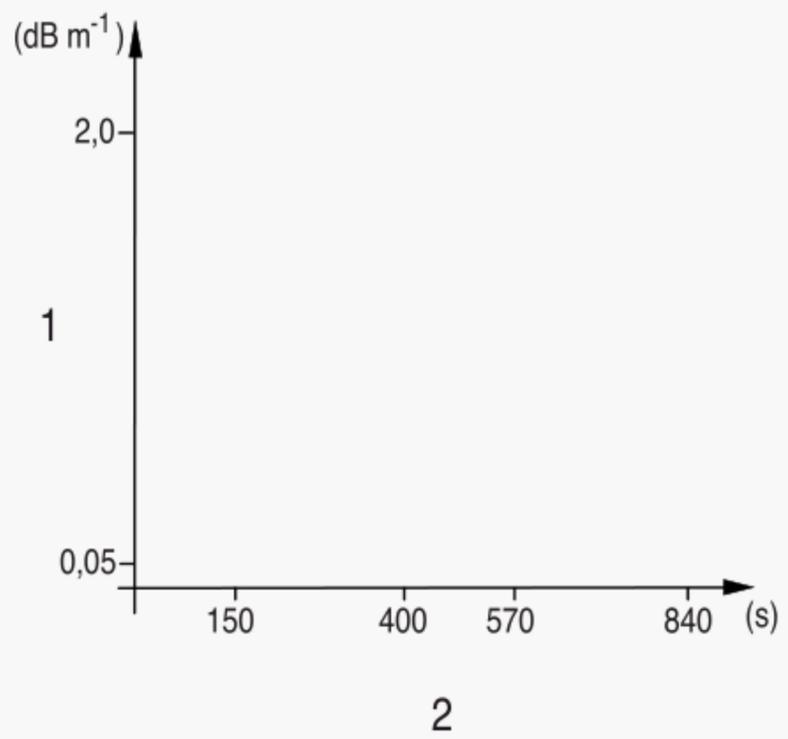
The development of the fire shall be such that the curves of  $m$  against  $y$ , and  $m$  against time, fall within the limits shown in Figures G.2 and G.3 respectively and no flaming occurs, up to the time when all of the specimens have generated an alarm signal, or  $m = 2 \text{ dB m}^{-1}$ , whichever is the earlier.

If the end of test condition,  $m_E = 2 \text{ dB m}^{-1}$ , is reached before all the specimens of detectors using ionization have responded, then the test is only considered valid if a  $y$ -value of 1,6 has been reached.



**Key**  
 1  $m$ -value  
 2  $y$ -value

**Figure G.2 — Limits for  $m$  against  $y$ ,  
 Fire TF2**



**Key**  
 1  $m$ -value  
 2 time

**Figure G.3 — Limits for  $m$  against time,  
 Fire TF2**

## Annex H (normative)

### Glowing smouldering cotton fire (TF3)

#### H.1 Fuel

Approximately 90 pieces of braided cotton wick, each approximately 80 cm long and weighing approximately 3 g. The wicks shall be free from any protective coating and shall be washed and dried if necessary.

#### H.2 Arrangement

The wicks shall be fastened to a ring approximately 10 cm in diameter and suspended approximately 1 m above a non combustible plate as shown in Figure H.1.

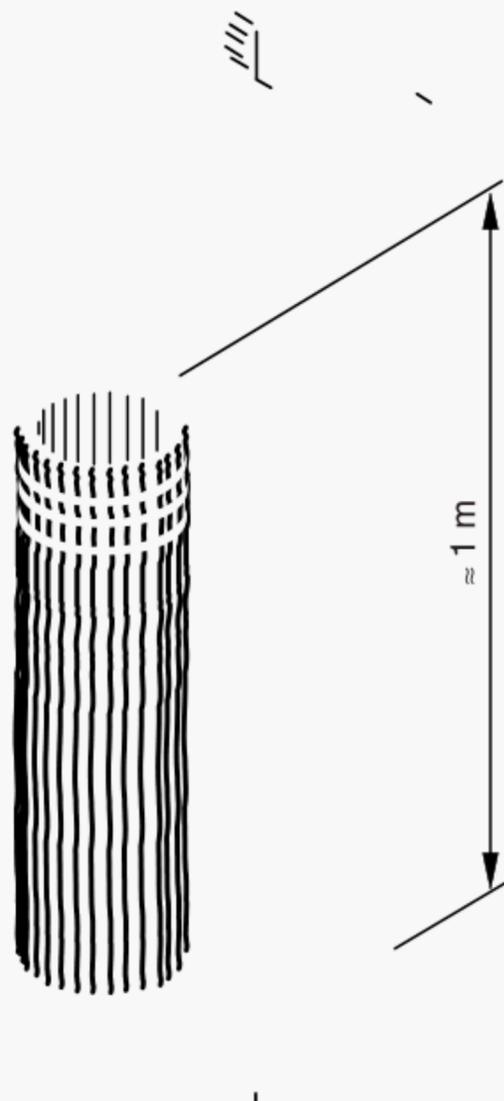


Figure H.1 — Arrangement of the cotton wicks

**H.3 Ignition**

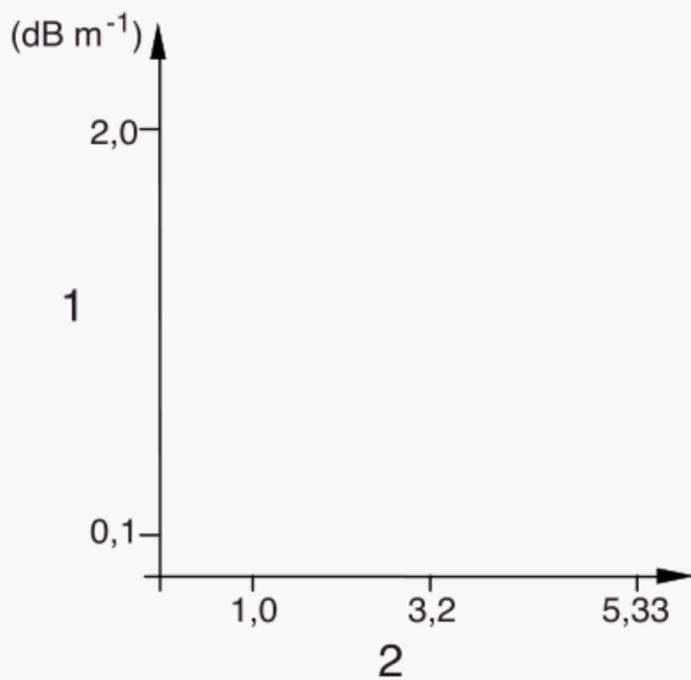
The lower end of each wick shall be ignited so that the wicks continue to glow. Any flaming shall be blown out immediately. The test time shall start when all wicks are glowing.

