INTERNATIONAL STANDARD

ISO 12239

Third edition
2021-11

Smoke alarms using scattered light, transmitted light or ionization

Dispositifs d'alarme de fumée fonctionnant suivant le principe de la diffusion de la lumière, de la transmission de la lumière ou de l'ionisation

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

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

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

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

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

This third edition cancels and replaces the second edition (ISO 12239:2010), which has been technically revised.

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

— This edition recognizes the introduction of combination and multi-criteria smoke alarms: smoke alarms that within the one housing provide multiple fire sensors.

— This edition recognizes the technology for open smoke alarms: smoke alarms where the detection of smoke occurs outside the smoke alarm enclosure.

— This edition permits the inclusion of a sensor within the smoke alarm that is unrelated to fire detection, e.g. carbon monoxide sensor.

— This edition introduces new requirements for:

  a) smoke alarms that derive their main power from the mains or a mains-derived source;

  b) external power supply equipment;

  c) temporary disablement facility;

  d) smoke alarms utilizing radio frequency links;

  e) assessment of wall-mounted smoke alarms.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document for smoke alarms is drafted on the basis of functions that are to be provided on all smoke alarms covered by this document, and optional functions with requirements which may additionally be provided. It is intended that the options will be used for specific applications, as recommended in application guidelines.

Each optional function is included as a separate entity, with its own set of associated requirements, in order to permit smoke alarms covered by this document with different combinations of functions to conform to this document.

Additional functions can also be provided, even if not specified in this document.

Smoke alarms using scattered light, transmitted light or ionization

IMPORTANT — Certain types of smoke alarms contain radioactive materials. The national requirements for radiation protection differ from country to country and they are not specified in this document. Such smoke alarms should, however, take into consideration the applicable national standards, which should take into consideration the recommendations of the Nuclear Energy Agency (NEA) of the Organization for Economic Co-operation and Development (OECD).

1 Scope

This document specifies requirements, test methods, performance criteria and manufacturers' instructions for smoke alarms that operate using scattered light, transmitted light or ionization, and are intended for household or similar residential applications.

For the testing of other types of smoke alarms, or smoke alarms working on different principles, this document is recommended only as guidance. Smoke alarms with special characteristics and developed for specific risks are not covered by this document.

This document allows, although it does not require, the inclusion within the smoke alarm of facilities for the following:

— visual fault condition indication;

— extended temperature-range operation;

— interconnection with other similar smoke alarms or accessories;

— temporary disablement;

— alarm silencing;

— signal frequency characteristics;

— standby power source low condition silence;

— smoke alarms with voice;

— smoke alarms using radio frequency links;

— response to slowly developing fires (drift compensation).

Where such facilities are included, this document specifies applicable requirements.

This document does not cover devices intended for incorporation in systems using separate control and indicating equipment. Such systems are specified in the ISO 7240 series.

2 Normative references

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

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

ISO 2919, *Radiological protection — Sealed radioactive sources — General requirements and classification*

ISO 7240-4, *Fire detection and alarm systems — Part 4: Power supply equipment*

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

ISO 7731, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

ISO 8201, *Alarm systems — Audible emergency evacuation signal — Requirements*

IEC 60065:2005, *20014, Audio, video and similar electronic apparatus — Safety requirements*

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

IEC 60068-2-1:2007, *Environmental testing — Part 2-1: Tests — Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing — Part 2-2: Tests — Test B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

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

IEC 60068-2-78:2012, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

IEC 60950-1:2005, *Information technology equipment — Safety — Part 1: General requirements*

IEC 61000-4-3, *Electromagnet compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated radio-frequency, electromagnetic field immunity test*

IEC 61672-1:2002, *Electroacoustics — Sound level meters — Part 1: Specifications*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
aerosol density
smoke density
amount of particulates per volume as described operationally by one of two parameters:

— *m* (3,14)

— *y* (3,28)

Note 1 to entry: Strictly speaking, these parameters are not concentrations, but represent values which are proportional to the concentration and have been shown to function in lieu of a true concentration value for the purposes of these tests.

3.2
alarm condition
audible signal specified by the manufacturer as indicating the existence of a fire

3.3
alarm-silence facility
means of temporarily silencing or desensitizing a smoke alarm after smoke has been detected

3.4
connectable device
device not conforming to this document, the operation of which will not jeopardize the performance of the connected smoke alarm(s)

3.5
audible alarm signal
audible signal intended to indicate an alarm condition

3.6
battery-low condition
combination of battery voltage and series resistance which results in a fault warning

3.7
combination smoke alarm
smoke alarm incorporating within one mechanical housing more than one fire sensor, with each sensor independently signalling a fire alarm condition, e.g. ionization and photoelectric

3.8
detachable smoke alarm
smoke alarm which consists of two components, the head and the base, and which allows them to be separated from each other for maintenance without damaging any of the components

3.9
fault condition
condition in which the smoke alarm is affected by an adverse condition of a component

3.10
fault warning
audible signal specified by the manufacturer as indicating the existence of an actual or incipient fault that may prevent an alarm condition

3.11
free-field conditions
conditions where there are a minimal number of sound wave or radio frequency wave reflecting or absorbing surfaces

3.12
interconnectable smoke alarm
smoke alarm which can be interconnected with other smoke alarms to provide a common alarm condition

3.13
least sensitive orientation
point of rotation, relative to air flow, about the vertical axis where a smoke alarm produces the maximum response threshold value

3.14
m
absorbance index
measured light attenuation characterizing the concentration of particulates in smoke or an aerosol

Note 1 to entry: The formula for *m* given in Annex C applies.

3.15
mains
AC supply from an electrical authority

3.16
main power source
source of power intended to supply the smoke alarm

3.17
most sensitive orientation
point of rotation, relative to air flow, about the vertical axis where a detector produces the minimum response threshold value

3.18
multi-criteria smoke alarm
smoke alarm incorporating within one mechanical housing a smoke sensor plus one or more additional sensors with all sensors separately monitored for the presence or absence of an output signal relating to fire development where the individual signal from each sensor is evaluated to determine when an alarm condition is reached

3.19
non-removable power source
internal power source, main or standby, integrated or fixed within the smoke alarm such that it is not intended as user-replaceable or serviceable

3.20
normal condition
condition in which the smoke alarm is supplied with power but is not giving either an alarm condition or a fault condition, but is able to give such signals if the occasion arises

3.21
open smoke alarm
optical smoke alarm with the sensing volume(s) outside its enclosure

3.22
radio frequency link
means of communication between at least two smoke alarm devices, using radio frequency wave propagation

3.23
response threshold
A_{th}
aerosol density in the proximity of the specimen at the moment that it generates an alarm condition, when tested as specified in 5.1.5

3.24
standby power source
source of power intended to supply the smoke alarm in the event that the main power source is unavailable

3.25
smoke alarm
device containing within one housing all the components, with or without an internal power source, necessary for detecting smoke and generating an alarm condition and which can comprise one or more parts such as a base (socket) and head (body)

3.26
temporary disablement facility
means of temporarily disabling or desensitizing a smoke alarm when it is in the normal condition

3.27
type A smoke alarm
type A
smoke alarm that does not contain radioactive materials

3.28
type B smoke alarm
type B
smoke alarm containing radioactive materials

3.29
y
dimensionless variable, reflecting the change in the current flowing in an ionization chamber as a known function of the concentration of particulates in the smoke or aerosol

Note 1 to entry: The formula for *y* is given in Annex C.

4 General requirements

4.1 Conformity

The manufacturer shall submit documentation which gives an overview of the product's design, components, materials and reliability prediction. This documentation shall contain sufficient detail for the design to be inspected and assessed for conformance with this document. Conformity assessment is the demonstration that the mandatory requirements relating to the product are fulfilled.

Combination and multi-criteria smoke alarms shall include a smoke sensor and irrespective of any additional sensor functionality, shall be tested to the requirements of this document.

Open smoke alarms shall be tested to the requirements of this document and the relevant clauses of ISO 7240-7.

The smoke alarm shall be resettable and:

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

b) shall be tested as specified in Clause 5;

c) shall meet the requirements of these tests; and

d) have a stated service life of at least 10 years under normal conditions of use.

4.2 Optional and additional functions

If an optional function is included, all the corresponding requirements shall be met.

Additional functions may be provided, even if not specified in this document. Where provided, such functions shall not jeopardize any function required by this document. Where non-fire sensors share functions of the smoke alarm such as the alarm sounder and visual alarm indicator, the indication shall be distinguishable from the smoke alarm indication.