**H.4 End of test condition**

$$m_E = 2 \text{ dB m}^{-1}$$

**H.5 Test validity criteria**

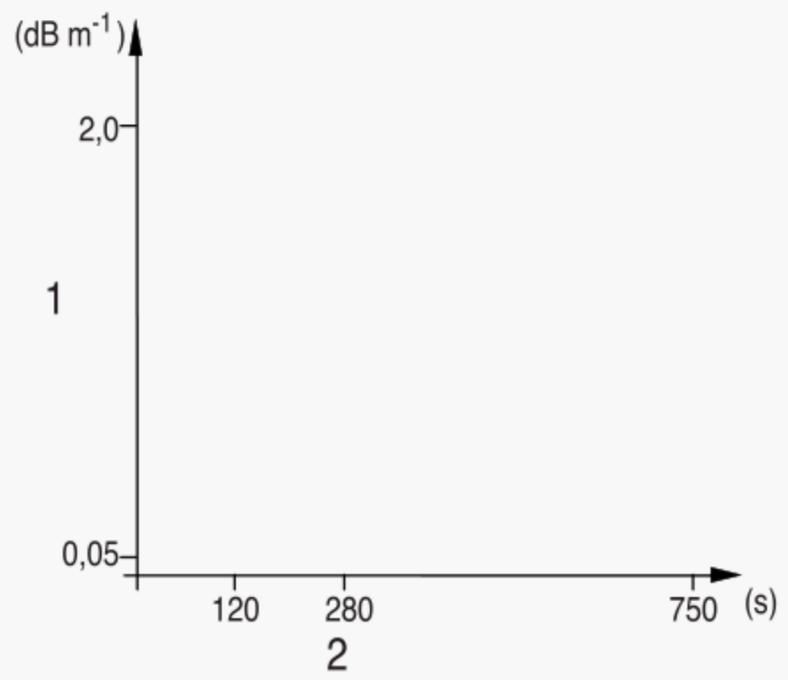
The development of the fire shall be such that the curves of  $m$  against  $y$ , and  $m$  against time, fall within the limits shown in Figures H2 and H3 respectively, up to the time when all of the specimens have generated an alarm signal, or  $m = 2 \text{ dB m}^{-1}$ , whichever is the earlier.



**Key**

- 1  $m$ -value
- 2  $y$ -value

**Figure H.2 — Limits for  $m$  against  $y$ ,  
 Fire TF3**



**Key**

- 1  $m$ -value
- 2 time

**Figure H.3 — Limits for  $m$  against time,  
 Fire TF3**

## Annex I (normative)

### Flaming plastics (polyurethane) fire (TF4)

#### I.1 Fuel

Soft polyurethane foam, without flame retardant additives and having a density of approximately  $20 \text{ kg m}^{-3}$ . 3 mats, approximately  $50 \text{ cm} \times 50 \text{ cm} \times 2 \text{ cm}$ , are usually found sufficient, however the exact fuel quantity may be adjusted to obtain valid tests.

#### I.2 Arrangement

The mats shall be placed one on top of another on a base formed from aluminium foil with the edges folded up to provide a tray.

#### I.3 Ignition

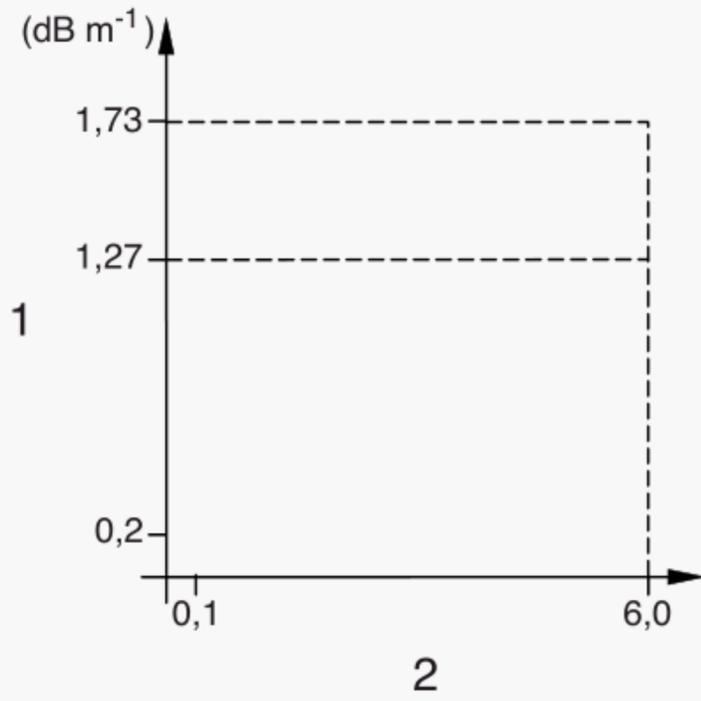
The mats shall normally be ignited at a corner of the lower mat, however the exact position of ignition may be adjusted to obtain valid tests. A small quantity of a clean burning material (e.g.  $5 \text{ cm}^3$  of methylated spirit) may be used to assist the ignition.

#### I.4 End of test condition

$$y_E = 6$$

#### I.5 Test validity criteria

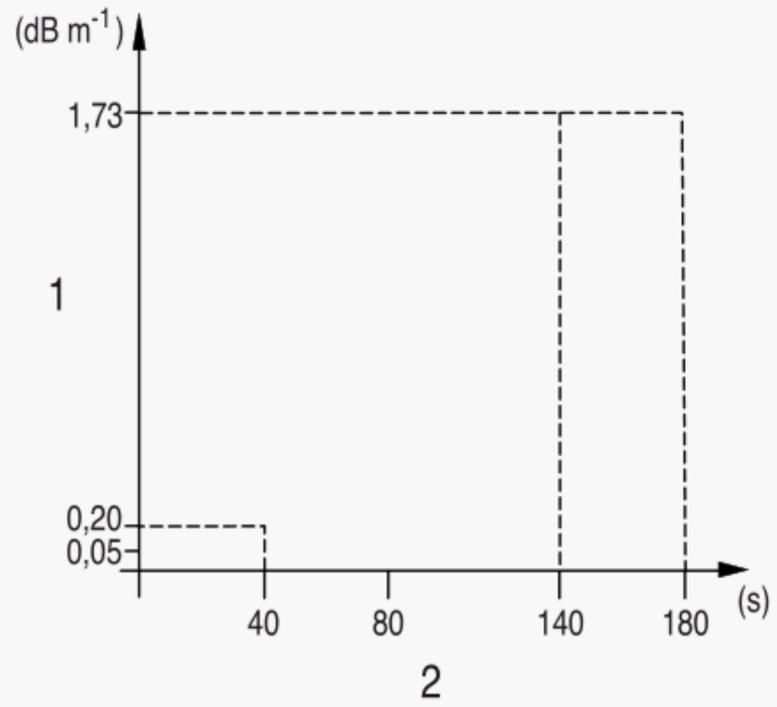
The development of the fire shall be such that the curves of  $m$  against  $y$ , and  $m$  against time, fall within the limits shown in Figures I.1 and I.2 respectively, up to the time when all of the specimens have generated an alarm signal, or  $y = 6$ , whichever is the earlier.