NOTE Each optional function is included in a separate clause, with its own set of associated requirements, in order to permit smoke alarms covered by this document to have different combinations of functions and still conform to this document.

4.3 Smoke alarm type

The smoke alarm shall be one or both of the following types:

a) Type A

b) Type B

4.4 Response threshold value of detectors using scattered or transmitted light

Detectors using scattered or transmitted light shall conform to one of the two response threshold value bands specified in Table 1 and the corresponding end-of-test conditions for the test fires specified in 5.16.

Table 1 — Response threshold value for detectors using scattered or transmitted light

Band	Response threshold value in smoke tunnel (aerosol) dB/m	Test fires end-of-test conditions			
		TF2 dB/m	TF3 dB/m	TF4 dimensionless	TF5 dimensionless
1	$0{,}05 < m$	$m = 2$	$m = 2$	$y = 6$	$y = 6$
2	$0{,}2 < m$	$m = 2$	$m = 2$	$y = 6{,}5$	$y = 7{,}5$
NOTE The smaller the m value, the higher the sensitivity of the detectors.					

4.5 Alarm condition

4.5.1 Aural indicator

4.5.1.1 Signal temporal pattern

The smoke alarm aural signal temporal pattern shall be either:

a) the emergency evacuation signal defined in ISO 8201, or

b) the auditory danger signal defined in ISO 7731.

NOTE The selection of the signal temporal pattern is related to the installation requirement of the smoke alarm and can be a requirement of national regulation.

4.5.1.2 Signal sound pressure level — Optional function

The alarm condition aural indicator shall commence sounding at a level not greater than 45 dBA, rising gradually to the maximum level of not more than 105 dBA over a period of between 3 s to 10 s (see 5.18 and 5.19).

4.5.1.3 Signal frequency characteristics — Optional function

The audible alarm signal shall have a fundamental frequency of 520 Hz with odd harmonics to approximate a square wave.

4.5.2 Visual indicators

4.5.2.1 Interconnectable smoke alarms — Optional function

Interconnectable smoke alarms shall be provided with an integral red visual alarm condition indicator, by which the smoke alarm, when in alarm condition, may be identified. The indicator shall flash or be continuously illuminated when the alarm condition is present. Visual indicators shall not operate on interconnected smoke alarms that have not detected smoke. This visual indicator may also perform other additional functions, but the alarm condition indication needs to be distinct from any additional function.

4.5.2.2 Non-interconnectable smoke alarms

Smoke alarms that do not include an interconnection function shall be provided with an integral red visual alarm condition indicator. The indicator shall flash or be continuously illuminated when the

alarm condition is present. The indicator may be combined with the fault condition visual indicator. The failure of any visual alarm condition indicator shall not prevent the alarm condition.

4.6 External main power source-on visual indicator

A smoke alarm intended for connection to the mains or mains derived supply shall be provided with an integral green visual indicator. The indicator shall be continuously illuminated when the external main power is present. The failure of any visual external main power source-on indicator shall not prevent the alarm condition.

4.7 Fault condition visual indicator — Optional function

The smoke alarm shall be provided with an integral amber or yellow visual fault condition indicator. The indicator shall flash or be continuously illuminated when the fault condition is present. The indicator may be combined with the alarm condition visual indicator. The failure of any visual fault condition indicator shall not prevent the alarm condition.

4.8 Visual indicator visibility

All visual indicators shall be visible from a distance of at least 1 m and from at least one point when the smoke alarm is mounted in an ambient light intensity of 500 lux.

4.9 Smoke alarm signals

The following conditions shall apply to smoke alarms which employ features in addition to the requirements of this document:

— The audible alarm signal shall take precedence over any other signal, even when such other signal is initiated first.

— The audible alarm signal shall be distinctive from the signals of non-alarm condition functions. Use of a common sounder is permitted if distinctive signals are obtained.

— If an audible fault condition signal is provided, it shall be distinctive from the audible alarm signal but may be common to all functions employed.

— Any fault condition associated with features, in addition to the requirements of this document, shall not interfere with the operation and supervision of the smoke alarm.

4.10 Test facility

A test facility shall be provided to simulate the response of the sensing assembly to detect the presence of smoke. The test facility may be integral to the smoke alarm enclosure or remote to the smoke alarm.

The test facility shall be accessible from outside the smoke alarm when installed as specified in the installation instructions. Where the test facility is remote from the smoke alarm, it shall have the same functionality as the test facility integral to the smoke alarm itself and be labelled to identify the function of the control.

4.11 Means of calibration

The means of calibration shall not be readily adjustable after manufacture.

4.12 User-replaceable components

Except for batteries or fuses, a smoke alarm shall have no user-replaceable or serviceable components.

4.13 Main power source

4.13.1 General

The main power source of the smoke alarm may be internal or external to the smoke alarm housing.

4.13.2 Internal

Where the main power source is internal to the smoke alarm, the source shall meet the following requirements:

a) be capable of supplying the quiescent load of the smoke alarm together with the additional load resulting from weekly operation of the test facility for 10 s, loads due to the radio circuitry and radio frequency messages (if applicable), additional load of the interconnection test (if applicable) and the loads of any additional features not described in this document for at least 1 year before the battery-low condition is given.

b) provide a distinctive battery-low condition audible signal before the battery is incapable of operating for alarm condition purposes (see 5.17). The battery low condition shall consist of at least an audible indication but may include other forms of indication. Indication of the battery-low condition shall occur at least once every 120s.

c) at the point when a battery-low condition commences, it shall have sufficient capacity for the smoke alarm to produce an alarm condition, as specified in 5.18 or 5.19 as appropriate, for at least 4 min or, in the absence of smoke, a battery-low condition for at least 30 d. Smoke alarms with radio frequency link shall in addition be able to transmit at least one radio frequency alarm signal in the event of a fire.

d) be replaceable by the user, unless the power-source is non-removable and its operating life in the smoke alarm is 10 years or greater.

In the absence of suitable test procedures to verify battery capacity, data concerning the smoke-alarm loads and the battery characteristics shall be provided by the manufacturer to indicate that the above requirement can be met.

4.13.3 External

Where the main power source is external to the smoke alarm, an internal or external standby power source shall be provided (see 4.14).

4.14 Standby power source

4.14.1 General

4.14.1.1 For smoke alarms intended for connection to an external main power source, a standby power source shall be provided and the following requirements shall apply:

a) non-rechargeable standby power source: the standby power source shall be capable of meeting the requirements of 4.13.2.

b) rechargeable standby power source: the standby power source shall be capable of supplying the quiescent load of the smoke alarm for a minimum period of 72 h, followed by an alarm condition as specified in 5.18 or 5.19 as appropriate, for at least 4 min in the event of fire or, in the absence of smoke, a fault warning for at least 24 h. At the point when the battery fault warning commences, smoke alarms with radio frequency link shall in addition be able to transmit at least one radio frequency alarm signal in the event of a fire.

4.14.1.2 In the absence of suitable test procedures to verify the standby power source, data concerning the smoke alarm loads and the standby facility characteristics shall be provided by the manufacturer to indicate that the above requirements can be met.

4.14.2 Monitoring of standby power source

The standby power source shall be monitored for fault conditions. These conditions shall include battery-low condition and open- and short-circuit failure of the standby power source. User replaceable standby power sources shall be monitored by the smoke alarm. In each case, the audible low battery warning signal shall be given at least once every minute. Where external power supply equipment (see 4.15) is used, the low battery warning shall be given at the PSE.

4.14.3 Standby power source low condition silence — Optional function

Where a rechargeable-cell standby power source is used and the standby power source has become depleted due to a loss of main power source, it shall be permitted, upon the restoration of the main power source, to silence the battery low condition for a maximum of 24 h by the operation of a battery-low condition silence control.

NOTE This control can be common with the test control.

4.15 External power supply equipment

Where both the main and standby power sources are external to the smoke alarm and provided by separate power supply equipment (PSE) the PSE shall:

a) conform to ISO 7240-4.

b) monitor the power connection between the external power supply equipment and the smoke alarm(s). A fault in the power connection shall initiate a visual and audible fault indication at the PSE.

4.16 Battery connections

4.16.1 Except where a polarized connector is used, lead or terminal connections to batteries shall be identified with the correct polarity (e.g. plus or minus). The polarity may be indicated on the unit adjacent to the battery terminals or leads.