**Key**

- 1  $m$ -value
- 2  $y$ -value

**Figure I.1 — Limits for  $m$  against  $y$ ,  
Fire TF4**



**Key**

- 1  $m$ -value
- 2 time

**Figure I.2 — Limits for  $m$  against time,  
Fire TF4**

## Annex J (normative)

### Flaming liquid (n-heptane) fire (TF5)

#### J.1 Fuel

Approximately 650 g of a mixture of n-heptane (purity  $\geq 99\%$ ) with approximately 3 % of toluene (purity  $\geq 99\%$ ), by volume. The precise quantities may be varied to obtain valid tests.

#### J.2 Arrangement

The heptane/toluene mixture shall be burnt in a square steel tray with dimensions approximately 33 cm  $\times$  33 cm  $\times$  5 cm.

#### J.3 Ignition

Ignition shall be by flame or spark etc.

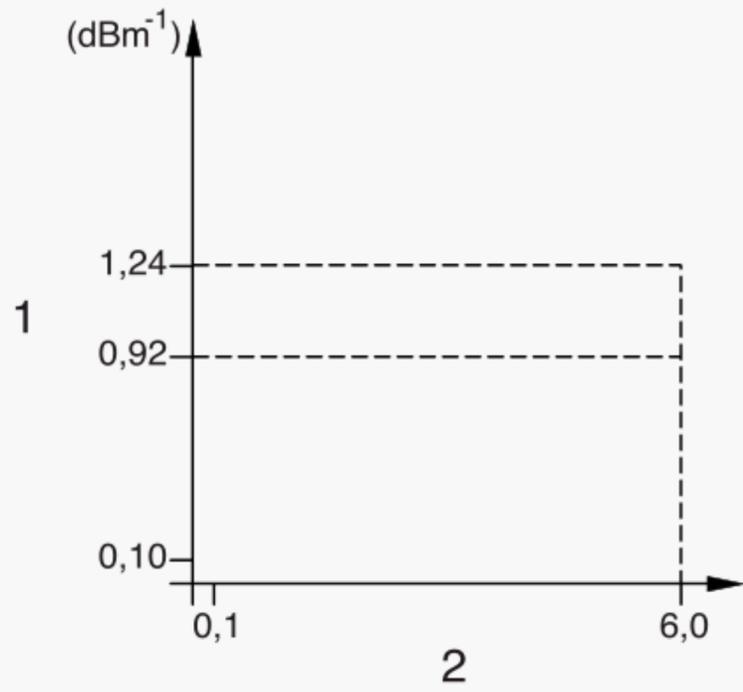
#### J.4 End of test condition

$$y_E = 6$$

#### J.5 Test validity criteria

The development of the fire shall be such that the curves of  $m$  against  $y$ , and  $m$  against time, fall within the limits shown in Figures J.1 and J.2 respectively, up to the time when all of the specimens have generated an alarm signal, or  $y = 6$ , whichever is the earlier.

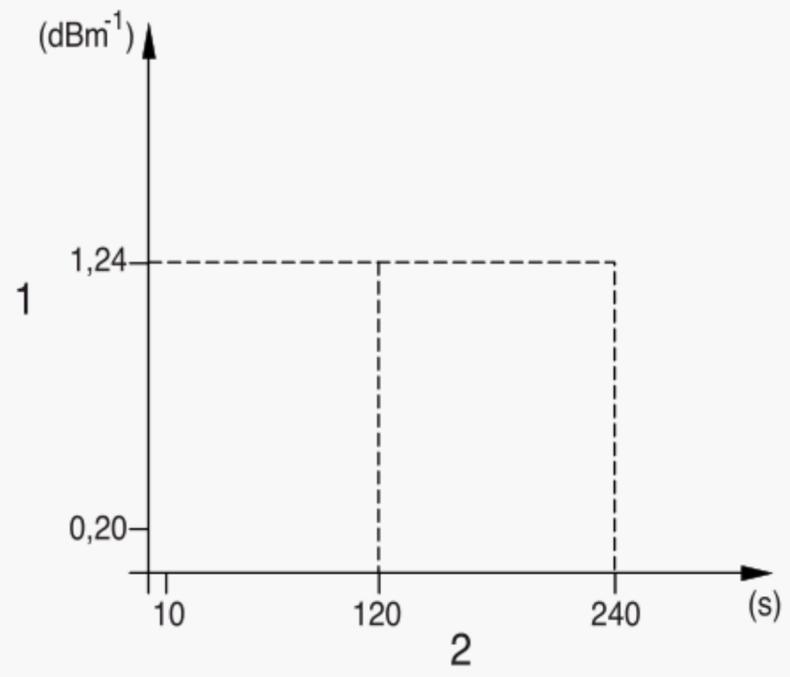
If the end of test condition,  $y_E = 6$ , is reached before all the specimens of detectors using scattered or transmitted light have responded, then the test is only considered valid if an  $m$ -value of 1,1 dB m<sup>-1</sup> has been reached.



**Key**

- 1  $m$ -value
- 2  $y$ -value

Figure J.1 — Limits for  $m$  against  $y$ ,  
Fire TF5



**Key**

- 1  $m$ -value
- 2 time

Figure J.2 — Limits for  $m$  against time,  
Fire TF5

## Annex K (informative)

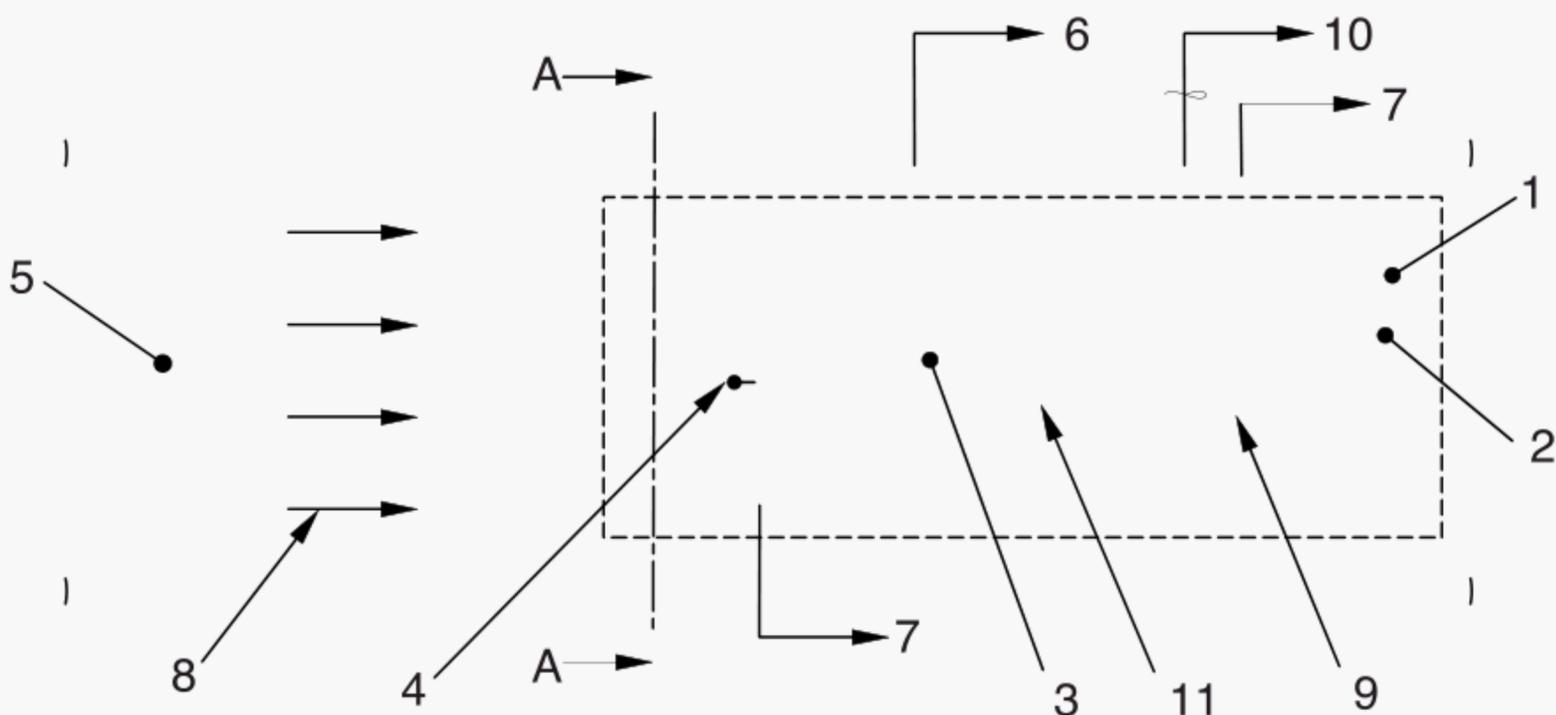
### Information concerning the construction of the smoke tunnel