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

4.17 User-replaceable battery

4.17.1 General

Removal and replacement of user-replaceable batteries shall not require the use of tools or disassembly of the smoke alarm. This requirement does not apply to the removal of a detachable smoke alarm from its mounting base.

4.17.2 Indication

The removal of any user-replaceable battery shall result in a visual, mechanical or audible warning that the battery has been removed. The visual warning shall not depend upon a power source.

It shall not be possible to install a smoke alarm upon its mounting base or bracket unless the user replaceable battery has been correctly installed within the smoke alarm housing.

NOTE This requirement does not apply to a battery or batteries dedicated to additional features.

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

— a warning flag that will be exposed with the battery removed and the cover closed;

— a hinged cover or battery compartment that cannot be closed when the battery is removed;

— a unit that cannot be replaced upon its mounting base/bracket with the battery removed.

4.18 Electrical safety

The smoke alarm shall be designed and constructed so as to present no danger, either in normal use or under fault conditions, as determined by 5.28.

4.19 Battery — disconnect facility

Smoke alarms having an internal non-removable power source shall have a battery disconnect facility. The disconnect facility shall not require the disassembly of the smoke alarm. Where the smoke alarm is a detachable smoke alarm, the removal of the head from its base is not disassembly.

The status of the disconnection shall be unambiguous, e.g. the removal of the head from its base or the extinguishing of an indicator.

4.20 Connection of external connectable devices

The smoke alarm may provide for connections to external connectable devices by hard wiring, radio frequency or by another means (e.g. remote indicators, control relays, transmitters). The open- or short-circuit failure of these connections or disruption of the transmission path shall not prevent the correct operation of the smoke alarm.

4.21 Terminals for external conductors

4.21.1 The smoke alarm or base, as appropriate, if intended to have external connections, shall provide for the connection of conductors by means of screws, nuts or equally effective devices.

4.21.2 For externally-powered smoke alarms which utilize a “flying lead”-type connector, the connector shall be regarded as a conductor. “Flying lead”-type connectors shall be subjected to a pull test, such that when the connector is subjected to a pull of 20 N without jerks for 1 min in any direction allowed by the design, the connector does not become detached.

4.21.3 If terminals are provided, they shall allow the connection of conductors having nominal cross-sectional areas of between 0,4 mm^2 and 1,5 mm^2. Terminals shall be designed so that they clamp the conductor between metal surfaces without rotation of those surfaces but with sufficient contact pressure and without damage to the conductor. Disconnection of the conductors, or access to the conductors for disconnection, shall not be possible without the use of a tool.

4.22 Protection against the ingress of foreign bodies

The smoke alarm shall be designed so that a sphere of diameter 1,3 ± 0,05mm cannot enter into the sensor chamber(s). The design shall also prevent a rectangular probe of cross-section 1,0 ± 0,05 mm by 2,0 ± 0,05 mm from passing the outer surface of the smoke chamber.

NOTE This requirement is intended to restrict the access of insects into the sensitive parts of the smoke alarm. 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 the access holes can introduce the danger of clogging by dust, etc. It can, therefore, be necessary to take other measures.

4.23 Interconnectable smoke alarms — Optional function

4.23.1 General

If a means of connecting a number of smoke alarms to give a common alarm condition is provided, the following shall apply:

a) The audible alarm signal shall be emitted by all of the interconnecting smoke alarms when smoke is detected by any of the interconnected smoke alarms.

b) If the smoke alarms are provided with an alarm-silence facility, initiation of the alarm-silence period of one of the smoke alarms shall not prevent the audible alarm signal being emitted by that smoke alarm when smoke is detected by any of the other smoke alarms.

c) The interconnection of the maximum number of smoke alarms allowed by the manufacturer shall not have a significant effect on the sensitivity of the smoke alarms nor on their ability to meet the battery capacity (see 5.17) or sound output requirements (see 5.18 or 5.19 as applicable).

NOTE The maximum number of interconnected devices also includes the interconnection of connectable devices such as heat alarms.

d) For battery-operated smoke alarms, open- or short-circuits of the interconnecting leads either shall not prevent the smoke alarms from functioning individually or shall result in an alarm condition or fault condition.

4.24 Alarm-silence facility — Optional function

If means of temporarily silencing an alarm signal after the smoke alarm has entered an alarm condition is provided, the following shall apply.

The initiation of the alarm-silencing period shall require the operation of a manual control. This control may be the same as a manual control provided for the test facility (see 4.7). This control may be integral or separate to the smoke alarm.

a) Operation of the alarm-silencing control shall not lead to an alarm silencing for more than 15 min. The sensitivity of the smoke alarm shall be automatically restored within 15 mins of operation of the alarm-silence control. If the alarm-silence period is adjustable, it shall not be possible to set it to less than 5 mins or to more than 15 mins.

b) Silencing the smoke alarm having entered the alarm condition can lead to alarm silencing of any interconnected smoke alarm which has not entered the alarm condition.

c) Alarm silencing at an interconnected smoke alarm which is in the alarm condition can silence the audible alarm signal of any other interconnected smoke alarm, but not any other smoke alarm having entered the alarm condition.

d) Continuous operation of the alarm-silence control shall not lead to the audible alarm signal being silenced for more than 15 mins without an alarm condition or a fault warning occurring.

NOTE This requirement is intended to prevent the audible alarm signal from being permanently silenced due to accidental or deliberate jamming of the control.

e) The manual control may be integral to the smoke alarm or remote from the smoke alarm. Where the manual control is remote from the smoke alarm, it shall have the same functionality as the manual control integral to the smoke alarm itself and be labelled to identify the function of the control.

4.25 Temporary disablement — Optional function

If means of temporary disablement of a smoke alarm while in the normal condition is provided, the following apply:

a) The initiation of the temporary disablement shall require the operation of a manual control. This control may be integral to or separate to the smoke alarm.

b) Operation of the temporary disablement shall not lead to the smoke alarm being disabled or desensitized for more than 15 min. The sensitivity of the smoke alarm shall be automatically restored within 15 mins of operation of the temporary disablement control. If the temporary disablement or desensitize period is adjustable, it shall not be possible to set it to less than 5 mins or to more than 15 mins.

c) Temporary disablement of a specific smoke alarm shall not lead to the disablement or desensitizing of any interconnected smoke alarms.

d) A disabled or desensitized smoke alarm shall be capable of sounding the alarm signal when interconnected to a smoke alarm that enters an alarm condition.

e) Continuous operation of the temporary disablement control, on the smoke alarm or remote or both, shall not lead to the smoke alarm being disabled or desensitized for more than 15 mins without either an alarm signal or fault warning being given by the smoke alarm.

NOTE This requirement is intended to prevent the permanent loss of sensitivity due to accidental or deliberate jamming of the control.

f) Where the manual control is remote from the smoke alarm, it shall have the same functionality as the manual control integral to the smoke alarm itself and be labelled to identify the function of the control.

4.26 Radioactive material in type B smoke alarms

4.26.1 Direct contact with radioactive sources shall not be possible without the use of tools.

4.26.2 Radioactive sources shall be sealed in conformance with the relevant requirements of ISO 2919, with a minimum classification of C32222.

4.26.3 The normal activity of the radionuclide shall be not more than 37 kBq. Radium-226 shall not be used.

4.27 Smoke alarms with voice — Optional function

4.27.1 General

Smoke alarms using voice messages shall be capable of producing an audible warning signal and a voice message or messages.

All messages related to fire safety shall be declared by the manufacturer and shall be considered by the testing authority. The message determined to be worst-case shall be subject to a conformance assessment.

When selecting the worst-case message, message length, loudness and repetition timing should be considered.

4.27.2 Voice messages

For messages that require immediate action, the warning signal and message sequence broadcast by the device shall be within the following limits:

a) warning signal, lasting for 2 s to 10 s; followed by

b) silence, lasting for 0,25 s to 2 s; followed by

c) voice message; followed by

d) silence, lasting for 0,25 s to 5 s.

The time for each cycle shall not exceed 30 s.

The periods of silence can need to be longer than indicated in certain circumstances, for example in spaces with long reverberation times, but shall not be such that the time between the start of each cycle exceeds 30 s.

NOTE For other messages, it is permitted to extend either the silence period after the voice message or the period within which the message is repeated, or both.