Smoke detectors respond when the signal(s) from one or more smoke sensors fulfil certain criteria. The smoke concentration at the sensor(s) is related to the smoke concentration surrounding the detector but the relation is usually complex and dependent on several factors, such as orientation, mounting, air velocity, turbulence, rate of rise of smoke density, etc. The relative change of the response threshold value measured in the smoke tunnel is the main parameter considered when the stability of smoke detectors is evaluated by testing in accordance with this standard.

Many different smoke tunnel designs are suitable for the tests specified in this standard but the following points should be considered when designing and characterizing a smoke tunnel.

The response threshold value measurements require increasing aerosol density until the detector responds. This can be facilitated in a closed circuit smoke tunnel. A purging system is required to purge the smoke tunnel after each aerosol exposure.

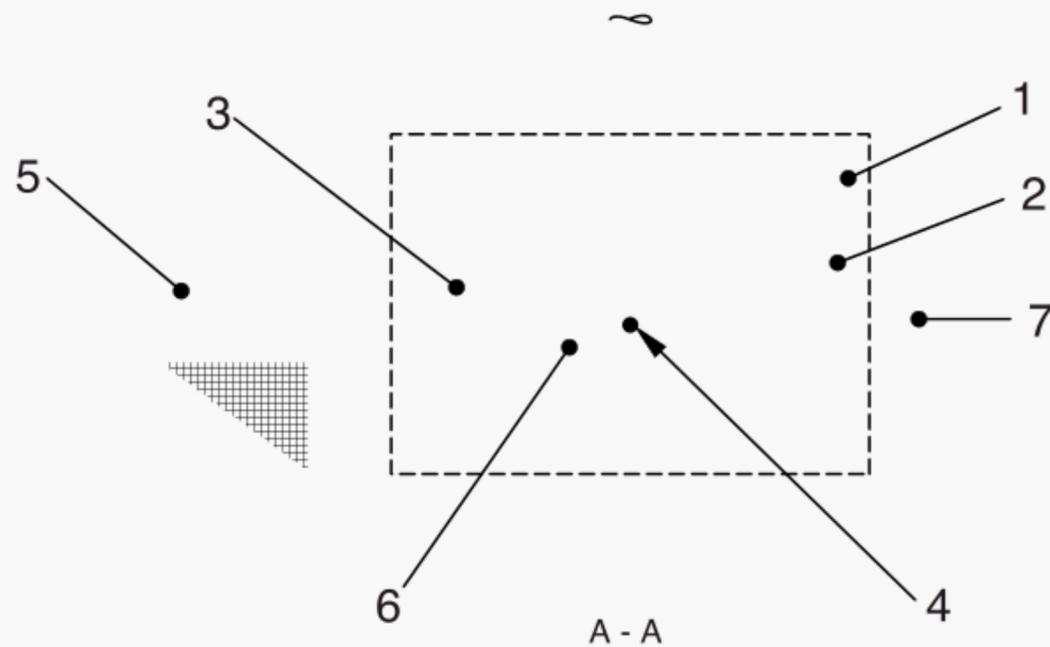
The air flow created by a fan in the tunnel will be turbulent, and needs to pass through an air straightener to create a nearly laminar and uniform air flow in the working volume (see Figure K.1 and K.2). This can be facilitated by using a filter, honeycomb or both, in line with, and upstream of the working section of the tunnel. If a filter is used it should be coarse enough to let the aerosol pass. Care should be taken to ensure that the airflow is well mixed to give a uniform temperature and aerosol density before entering the flow straightener. Efficient mixing can be obtained by feeding the aerosol to the tunnel upstream of the fan.



#### Key

- |                                   |                                     |
|-----------------------------------|-------------------------------------|
| 1 working volume                  | 7 control and measuring equipment   |
| 2 mounting board                  | 8 air flow                          |
| 3 detector(s) under test          | 9 MIC, measuring ionization chamber |
| 4 temperature sensor              | 10 MIC suction                      |
| 5 flow straightener               | 11 obscuration meter                |
| 6 supply and monitoring equipment |                                     |

Figure K.1 — Smoke tunnel, working section, side view



### Key

- 1 working volume
- 2 mounting board
- 3 detector(s) under test
- 4 temperature sensor
- 5 obscuration meter
- 6 MIC, measuring ionization chamber
- 7 reflector for obscuration meter

**Figure K.2 — Smoke tunnel, working section, cross section A-A**

Means for heating the air before it enters the working section are required. The tunnel should have a system capable of controlling the heating as to achieve the specified temperatures and temperature profiles in the working volume. The heating should be achieved by means of low temperature heaters to avoid the production of extraneous aerosols or alteration of the test aerosol.

Special attention should be given to the arrangement of the elements in the working volume in order to avoid disturbance of the test conditions e.g. due to turbulence. The suction through the MIC creates a mean air velocity of approximately  $0,04 \text{ m s}^{-1}$  in the plane of the entrance openings in the chamber housing. However, the effect of the suction will be negligible if the MIC is placed 10 cm to 15 cm downstream of the detector position.

The smoke tunnel may be designed for aerosol-free wind exposures with  $5 \text{ m s}^{-1}$  and  $10 \text{ m s}^{-1}$ , provided this does not interfere with the operation when the tunnel is used for response threshold value measurements.

## Annex L (informative)

### Information concerning the requirements for the response to slowly developing fires

A simple detector operates by comparing the signal from the sensor with a certain fixed threshold (alarm threshold). When the sensor signal reaches the threshold, the detector generates an alarm signal. The smoke density at which this occurs is the response threshold value for the detector. In this simple detector the alarm threshold is fixed and does not depend on the rate of change of sensor signal with time.