4.28 Smoke alarms using radio frequency links — Optional function

4.28.1 General

For smoke alarms using radio frequency links for interconnection, subclauses 4.28.2, 4.28.3, 4.28.4 and 4.28.5 and Annex M shall apply.

4.28.2 Response time

The time from the transmission of a radio link signal and its processing by a receiver shall not be greater than 30 s.

4.28.3 Radio frequency link range

The radio frequency link shall have a minimum free field range of 100 m. Where the manufacturer specifies a range of greater than 100 m, the declared range shall be verified.

4.28.4 Identification code verification

Smoke alarms using radio frequency links for interconnection shall meet the following requirements:

a) have a sufficient coding scheme to prevent the triggering or receiving of alarms from another unrelated radio frequency smoke alarm system within the same radio range, and

b) have a minimum of 65 000 identification codes, or

c) provide a means to the user on site to choose an identification code from a minimum of 255 codes.

4.28.5 Environmental requirements for radio frequency interconnected smoke alarms

Equipment provided for the radio frequency link interconnection of smoke alarms shall function correctly when tested to the environmental requirements defined in this document.

4.29 Response to slowly developing fires (drift compensation) — Optional function

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

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

The smoke alarm shall be deemed to meet the requirements of this clause if this assessment shows the following:

a) that for any rate of increase in smoke density, R, which is greater than 25 % of the initial uncompensated response threshold value of the smoke alarm, $A_{th,u}$, per hour, the time for the smoke alarm to give an alarm does not exceed 1,6 × ($A_{th,u}$:R) by more than 100 s;

b) that the total compensation, C_t, is limited such that $C_t < 0{,}6\ A_{th,u}$ throughout this range, and that the fully compensated response threshold value, $A_{th,c}$, does not exceed its initial value, $A_{th,u}$, by a factor greater than 1,6.

4.30 Marking

4.30.1 General

Where any marking on the device uses symbols or abbreviations not in common use, these shall be explained in the documentation supplied with the smoke alarm.

Markings shall:

a) be visible during installation; and

b) shall be accessible during maintenance; and

c) shall not be placed on screws or other removable parts.

4.30.2 Smoke alarm

4.30.2.1 Each smoke alarm shall be legibly and indelibly marked with the following:

a) the number and date of this document (i.e. ISO 12239:2021);

b) the name or trademark and address of the manufacturer or supplier;

c) the model designation (type or number);

d) the type of smoke alarm (type A and/or type B) and an explanation of the meaning of the type designation;

e) the nominal sound level output as measured in 5.18 or 5.19 as appropriate;

f) the aural alarm condition signal (ISO 8201 or ISO 7731);

g) the extended temperature range if the smoke alarm has been assessed for use in extended temperatures (if applicable);

h) the date of manufacture or the batch number by which the manufacturer can identify the date or batch and place of manufacture and the version/revision of any software utilized within the smoke alarm;

i) the manufacturer's recommended date for replacement, subject to normal, regular maintenance (provision may be made for a place to note the date of change of the smoke alarm);

j) for smoke alarms incorporating user-replaceable batteries, the type and number of batteries recommended by the manufacturer and the following instruction to the user, which shall be visible during the operation of changing the batteries:

"Test the smoke alarm for correct operation using the test facility whenever the battery is replaced"

k) for smoke alarms incorporating non-replaceable batteries, the following warning which shall be visible during normal use:

"WARNING — Battery not replaceable — See instruction manual"

l) for type B, smoke alarms shall be permanently marked with the trefoil symbol, name of radionuclide and activity. Additional marking requirements may be required by national regulations, and include any additional advice regarding restrictions of trade, transport or disposal of the smoke alarm;

m) markings required in IEC 60065:2005, Clause 5, which may be on any external part of the smoke alarm, but it is not necessary for the specified markings to be visible after installation;

n) for class I apparatus in accordance with IEC 60065, the following information shall be visible near the mains input terminals:

"WARNING — THIS SMOKE ALARM MUST BE GROUNDED" and

if live parts are made accessible when a cover is removed or opened, a warning to that effect, which is visible before the cover is removed or opened;

o) a notice on the outer surface of the enclosure: DO NOT PAINT. The letters shall be not less than 3 mm high and plainly visible after the smoke alarm is installed in its intended manner;

p) for smoke alarms using scattered or transmitted light, the response threshold value band. Example Band 1 or (0,2 < *m*) dB/m.

4.30.2.2 Conformity shall be checked by visual inspection. The indelibility of the marking shall be checked by establishing that it cannot be removed when rubbed lightly with a piece of cloth soaked first with petroleum spirit then with water.

4.31 Packaging

The point-of-sale packaging shall be marked with the following:

a) the number and date of this document (i.e. ISO 12239:2021);

b) the model designation (type or number);

c) the type of smoke alarm (type A and/or type B) and an explanation of the meaning of the type designation;

d) the nominal sound level output as measured in 5.18 or 5.19 as appropriate;

e) the aural alarm condition signal (ISO 8201 or ISO 7731);

f) for smoke alarms using 520 Hz alarm condition signal frequency, the nominal frequency;

g) the smoke alarm is suitable for use in extended temperature range, if applicable;

h) for type B smoke alarms, permanently marked with the trefoil symbol, name of radionuclide and activity. The markings shall be visible from the outside of the packaging. Additional markings may

be required by national regulations and include any additional advice regarding restrictions of trade or disposal of the smoke alarm.

4.32 Hardware documentation

4.32.1 Hardware documentation necessary for conformity assessment to this document shall be provided.

4.32.2 Hardware documentation for the correct use of the smoke alarm shall be provided with each smoke alarm and shall include as a minimum the following:

a) Information detailing the product itself including all its functions and an explanation of all controls and indicators.

b) Information and instructions on siting, installation and maintenance.

c) Explanation of the interconnection provisions (if provided).

d) Explanation of possible programming or parameterization.

e) Instruction on the remote control (wireless/wired) of smoke alarm functions (if provided).

f) Detailed explanation for commissioning the smoke alarm to ensure correct operation.

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

h) Information stating which procedure should be followed or how to return the smoke alarm for repair or assessment if the smoke alarm fails to operate correctly.

i) For smoke alarms incorporating non-replaceable batteries, information on the action to be taken if a battery-low condition is indicated.

j) Information for interconnectable smoke alarms stating the maximum number of devices that may be interconnected. Such devices may be other than smoke alarms, e.g. Heat alarms.

k) Where applicable, information for interconnected smoke alarms detailing the suitable cables to be used.

l) Information for smoke alarms intended for connection to mains supplies including a warning that draws attention to the hazards associated with mains voltages and that recommends that the smoke alarm, together with any associated supply and interconnect wiring, be installed in accordance with appropriate national electrical installation regulations.

m) Where applicable, information for the interconnection of smoke alarms using radio frequency links and any precautions recommended.

n) Information detailing assessed temperature range if it is claimed that the smoke alarm is also suitable for use in extended temperature range.

o) Information detailing the suitability of the smoke alarm for use with non-sinusoidal power sources, e.g. modified sine wave or square wave inverters.

4.33 Additional requirements for software-controlled smoke alarms

4.33.1 General

For smoke alarms which rely on software control in order to fulfil the requirements of this document, the requirements of 4.33.2, 4.33.3 and 4.33.4 shall be met.

4.33.2 Software documentation

The manufacturer shall submit documentation which gives an overview of the software design. This documentation shall be sufficiently detailed for the design to be inspected for conformance with this document and shall include at least the following:

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

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

   2) the way in which the modules interact,

   3) the overall hierarchy of the program,

   4) the way in which the software interacts with the hardware of the smoke alarm,

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

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

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

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

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

b) description of each part of the program, containing at least:

   1) the name of the part,

   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 (CASE tools, compilers, etc.).

NOTE This detailed design documentation can be reviewed at the manufacturer's premises.

4.33.3 Software design

In order to ensure the reliability of the device, the following requirements for software design apply:

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

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

4.33.4 Storage of programs and data

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

4.33.4.2 Site-specific data shall be held in memory which retains data for at least two weeks without external power to the device, 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 Optional functions

If an option is taken, all the corresponding requirements shall be met.

Other functions may also be provided, even if not specified in this document. However, such options shall not contradict any requirements of this document and shall not, in case of a fault, jeopardize any function required by this document.

NOTE 1 Each optional function is included as a separate entity, with its own set of associated requirements, in order to permit smoke alarms covered by this document with different combinations of functions to conform to this document.

Two optional sound output levels are specified in this document. The options allow national regulators to specify minimum sound output levels (70 dBA or 85 dBA) as required under national regulations. In the absence of regulations, the louder of the two options should be installed.

NOTE 2 An optional extended temperature range test is included for smoke alarms installed in areas subject to a greater temperature range, such as leisure accommodation vehicles.

5.1.2 Atmospheric conditions for tests

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

— temperature: (15 to 35) °C

— relative humidity: (25 to 75) %

— air pressure: (86 to 106) kPa

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

5.1.3 Operating conditions for tests

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

The details of the power source used shall be given in the test report (see Clause 6).

5.1.4 Mounting arrangements

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

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

5.1.6 Measurement of response threshold value

Install the specimen for which the response threshold value is to be measured 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 air flow shall be the least sensitive orientation, as determined in the directional dependence test, unless otherwise specified in the test procedure.

Before commencing each measurement, purge the smoke tunnel with clean air 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 ± 0,04) m/s 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 ± 5) °C and shall not vary by more than 5 °C for all the measurements on a particular smoke-alarm type.

Connect the specimen to its power source as specified in 5.1.3 and allow it to stabilize for at least 15 mins.

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

— for smoke alarms using scattered or transmitted light, in decibels per metre per minute: $0{,}015 \leq \frac{\Delta m}{\Delta t} \leq 0{,}1$

— for smoke alarms using ionization, per minute: $0{,}05 \leq \frac{\Delta y}{\Delta t} \leq 0{,}3$

NOTE These ranges are intended to allow the selection of a convenient rate, depending upon the sensitivity of the smoke alarm, to obtain a response in a reasonable time.

The initially selected rate of increase in aerosol density shall be similar for all measurements on a particular smoke-alarm type.

All aerosol density measurements shall be made in the proximity of the specimen.

The response threshold value is the aerosol density (m or y) at the moment that the specimen gives an alarm condition. This shall be recorded as m, expressed as decibels per metre (dB/m), for smoke alarms using scattered or transmitted light, or as y for smoke alarms using ionization (Annex C applies).

5.1.7 Provision for tests

Provide the following for testing conformance with this document:

a) 20 specimens and in addition the number of specimens necessary for the interconnection test and the electrical safety test as specified in 5.21 and 5.28 respectively;

b) the data specified in 4.20 and 4.25;

c) design documentation (e.g. drawings, parts lists, block diagrams and descriptions of the principles of operation of the test facility).

The specimens submitted shall be deemed representative of the manufacturer's normal production with regard to their construction and calibration. This implies that the mean response threshold value of the 20 specimens found in the initial sensitivity test (5.3) should also represent the production mean, and that the limits specified in the initial sensitivity test should also be applicable to the manufacturer's production.

5.1.8 Test schedule

Number the smoke alarms as specified in 5.3.2. Carry out the tests, as specified in Table 2, on each smoke alarm in the order in which they are listed.

5.1.9 Test report

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

Table 2 — Test schedule

Test	Subclause	Specimen no(s).
Directional dependence	5.2	One chosen arbitrarily
Initial sensitivity	5.3	All specimens
Repeatability	5.4	One chosen arbitrarily
Air movement	5.5	1
Dazzling[a]	5.6	2
Dry heat (operational)	5.7	3
Cold (operational)	5.8	4
Damp heat (operational)	5.9	5
Sulfur dioxide (SO_2) corrosion	5.10	6, 7
Impact	5.11	8
Vibration (operational)	5.12	9
Vibration (endurance)	5.13	9
Extended temperature	5.14	3, 4
Electromagnetic compatibility (EMC) immunity tests (operational)	5.15	
Mains-supply voltage dips and short interruptions		2
Electrostatic discharge		10
Radiated electromagnetic fields		11
Conducted disturbance induced by electromagnetic fields		12
Fast transient bursts		13
Slow high energy transients		14
Fire sensitivity	5.16	17, 18 19, 20

[a] This test applies only to smoke alarms using a scattered light or transmitted light principle of operation.

[b] Sound output shall be tested as specified in either 5.18 or 5.19 as nominated by the manufacturer.

[c] Number of specimens depends on manufacturer's specification.

[d] This test only applies to smoke alarms with a standby power source.

Table 2 *(continued)*

Test	Subclause	Specimen no(s).
Battery-low condition	5.17	1, 15
Sound output[b]	5.18 or 5.19	1, 15
Sounder durability	5.20	3, 4, 5, 6, 7
Interconnectable smoke alarms	5.21	21[c]
Smoke alarms using radio frequency links	5.22	Additional specimens required
Alarm-silence facility	5.23	16
Temporary disablement facility	5.24	16
Variation in supply voltage	5.25	20
Polarity reversal	5.26	20
Standby power source[d]	5.27	1, 15
Electrical safety	5.28	Additional specimens (as required)
Sequence timing for smoke alarms with voice	5.29	2, 3

[a] This test applies only to smoke alarms using a scattered light or transmitted light principle of operation.

[b] Sound output shall be tested as specified in either 5.18 or 5.19 as nominated by the manufacturer.

[c] Number of specimens depends on manufacturer's specification.

[d] This test only applies to smoke alarms with a standby power source.

5.2 Directional dependence

5.2.1 Object of test

The object of the test is to show that the sensitivity of the specimen is not unduly dependent on the direction of air flow around the smoke alarm.

5.2.2 Test procedure

Measure the response threshold value of the specimen to be tested eight times as specified in 5.1.6 with 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.

Designate the maximum response threshold value y_{max} or m_{max} and the minimum value as y_{min} or m_{min}.

Record the least sensitive orientation and the most sensitive orientation. The orientation for which the maximum response threshold is measured is referred to as the least sensitive orientation, and the orientation for which the minimum response threshold is measured is referred to as the most sensitive orientation.

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 not be less than 0,2, or m_{min} shall not be less than 0,05 dB/m.

5.3 Initial sensitivity

5.3.1 Object of test

The object of the test is to establish the sensitivity of each specimen prior to testing. This will be used as a baseline for some of the other tests.

5.3.2 Test procedure

Measure the response threshold value of the specimen as specified in 5.1.6. Number the smoke alarms in order of sensitivity, No. 1 having the lowest response threshold and No. 20 having the highest response threshold.

Designate the maximum response threshold value as y_{max} or m_{max} and the minimum value as y_{min} or m_{min}. Calculate the mean of these response threshold values and designate it as $\bar{y}$ or $\bar{m}$.

5.3.3 Requirement

The following relationships shall apply: y_{max}: $\bar{y}$ or m_{max}: $\bar{m} \leq 1{,}33$ and $\bar{y} : y_{min}$ or $\bar{m} : m_{min} \leq 1{,}5$.

5.4 Repeatability

5.4.1 Object of test

The object of the test is to show that the specimen has stable behaviour with respect to its sensitivity even after a number of alarm conditions.

5.4.2 Test procedure

Measure the response threshold value of the specimen to be tested six times as specified in 5.1.6.

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

Designate the maximum response threshold value as y_{max} or m_{max} and the minimum value as y_{min} or m_{min}.

5.4.3 Requirements

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

The lower response threshold value y_{min} shall be not less than 0,2.

The lower response threshold value m_{min} shall be not less than:

— 0,05 dB/m for detectors with a declared response threshold of band 1, or

— 0,2 dB/m for detectors with a declared response threshold value of band 2.

The higher response threshold value m_{max} shall be the value reached prior to end test condition.

5.5 Air movement

5.5.1 Object of test

The object of the test is to show that the sensitivity of the specimen 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.

5.5.2 Test procedure

Measure the response threshold value of the specimen to be tested as specified in 5.1.6 in the most and least sensitive orientations, as determined in 5.3. Designate these appropriately as $y_{(0,2)max}$ and $y_{(0,2)min}$ or $m_{(0,2)max}$ and $m_{(0,2)min}$.

Repeat these measurements, but with an air velocity in the proximity of the smoke alarm of (1 ± 0,2) m/s. Designate the response threshold values in these tests as $y_{(1,0)max}$ and $y_{(1,0)min}$ or $m_{(1,0)max}$ and $m_{(1,0)min}$.

For ionization-chamber smoke alarms, subject the specimen to be tested, in its most sensitive orientation, to an aerosol-free air flow at a velocity of (5 ± 0,5) m/s for a period of 5 min.

5.5.3 Requirements

One of the following relationships shall apply:

— for smoke alarms using ionization:

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

— for smoke alarms using scattered or transmitted light:

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

The smoke alarm shall not emit either a fault condition or an alarm condition during the test with aerosol-free air.