It is known that the sensor signal in clean air can change over the life of the detector. Such changes can be caused, for example, by contamination of the sensing chamber with dust or by other long-term effects such as component ageing. This drift can, in time, lead to increased sensitivity and eventually to false alarms.

It may be considered beneficial therefore to provide compensation for such drift in order to maintain a more constant level of response threshold value with time. For the purposes of this discussion it is assumed that the compensation is achieved by increasing the alarm threshold to offset some or all of the upward drift in the sensor output.

Any compensation for drift will reduce the sensitivity of the detector to slow changes in the sensor output even if these changes are caused by a real, but gradual, increase in smoke level. The object of requirement 4.8 a) is to ensure that the compensation does not reduce the sensitivity to a slowly developing fire to an unacceptable degree.

For the purposes of this standard it is assumed that the development of any fire which presents a serious danger to life or property will be such that the sensor output will change at a rate of at least  $A/4$  per hour where  $A$  is the nominal response threshold value of the detector. The response to rates of change less than  $A/4$  per hour is not specified in this standard, and there is therefore no requirement for the detector to respond to these lower rates of change.

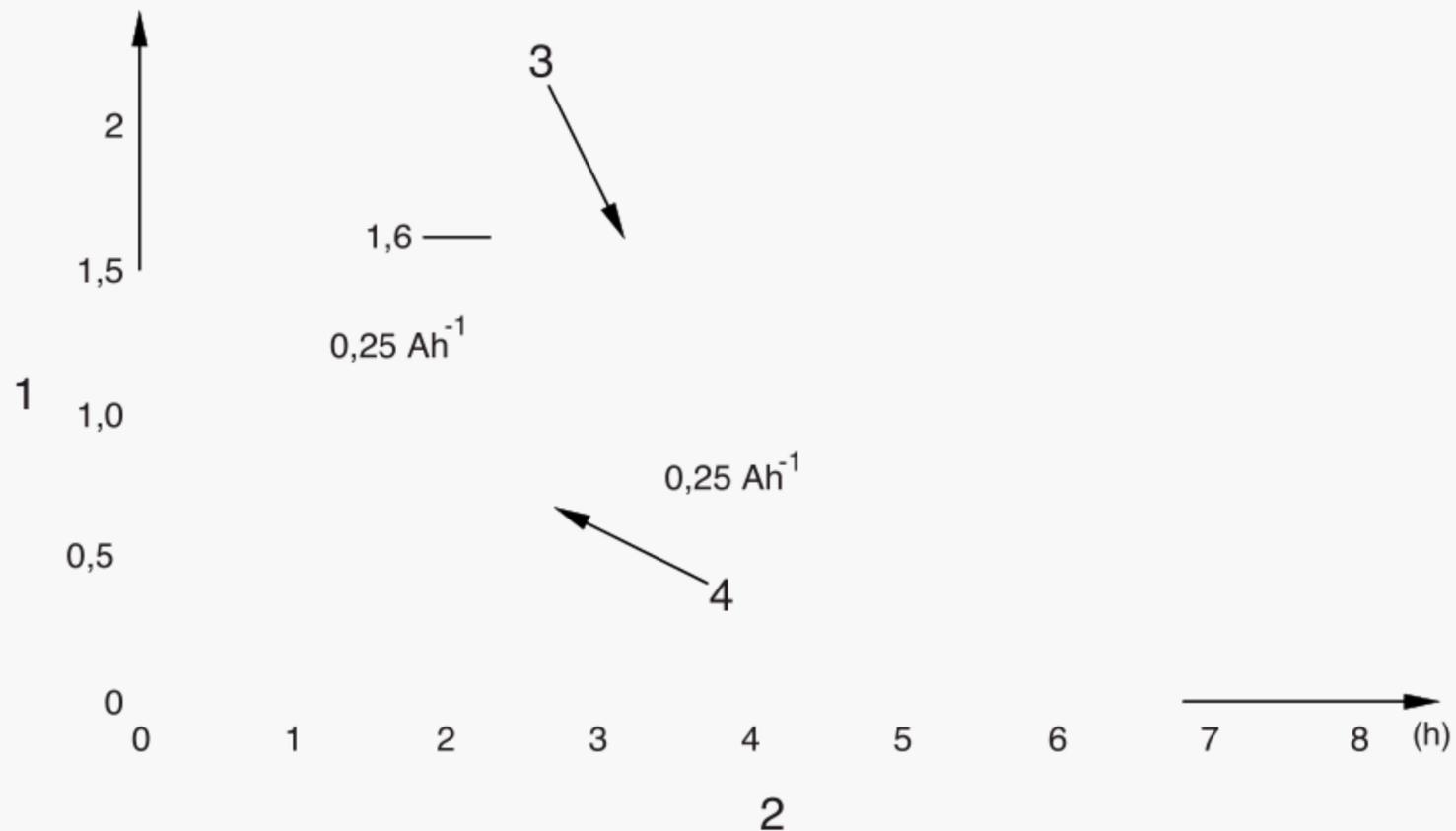
In order not to restrict the way in which compensation is achieved, 4.8 requires only that the time to alarm, for all rates of change greater than  $A/4$  per hour, does not exceed  $1,6 \times$  the time to alarm, if the compensation were not present.

If the threshold increases in a linear fashion with time in response to a rise in the sensor signal, and if the extent of the compensation is not limited, then the maximum rate of compensation allowed can be seen from Figure L.1 to be  $0,6A/6,4 = 0,094A$  per hour, since at this compensation rate the sensor output will reach the compensated threshold in exactly 6,4 h.

Although it has been assumed above that the threshold is compensated linearly and continuously, the process need not be linear or continuous. For example, the stepwise adjustment shown in Figure L.2 also meets the requirement since, in this case, an alarm is reached in 6 h, which is less than the limiting value of 6,4 h.



Furthermore, the rate of compensation need not be limited to  $0,094A$  per hour if the extent of the compensation is restricted to  $0,6A$ . The relatively rapid rate of compensation shown in Figure L.3 also meets the requirement in reaching an alarm condition in 6,4 hours. In this case the maximum rate of compensation will be limited only by the requirements of the test fires.