5.6 Dazzling

5.6.1 Object of test

The object of the test is to show that the sensitivity of the specimen is not unduly influenced by the close proximity of artificial light sources. This test is applied only to smoke alarms using scattered light or transmitted light, as ionization chamber smoke alarms are considered unlikely to be influenced.

5.6.2 Test procedure

Install the dazzling apparatus (in accordance with Annex D) in the smoke tunnel (in accordance with Annex A). Install the specimen in the dazzling apparatus in the least sensitive orientation and connect it to its supply and monitoring equipment.

Perform the following procedure:

a) Measure the response threshold value as specified in 5.1.6.

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

c) Switch the four lamps ON again and after at least 1 min, measure the response threshold value as specified in 5.1.6, with the lamps ON.

d) Then switch the four lamps OFF.

Repeat a) to d), but with the detector rotated 90° in one direction (either direction can be chosen) from the least sensitive orientation.

For each orientation, designate the maximum response threshold value as m_{max} and the minimum response threshold value as m_{min}.

5.6.3 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 not emit either an alarm or a fault signal.

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

5.7 Dry heat (operational)

5.7.1 Object of test

The object of the test is to demonstrate the ability of the specimen to function correctly at high ambient temperatures, which may occur for short periods in the service environment.

5.7.2 Test procedure

5.7.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2:2007, Test Bb, and in 5.7.2.2 to 5.7.2.5.

5.7.2.2 State of specimen during conditioning

Mount the specimen to be tested as specified in 5.1.4 in the smoke tunnel (in accordance with Annex A), in its least sensitive orientation, and connect it to its supply and monitoring equipment as specified in 5.1.3.

5.7.2.3 Conditioning

Condition the specimen as follows:

temperature: Starting at an initial air temperature of (23 ± 5) °C, increase the air temperature to (40 ± 2) °C.

duration: Maintain this temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of ≤ 1 K/min for the transitions to and from the conditioning temperature.

5.7.2.4 Measurements during conditioning

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

5.7.2.5 Final measurements

Measure the response threshold value as specified in 5.1.6, but at a temperature of (40 ± 2) °C.

Of the two response threshold values measured for the specimen in this test and in the initial sensitivity test, designate the greater as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.7.3 Requirements

No alarm condition or fault condition 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.

5.8 Cold (operational)

5.8.1 Object of test

The object of the test is to demonstrate the ability of the specimen to function correctly at low ambient temperatures, which may occur for short periods in the service environment.

5.8.2 Test procedure

5.8.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1:2007, Test Ab, and in 5.8.2.2 to 5.8.2.5.

5.8.2.2 State of specimen during conditioning

Mount the specimen to be tested as specified in 5.1.4 in the smoke tunnel specified in Annex A, in the least sensitive orientation, with an initial air temperature of (23 ± 5) °C, and connect it to its power source as specified in 5.1.3.

5.8.2.3 Conditioning

Condition the test specimen as follows:

temperature: Starting at an initial air temperature of (23 ± 5) °C, decrease the air temperature in the tunnel to (0 ± 2) °C, at a rate not exceeding 1 K/min, and maintain this temperature for 2 h.

duration: Maintain this temperature for 2 h.

NOTE Test Ab specifies rates of change of temperature of ≤ 1 K/min for the transitions to and from the conditioning temperature.

5.8.2.4 Measurements during conditioning

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

5.8.2.5 Final measurements

Measure the response threshold value as specified in 5.1.6, but at a temperature of (0 ± 2) °C.

Of the two response threshold values measured for the specimen in this test and in the initial sensitivity test, designate the greater as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.8.3 Requirement

No alarm condition or fault condition shall be given during the transition to or 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.

5.9 Damp heat (operational)

5.9.1 Object of test

The object of the test is to demonstrate the ability of the specimen to function correctly after exposure to high relative humidity (without condensation) and temperature, which may occur for short periods in the service environment.

5.9.2 Test procedure

5.9.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78:2012, Test Cab, and in 5.9.2.2 to 5.9.2.5.

5.9.2.2 State of the specimen during conditioning

Mount the specimen to be tested as specified in 5.1.4 in the smoke tunnel described in Annex B, in its least sensitive orientation, with an initial air temperature of (23 ± 5) °C, and connect it to its power source as specified in 5.1.3.

5.9.2.3 Conditioning

Condition the test specimen as follows.

— expose the specimen to be tested to an initial air temperature of (40 ± 2) °C, and a relative humidity of less than 45 %.

— after 2 h, increase the relative humidity to (93 ± 3) % over a period of 1 h. Maintain this temperature and humidity for a period of 4 d.

— allow the specimen to recover for a period of 1 h to 2 h at standard laboratory conditions.

5.9.2.4 Measurements during conditioning

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

5.9.2.5 Final measurements

Measure the response threshold value as specified in 5.1.6.

Of the two response threshold values measured for the specimen in this test and in the initial sensitivity test, designate the greater as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.9.3 Requirements

No alarm condition or fault condition 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.

5.10 Sulfur dioxide (SO_2) corrosion

5.10.1 Object of test

The object of the test is to demonstrate the ability of the specimen to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

5.10.2 Test procedure

5.10.2.1 Reference

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-42, but carry out the conditioning as specified in 5.10.2.2 to 5.10.2.4.

5.10.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.4. Do not supply it with power during the conditioning, but equip it with untinned copper wires, of the appropriate diameter, connected to a sufficient number of terminals to allow the final measurement to be made without making further connections to the specimen.

5.10.2.3 Conditioning

Condition the test specimen as follows:

— temperature: (25 ± 2) °C;

— relative humidity: (93 ± 3) %;

— SO_2 concentration: (25 ± 5) µl/l;

— duration: 21 d.

5.10.2.4 Final measurements

Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, ≤ 50 % RH, followed by a recovery period of 1 h to 2 h at standard laboratory conditions. After this recovery period, measure the response threshold value as specified in 5.1.6.

Designate the greater of the response threshold values measured in this test and that measured for the same specimen in the initial sensitivity test as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.10.3 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.

5.11 Impact (operational)

5.11.1 Object of test

The object of the test is to demonstrate the immunity of the specimen to mechanical impacts upon its surface, which it may sustain in the normal shipping, installation and service environments, and which it can reasonably be expected to withstand.

5.11.2 Test procedure

5.11.2.1 Apparatus

The test apparatus shall consist of a swinging hammer incorporating a rectangular-section aluminium-alloy head (aluminium alloy Al Cu4SiMg conforming with ISO 209, solution- and precipitation-treated condition) with the plane impact face chamfered to an angle of 60° to the horizontal, when in the striking position (i.e. when the hammer shaft is vertical). The apparatus shall be as described in Annex E.

5.11.2.2 State of the specimen during conditioning

Mount the specimen rigidly to the apparatus by its normal mounting means and position it 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 hammerhead is moving horizontally). Choose the azimuthal direction and the position of impact relative to the specimen as that most likely to impair the normal functioning of the specimen.

Connect the specimen to its power source as specified in 5.1.3.

5.11.2.3 Conditioning

Use the following test parameters during the conditioning:

— impact energy: (1,9 ± 0,1) J;

— hammer velocity: (1,5 ± 0,13) m/s;

— number of impacts: 1.

5.11.2.4 Measurements during conditioning

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

5.11.2.5 Final measurements

After the conditioning, measure the response threshold value as specified in 5.1.6.

Designate the greater of the response threshold values measured in this test and that measured for the same specimen in the initial sensitivity test as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.11.3 Requirements

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

The impact shall not detach the smoke alarm from its base, or the base from the mounting.

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 Vibration, sinusoidal (operational)

5.12.1 Object of test

The object of the test is to demonstrate the immunity of the specimen to vibration at levels considered appropriate to the normal shipping, installation, and service environment.

5.12.2 Test procedure

5.12.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6:2007, Test Fc, and in 5.12.2.2 to 5.12.2.5.

5.12.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.4 and connect it to its power source as specified in 5.1.3.

Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

5.12.2.3 Conditioning

Condition the test specimen as follows:

— frequency range: (10 to 150) Hz;

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

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 1/axis.

The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. Only one final measurement then needs to be made.

5.12.2.4 Measurements during conditioning

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

5.12.2.5 Final measurements

After conditioning, visually inspect the specimen both internally and externally for mechanical damage. Then measure the response threshold as specified in 5.1.6.