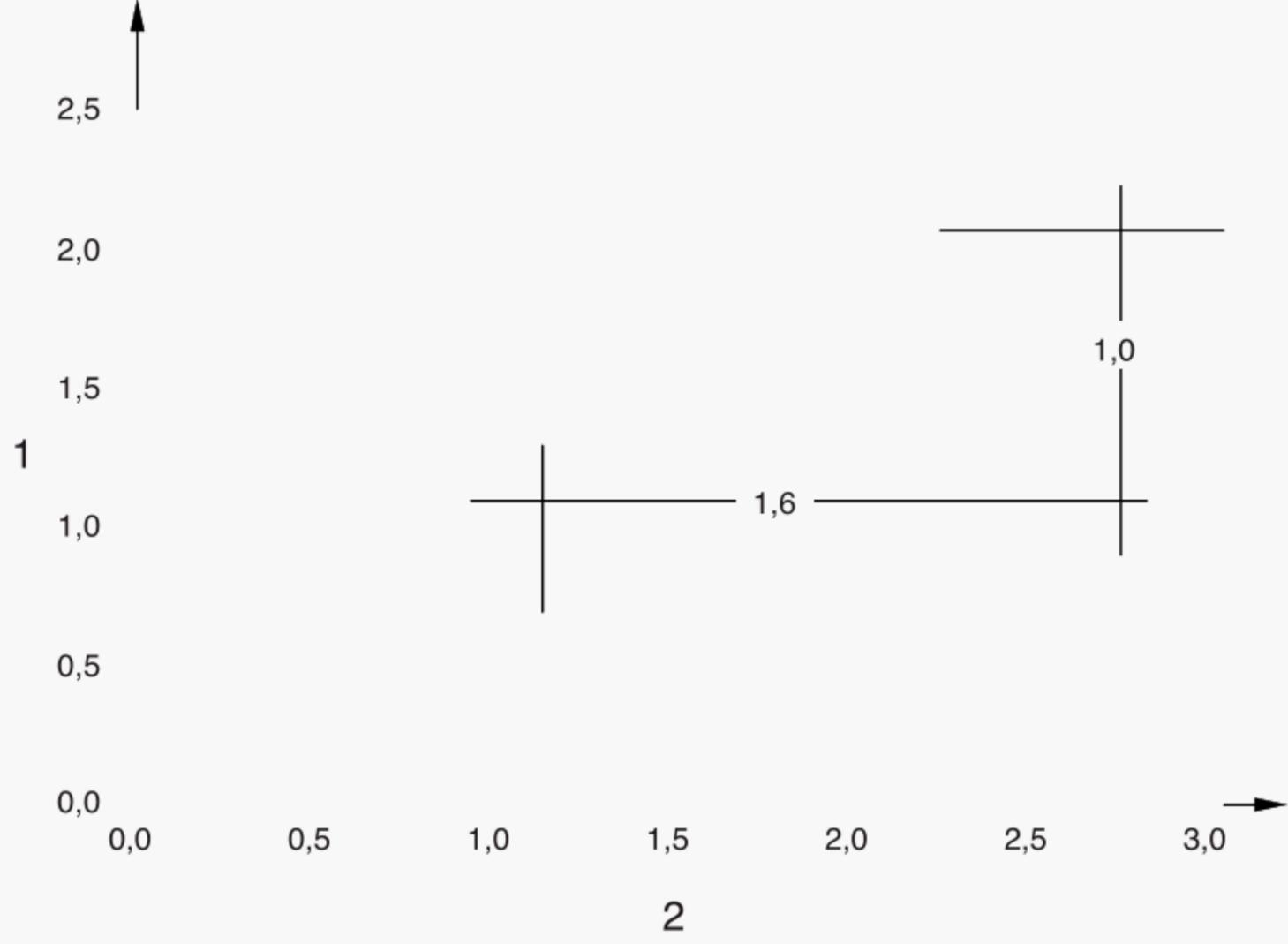
**Key**

- |   |                               |
|---|-------------------------------|
| 1 Relative alarm threshold (relative to $A$ ) | 3 Compensated alarm threshold |
| 2 Time  | 4 Sensor output               |

**Figure L.3 — High-rate, limited-extent compensation**

The requirements of 4.8 a) allow considerable freedom in the way in which compensation for slow changes is achieved. However, it is recognized that in any practical detector the range over which the output of the sensor is linearly related to smoke (or other stimulus which is equivalent to smoke) is finite. If the range of compensation takes the sensor output into this non-linear region then the sensitivity of the detector could become degraded to an unacceptable degree.

As an example, consider a detector having the transfer characteristic shown in Figure L.4, in which both axes are expressed in terms of response threshold value  $A$ . The non-linearity of the characteristic causes the effective sensitivity to reduce at higher values of stimulus. In this instance, it is necessary to limit the compensation to less than  $1,1 \times A$ , since in order to produce a change in output of  $A$ , the stimulus has to increase from  $1,1 \times A$  to  $2,7 \times A$ . This reduction in sensitivity by a factor of 1,6 represents the maximum allowed by 4.8 b).



**Key**

- 1 Output
- 2 Stimulus

**Figure L.4 — Example of non-linear transfer characteristic**

## Annex M (informative)

### Information concerning the construction of the measuring ionization chamber

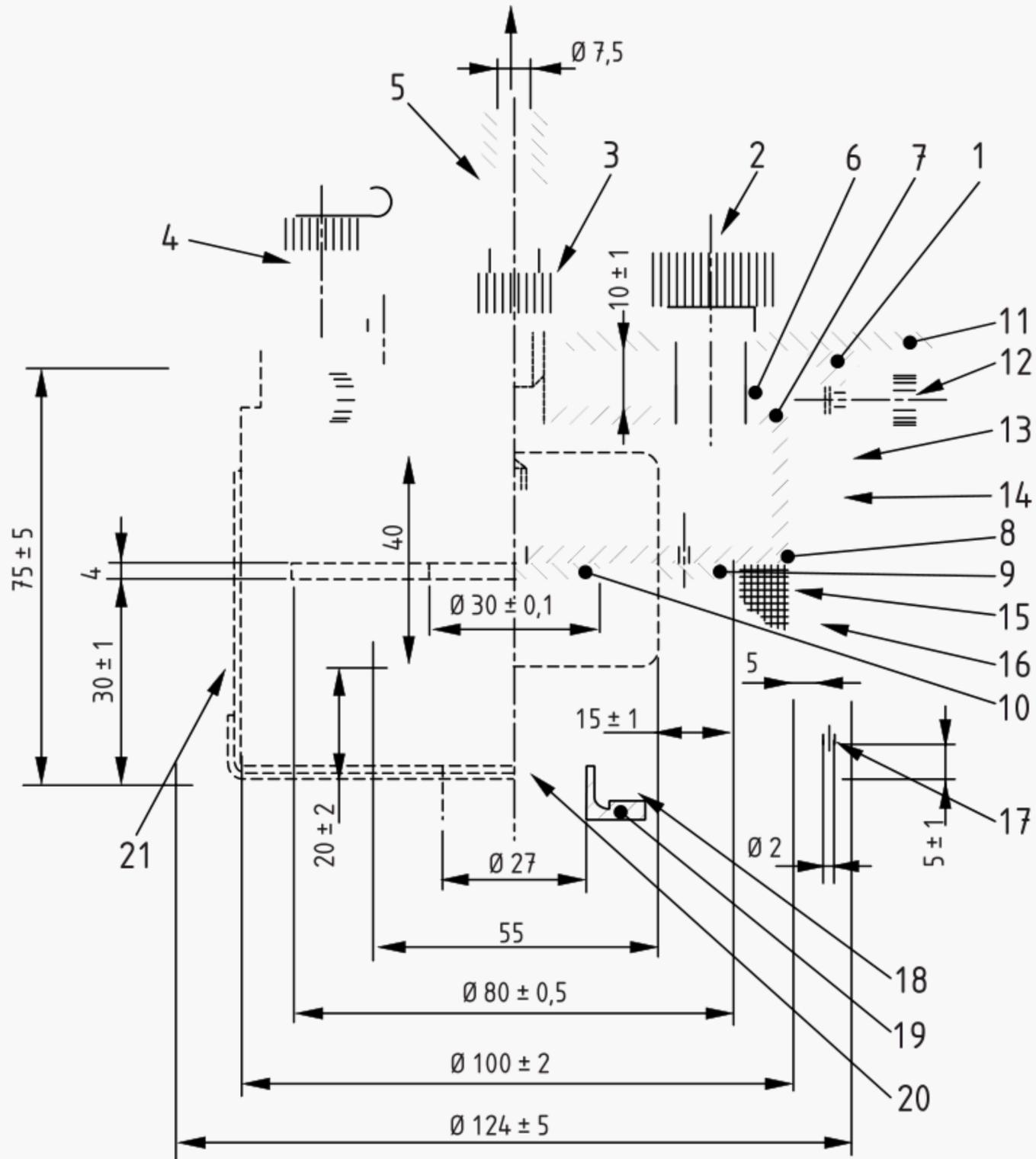
The mechanical construction of the measuring ionization chamber<sup>3)</sup> is shown in Figure M.1. The functionally important dimensions are marked with their tolerances. Further details of the various parts of the device are given in Table M.1.

**Table M.1 — List of parts of the measuring ionization chamber**

Reference No.	Item	Number provided	Dimensions, Special features	Material
1	Insulating ring	1		Polyamide
2	Multipole socket	1	10-pole	
3	Measuring electrode terminal	1	To chamber supply	
4	Measuring electrode terminal	1	To amplifier or current measuring device	
5	Suction nozzle	1		
6	Guide socket	4		Polyamide
7	Housing	1		Aluminium
8	Insulating plate	1		Polycarbonate
9	Guard ring	1		Stainless steel
10	Measuring electrode	1		Stainless steel
11	Assembly plate	1		Aluminium
12	Fixing screw with milled nut	3	M3	Nickel plated brass
13	Cover	1	Six openings	Stainless steel
14	Outer grid	1	Wire 0,2 mm diameter 0,8 mm internal mesh width	Stainless steel
15	Inner grid	1	Wire 0,4 mm diameter 1,6 mm internal mesh width	Stainless steel
16	Windshield	1		Stainless steel
17	Intermediate ring	1	With 72 equispaced holes each 2 mm diameter	
18	Threaded ring	1		Nickel plated brass
19	Source holder	1		Nickel plated brass
20	Source	1	27 mm diameter	See C.2.3
21	Openings on the periphery	6		

<sup>3)</sup> The measuring ionization chamber is fully described in "Investigation of ionization chamber for reference measurements of smoke density" by M. Avlund, published by DELTA Electronics, Venlighedsvej 4 DK-2970 Hørsholm, Denmark.

Dimensions in millimetres



NOTE 1: See Table M.1 for the list of parts.

NOTE 2: Dimensions without a tolerance marked are recommended dimensions.

**Figure M.1 — Mechanical construction of the measuring ionization chamber**

## **A<sub>2</sub>** Annex N (normative)

### **Additional requirements and test methods for smoke detectors with more than one smoke sensor**

#### **N.1 General**

In addition to the testing described in the rest of this standard, smoke detectors with more than one smoke sensor shall be tested as described in this annex to demonstrate the stability of each smoke sensor and its associated circuitry.

#### **N.2 Measurement of the response threshold value for smoke detectors with more than one smoke sensor**

The response threshold value of smoke detectors with more than one smoke sensor shall be measured as described in 5.1.5, in the same manner as for smoke detectors with a single smoke sensor, but with the following taken into account:

- if the smoke detector incorporates at least one scattered light or transmitted light sensor and at least one ionisation sensor then, in tests 5.2 to 5.17, the response threshold value shall be recorded consistently as either  $m$  or  $y$ , at the choice of the manufacturer;
- if the smoke detector incorporates only scattered light or transmitted light sensors then, in tests 5.2 to 5.17, the response threshold value shall be recorded as  $m$ ;
- if the smoke detector incorporates only ionisation sensors then, in tests 5.2 to 5.17, the response threshold value shall be recorded as  $y$ .

#### **N.3 Assessment of sensor stability**

In addition to the measurements of response threshold values made for the smoke detector in tests 5.2 to 5.17, response values shall be recorded for each smoke sensor. The response value for a particular smoke sensor shall be the aerosol density (expressed as  $m$  for sensors using scattered or transmitted light or  $y$  for sensors using ionisation) in the proximity of the detector at the moment that a predetermined event associated with that sensor occurs. The manufacturer may choose the predetermined event to be either the moment the detector signals an alarm due to the effects on that sensor only or the moment the sensor, with its associated circuitry, produces a predetermined signal.

The manufacturer shall provide the means for a measurement technique that allows the response of each smoke sensor with its associated circuitry to be assessed individually (e.g. the detector may provide outputs of the response data for each sensor or a method may be provided for switching off each sensor independently).

NOTE 1 To facilitate the making of reliable measurements, it is recommended that the predetermined signal is at a level which is normally produced by the sensor when the aerosol density in the proximity of the detector is within  $\pm 50\%$  of  $\bar{m}$  or  $\bar{y}$  as determined in 5.4. **A<sub>2</sub>**

**A<sub>2</sub>** NOTE 2 If possible, these response measurements may be made at the same time as the response threshold value measurements made on the detectors, or they may be made in separate tests on additional detectors or detectors, specially prepared to allow the monitoring of the predetermined events or signals mentioned above, or by a combination of these.

NOTE 3 In the interests of test economy, the additional or specially prepared detectors may be used for more than one test. In that case, the final measurements of the sensor response between tests on the same detector may be deleted and the final measurement made at the end of a test sequence on a detector. However, it should be noted that in the event of a failure, it may not be possible to identify which test exposure caused the failure.

These response measurements, for individual sensors, shall meet the ratio requirements specified for the response threshold values in tests 5.2 to 5.17.

NOTE 4 The requirements specifying minimum response threshold values are not applicable to these response measurements made on the individual sensors. **A<sub>2</sub>**

## **Annex ZA** (informative)

### **Clauses of this European Standard addressing essential requirements or other provisions of EU Directives**

#### **ZA.1 Scope and relevant clauses**

This European Standard has been prepared under the mandate M/109 given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard, shown in this annex, meet the requirements of the Mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the construction product covered by this European Standard for its intended use according to clause 1 (Scope) of this standard.

**WARNING:** Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

**NOTE 1** In addition to any specific clauses relating to dangerous substances contained in this standard, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). These requirements need also to be complied with, when and where they apply.

**NOTE 2** *An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA (CREATE, accessed through <http://europa.eu.int/comm/enterprise/construction/internal/hygiene.thm>)*

This annex ZA has the same scope, in relation to the products covered, as clause 1 of this standard. This annex establishes the conditions for the CE marking of point smoke detectors intended for the use shown below and identifies the relevant clauses applicable. **Annex ZA**



**Construction Product:** Smoke detectors — Point detectors using scattered light, transmitted light or ionization for fire detection and fire alarm systems for buildings.