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

Designate the greater of the response threshold values measured in this test and that measured for the same specimen in the initial sensitivity test as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.12.3 Requirements

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

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

5.13 Vibration, sinusoidal (endurance)

5.13.1 Object of test

The object of the test is to demonstrate the ability of the specimen to withstand the long-term effects of vibration at levels appropriate to the shipping, installation and service environments.

5.13.2 Test procedure

5.13.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6:2007, Test Fc, and in 5.13.2.2 to 5.13.2.4.

5.13.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.4, but do not supply it with power during conditioning.

Apply the vibration to each of three mutually perpendicular axes in turn, and so that one of the three axes of applied vibration is perpendicular to the normal mounting axis of the specimen.

5.13.2.3 Conditioning

Condition the test specimen as follows:

— frequency range: (10 to 150) Hz;

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

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 20/axis.

The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning for one axis before changing to the next axis. Only one final measurement then needs to be made.

5.13.2.4 Final measurements

After conditioning, measure the response threshold value as specified in 5.1.6.

Designate the greater of the response threshold values measured in this test and that measured for the same specimen in the initial sensitivity test as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.13.3 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.

5.14 Extended temperature (operational) — optional function

5.14.1 Object of test

The object of the test is to demonstrate the ability of the specimen to function correctly in an extended temperature range.

5.14.2 Test procedure

Mount the specimen to be tested in the smoke tunnel described in Annex B, in its least sensitive orientation, with an initial air temperature of (23 ± 5) °C, and connect it to its power source as specified in 5.1.3.

Apply the following temperature cycle 10 times:

a) Raise the temperature to (65 ± 2) °C in (2 ± 0,5) h.

b) Hold the temperature at (65 ± 2) °C until 8,5 h after the beginning of the cycle.

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

d) Hold the temperature at (–10 ± 2) °C until 19,5 h after the beginning of the cycle.

e) Increase the temperature to (23 ± 5) °C in (2 ± 0,5) h.

f) Hold the temperature at (23 ± 5) °C until 24 h after the beginning of the cycle.

After each cycle of temperature conditioning has been completed, measure the response threshold value as specified in 5.1.6, but at a temperature of (0 ± 2) °C.

Of the 10 response threshold values measured for the specimen in this test and the initial sensitivity test, designate the greater as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.14.3 Requirement

No alarm condition or fault condition 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.

5.15 Electromagnetic compatibility (EMC) immunity tests (operational)

5.15.1 Carry out the following EMC immunity tests as specified in IEC 62599-2:

a) mains-supply voltage dips and short interruptions;

b) electrostatic discharge;

c) radiated electromagnetic fields;

d) conducted disturbances induced by electromagnetic fields;

e) fast transient bursts at a repletion rate of 100Hz;

f) slow high-energy voltage surges.

5.15.2 For these tests, the criteria for conformance specified in IEC 62599-2 and the following shall apply.

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

   — Measure the response threshold value as specified in 5.1.6.

   — Designate the greater of the response threshold values measured in this test and that measured for the same specimen in the initial sensitivity test as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

b) The required operating condition shall be as specified in 5.1.3.

c) The acceptance criteria for the functional test after the conditioning shall be that 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 Fire sensitivity

5.16.1 Object of test

The object of the test is to demonstrate the ability of the specimen to respond to a broad spectrum of smoke types as required for general application in residences.

5.16.2 Test procedure

5.16.2.1 Principle of test

The specimens are mounted in a standard fire test room (in accordance with Annex F) and exposed to a series of test fires designed to produce smoke representative of a wide spectrum of types of smoke and smoke flow conditions.

5.16.2.2 Test fires

Subject the specimens determined in 5.3 to the four test fires, TF2 to TF5.

NOTE Test fire 1 (TF1) is not considered applicable to this document.

The type, quantity and arrangement of the fuel and the method of combustion shall be as described for each test fire in Annexes G to J, 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, t, fall within the specified limits, up to the time when all of the specimens have generated an alarm condition, 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 can be necessary, to adjust the quantity and arrangement of the fuel to obtain valid test fires.

5.16.2.3 Mounting of the specimens

Mount the specimens 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.

For smoke alarms intended for wall-mounting only, mount the four specimens (Nos. 17 to 20) within 0,5 m of the middle of the long walls as shown in Annex G with specimen Nos. 18 and 19 closest to the ceiling, and specimen Nos. 17 and 20 furthest removed from ceiling, consistent with the manufacturer's instructions.

For smoke alarms intended for either ceiling or wall mounting, mount specimen Nos. 17 and 18 on the ceiling within the designated area and mount specimen Nos. 19 and 20 on the walls as described above.

Connect each specimen to its power source as specified in 5.1.3 and allow it to stabilize in its quiescent condition before the start of each test fire.

5.16.2.4 Initial conditions

IMPORTANT — The stability of the air and temperature affects the smoke flow within the room. This is particularly important for the test fires which produce low thermal lift for the smoke (e.g. TF2 and TF3). Therefore, the difference between the temperature near the floor and the ceiling should be < 2 °C, and 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.

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

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

— temperature, T: (23 ± 5) °C;

— air movement: negligible;

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

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

5.16.2.5 Recording of the fire parameters and response values

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

Table 3 — Fire parameters

Parameter	Symbol	Unit
Temperature change	ΔT	K

Table 3 *(continued)*

Parameter	Symbol	Unit
Smoke density (ionization)	y	(dimensionless)
Smoke density (optical)	m	dB/m

The alarm condition given by the specimen shall be taken as the indication that a smoke alarm has responded to the test fire.

Record the time of response (alarm condition) of each specimen, along with ΔT_a, y_a, and m_a, the fire parameters at the moment of response. A response of the smoke alarm after the end-of-test condition is ignored.

NOTE $_a$ indicates the designated value at entering the alarm condition.

5.16.3 Requirements

All four specimens shall generate an alarm condition in each test fire before the specified end-of-test condition.

5.17 Battery-low condition

5.17.1 Object of test

The object of the test is to demonstrate that a specimen will give a battery-low condition before an increase in the internal resistance or decrease in the terminal voltage of the battery prevents correct operation.

NOTE Where this test method is not appropriate to apply, an alternative method can be agreed between the manufacturer and the test house.

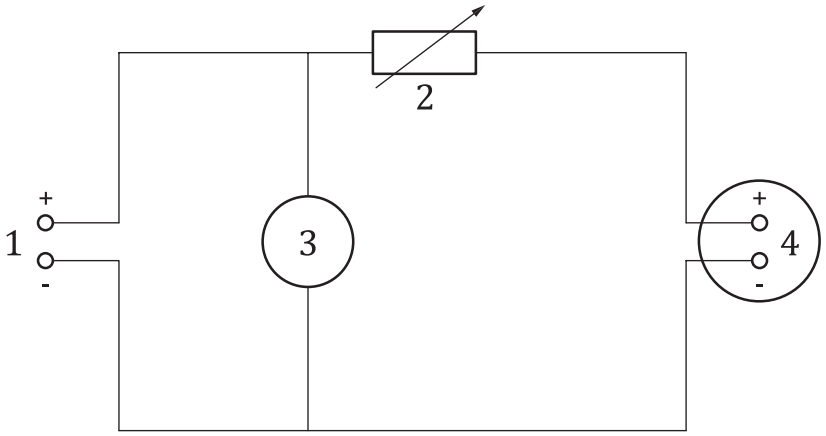
5.17.2 Test procedure

Connect the smoke alarm as shown in Figure 1.

With the series resistor, R, set to 0 and the supply voltage, V, set to the rated battery voltage, V_R, measure the response threshold of the smoke alarm as specified in 5.1.6.

With the series resistor, R, set to 0, decrease the supply voltage, V, in stages of $0{,}01 \times V_R$ at intervals of at least 1 min, until the battery-low condition is indicated. Record the supply voltage at which the battery-low condition is given as V_E and measure the response threshold of the smoke alarm as specified in 5.1.6.

With the supply voltage V set at V_R, increase the resistance of the series resistor R from 0 in increments of 0,1 Ω at intervals of at least 1 min until the battery-low condition is given. Record the resistance at which the battery-low condition is given as R_E and measure the response threshold of the smoke alarm as specified in 5.1.6.