**Intended use:** Fire Safety.

Table ZA.1 — Relevant clauses

Essential characteristics	Clauses in this European Standard	Mandated level(s)	Notes
Nominal activation conditions/Sensitivity, Response delay (response time) and Performance under fire conditions	4.8, 5.2, 5.3, 5.4, 5.6, 5.7, 5.18	None	
Operational reliability	4.2 to 4.7, 4.9 to 4.11		
Tolerance to supply voltage	5.5		
Durability of operational reliability and response delay; temperature resistance	5.8, 5.9		
Durability of operational reliability; vibration resistance	5.13 to 5.16		
Durability of operational reliability; humidity resistance	5.10, 5.11		
Durability of operational reliability; corrosion resistance	5.12		
Durability of operational reliability; electrical stability	5.17		

## ZA.2 Procedures for the attestation of conformity of point smoke detectors covered by this standard

### ZA.2.1 System of attestation of conformity

The mandate requires that the attestation of conformity system to be applied shall be that shown in Table ZA.2.

Table ZA.2 — Attestation of conformity system

Product	Intended use	Levels or classes	Attestation of conformity system
<i>Fire detection/Fire alarm:</i> Smoke detectors — Point detectors using scattered light, transmitted light or ionization	Fire safety	None	1
System 1: See CPD Annex III.2.(i), without audit-testing of samples			





This requires:

- a) Tasks to be provided by the manufacturer:
  - 1) factory production control (see ZA.2.2b);
  - 2) testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan;
- b) Tasks to be undertaken under the authority of a Notified Product Certification Body<sup>4</sup>:
  - 1) type testing of the product;
  - 2) inspection of the factory and factory production control;
  - 3) continuous/periodic surveillance, assessment and approval of the factory production control.

### ZA.2.2 Evaluation of conformity

The evaluation of conformity of point smoke detectors covered by this European Standard shall be by the following:

#### a) Type testing

Type testing of the product shall be carried out in accordance with the clauses shown in Table ZA.1. The products tested shall be representative of the manufacturer's normal production with regard to their construction, operation and calibration. Tests previously performed in accordance with the provisions of this standard may be taken into account providing that they were made to the same system of attestation of conformity on the same product or products of similar design, construction and functionality, such that the results may be considered applicable to the product in question. Wherever a change, for example in the product design, materials or supplier of the components or of the production process occurs, which could change significantly one or more of the characteristics, the type testing shall be repeated for the relevant product performance.

#### b) Factory production control

The manufacturer shall establish, document and maintain a permanent factory production control system to ensure that the products placed on the market conform with the stated performance characteristics. The factory production control system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control incoming materials or components, equipment, the production process and the product.

The production control procedure shall be adequately extensive and detailed so that the conformity of the products is made apparent to the manufacturer and so that irregularities can be detected at the earliest possible stage.

A factory production control system conforming with the requirements of EN ISO 9001, and made specific to the requirements of this standard, should be considered to satisfy the above requirements.

The production control procedure shall be recorded in a manual, which shall be made available for inspection.

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<sup>4</sup> A Notified Product Certification Body is an approved product certification body notified to the Commission by a member state, for this purpose, in accordance with article 18 of the Construction Products Directive (89/106/EEC).

The factory production control shall be recorded. These records shall be available for inspection and shall include at least the following:

- 1) identification of the product tested;
- 2) the dates of sampling;
- 3) the test methods applied;
- 4) the test and inspection results;
- 5) the date of tests;
- 6) the identification of the responsible authority within the factory;
- 7) calibration records;
- 8) actions taken.

### **ZA.3 CE Marking and labelling and accompanying documentation**

The CE marking symbol (in accordance with Directive 93/68/EEC) shall be placed on the product and be accompanied by:

- i) the identification number of the Notified Product Certification Body;
- ii) the number of the EC certificate of conformity.

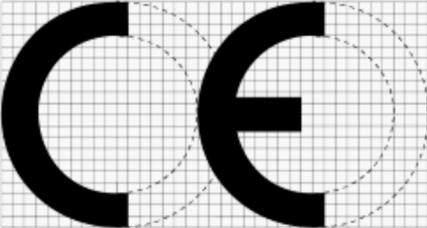
The CE marking symbol shall in addition be shown on the accompanying commercial documentation supplemented by:

- a) the identification number of the Notified Product Certification Body;
- b) the name or identifying mark and registered address of the manufacturer;
- c) the last two digits of the year in which the marking was affixed;
- d) the number of the EC certificate of conformity;
- e) the reference to this European Standard (EN 54-7);
- f) the description of the construction product (Point type smoke detector for fire detection and fire alarm systems for buildings);
- g) the type/model designation of the product;
- h) the data required by 4.10 or a reference to a document, which shall be uniquely identifiable and available from the manufacturer, containing these data.

Where the product exceeds the minimum performance levels stated in this standard, and where the manufacturer so desires, the CE marking may be accompanied by an indication of the parameter(s) concerned and the actual test result(s). **A1**



Figure ZA.1 gives an example of the information to be given on the commercial documents.

 0123
<b>AnyCo Ltd, P.O. Box 21, B1050</b>  <b>01</b>  0123 — CPD — 001
EN 54-7  Point type smoke detector (ionization)  ABC 123  Technical data: see Doc.123/2000 held by the manufacturer.

**Figure ZA.1 — Example of CE marking information on the accompanying commercial documentation**

#### **ZA.4 EC certificate and declaration of conformity**

The manufacturer, or his agent established in the EEA, shall prepare and retain a declaration of conformity, which authorizes the affixing of the CE marking. This declaration shall include:

- the name and address of the manufacturer, or his authorized representative established in the EEA, and the place of production;
- the description of the construction product (e.g. Point smoke detectors for fire detection and fire alarm systems for buildings);
- the type/model designation of the product;
- the provisions to which the product conforms (e.g. annex ZA of this EN);
- any particular conditions applicable to the use of the product (if necessary);
- the name and address (or identification number) of the Notified Product Certification Body;
- the name of and position held by the person empowered to sign the declaration on behalf of the manufacturer or of his authorized representative. 



The declaration shall contain a certificate of conformity with the following information:

- the name and address of the Notified Product Certification Body;
- the certificate number;
- the name and address of the manufacturer, or his authorized representative established in the EEA;
- the description of the construction product (e.g. Point smoke detectors for fire detection and fire alarm systems for buildings);
- the type/model designation of the product;
- the provisions to which the product conforms (e.g. annex ZA of this EN);
- any particular conditions applicable to the use of the product (if necessary);
- any conditions and period of validity of the certificate, where applicable;
- the name of and position held by the person empowered to sign the certificate.

The above mentioned declaration and certificate shall be presented (if requested) in the official language or languages of the Member State in which the product is to be used. 

## **Ⓐ** Bibliography

EN ISO 9001, *Quality management systems — Requirements (ISO 9001:2000)*. **Ⓐ**

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