Key

1 regulated DC. power supply
2 series resistor
3 supply voltage
4 smoke alarm with battery removed

Figure 1 — Battery-low condition test configuration

5.17.3 Requirements

The ratio of the response thresholds measured at V_E and R_E to the response threshold measured with the series resistor set to 0 and the supply voltage set to V_R shall be not less than 0,625 and not greater than 1,6.

5.18 85 dBA Sound output — Optional function

5.18.1 Object of test

The object of the test is to demonstrate that the specimen shall be capable of providing an output of at least 85 dBA and no more than 105 dBA at 3 m.

5.18.2 Method of test

Test at least two samples. Additionally, test units intended for multiple-station interconnection in that configuration, with the maximum line resistance and maximum number of networked alarms, and the sound output measured on the smoke alarm subject to an alarm condition. Externally powered smoke alarms shall be tested when connected to a source of rated voltage and frequency. For rechargeable or main batteries, a stabilized power supply shall be used set to a point just above or at the battery-low condition with the specified battery still in position but disconnected. Externally powered smoke alarms incorporating a stand-by power source shall be tested both as externally and battery powered as described above.

NOTE If more than five smoke alarms can be interconnected it is permissible to interconnect a minimum of five alarms and simulate the remainder by an equivalent electrical load.

A sound-level meter conforming to IEC 61672-1:2002 Class 2 or better shall be used. The A-weighted sound pressure level shall be measured and recorded in dB(A) using the F (Fast) (0,125 s) and maximum hold detector indicator characteristic. It shall be possible to selectively measure the sound pressure level in the 4 to 20 kHz frequency range.

Take the measurement in a free-field condition to minimize the effects of reflected sound energy. The ambient noise level shall be at least 10 dB below the measured level produced by the smoke alarm.

Free-field conditions may be simulated by mounting the unit on a wooden board (see ISO 7240-3). The sound pressure level requirements shall be met at 3 m from the smoke alarm. The measurements may be conducted outdoors on a clear day with a wind velocity of not more than 8 km/h and an ambient temperature of 15 °C to 25 °C.

Alternatively, an anechoic chamber of not less than 28 m^3, with no dimension less than 2 m and with an absorption factor of 0,99 or greater from 100 Hz to 10 kHz for all surfaces, may be used for this measurement.

The sound pressure shall be measured either directly in front of the smoke alarm or at an angle within an arc horizontally of 45° either side of it.

For smoke alarms using 520 Hz nominal output frequency, measure the fundamental frequency and the 3rd and 5th harmonics.

5.18.3 Requirements

The sound output shall commence at a level not greater than 45 dBA, rising gradually to at least 85 dBA and no more than 105 dBA over a period of between 3 s and 10 s (optional).

For battery-operated smoke alarms, the sound output shall be at least 85 dBA and no more than 105 dBA after 1 min of alarm operation and at least 82 dBA after 4 min of alarm operation.

For externally powered smoke alarms, the sound output shall be at least 85 dBA and no more than 105 dBA after 4 min of alarm operation.

For smoke alarms using 520 Hz nominal output frequency,

— the 3rd harmonic shall be (−9,6 ± 2) dB, and

— the 5th harmonic shall be (−14 ± 2) dB

relative sound pressure level to the measured fundamental frequency.

5.19 70 dBA Sound output — Optional function

5.19.1 Object of test

The object of the test is to demonstrate that the specimen shall be capable of providing an output of at least 70 dBA and no more than 105 dBA at 3 m.

5.19.2 Method of test

Test at least two samples. Additionally, test units intended for multiple-station interconnection in that configuration, with the maximum line resistance and maximum number of networked alarms, and the sound output measured on the smoke alarm subject to an alarm condition. Externally powered smoke alarms shall be tested when connected to a source of rated voltage and frequency. For rechargeable or main batteries, a stabilized power supply shall be used set to a point just above or at the battery-low condition with the specified battery still in position but disconnected. Externally powered smoke alarms incorporating a stand-by power source shall be tested both as externally and battery powered as described above.

NOTE If more than five smoke alarms can be interconnected it is permissible to interconnect a minimum of five alarms and simulate the remainder by an equivalent electrical load.

A sound-level meter conforming to IEC 61672-1:2002 Class 2 or better shall be used. The A-weighted sound pressure level shall be measured and recorded in dB(A) using the F (Fast) (0,125 s) and maximum hold detector indicator characteristic. It shall be possible to selectively measure the sound pressure level in the 4 to 20 kHz frequency range.

Make the measurement in a free-field condition to minimize the effects of reflected sound energy. The ambient noise level shall be at least 10 dB below the measured level produced by the smoke alarm.

Free-field conditions may be simulated by mounting the unit on a wooden board (see ISO 7240-3). The sound pressure level requirements shall be met at 3 m from the smoke alarm. The measurements may be conducted outdoors on a clear day with a wind velocity of not more than 8 km/h and an ambient temperature of 15 °C to 25 °C.

Alternatively, an anechoic chamber of not less than 28 m^3, with no dimension less than 2 m and with an absorption factor of 0,99 or greater from 100 Hz to 10 kHz for all surfaces, may be used for this measurement

The sound pressure shall be measured either directly in front of the smoke alarm or at an angle within an arc horizontally of 45° either side of this.

For smoke alarms using 520 Hz nominal output frequency, measure the fundamental frequency and the 3rd and 5th harmonics.

5.19.3 Requirements

The sound output shall commence at a level not greater than 45 dBA, rising gradually to at least 70 dBA and no more than 105 dBA over a period of between 3 s to 10 s (optional).

For battery-operated smoke alarms, the sound output shall be at least 70 dBA and no more than 105 dBA after 1 min of alarm operation and at least 67 dBA after 4 min of alarm operation.

For externally powered smoke alarms, the sound output shall be at least 70 dBA and no more than 105 dBA after 4 min of alarm operation.

For smoke alarms using 520 Hz nominal output frequency,

— the 3rd harmonic shall be (−9,6 ± 2) dB, and

— the 5th harmonic shall be (−14 ± 2) dB

relative sound pressure level to the measured fundamental frequency.

5.20 Sounder durability

5.20.1 Object of test

The object of the test is to demonstrate the ability of the specimen sounder to operate as intended after an endurance test.

5.20.2 Test procedure

Connect the specimen to its power source as specified in 5.1.3. Where the main power source is internal, a filtered supply adjusted to the specified voltage should be used.

Operate the specimen for 8 h of alternating 5 min periods of energization and de-energization in the standby and the alarm conditions.

After conditioning, measure the sound output of the smoke alarm as specified in 5.18 or 5.19 as nominated by the manufacturer.

5.20.3 Requirements

The specimen shall meet the sound output requirements as specified in 5.18 or 5.19 as nominated by the manufacturer.

5.21 Interconnectable smoke alarms

5.21.1 Object of test

The object of the test is to demonstrate the ability of interconnectable specimen to operate as intended and to ensure that the interconnect facility does not impair the operation of any single smoke alarm.

5.21.2 Test procedure

Connect the smoke alarm under test with the maximum number of smoke alarms allowed in the manufacturer's instructions [see 4.22 c)].

If more than five smoke alarms may be interconnected, it is permissible to interconnect a minimum of five smoke alarms and simulate the remainder by an equivalent electrical load.

Trigger one smoke alarm into the alarm condition and check all of the interconnected smoke alarms for an alarm condition.

If the smoke alarms have an alarm-silence facility, operate the alarm-silence control on one smoke alarm and, during the alarm-silence period, trigger another smoke alarm into the alarm condition. Check the interconnected smoke alarms for an alarm condition, including the smoke alarm in the alarm-silence condition.

With the smoke alarms interconnected, measure the response threshold of the smoke alarm under test as specified in 5.1.8. Where the main power source is internal, repeat the response threshold test with the interconnecting leads short-circuited.

With smoke alarms interconnected, repeat the sound-output test described in 5.18 or 5.19, as applicable, on one of the smoke alarms. During this test, ensure that the other interconnected smoke alarms are sufficiently screened or distanced so that their alarm conditions do not influence the measurement. Where the main power source is internal, repeat the sound output test with the interconnecting leads short-circuited.

Where the main power source is internal, reassess the capacity requirements, including the load introduced by interconnecting the maximum permitted number of smoke alarms (see 4.10).

5.21.3 Requirements

Requirements for interconnectable smoke alarms are the following:

— All of the interconnected smoke alarms shall give an alarm condition within 1 min of an alarm condition.

— The ratio(s) of the response threshold(s) measured in this test to the response threshold measured in the initial sensitivity test shall be between 0,625 and 1,6.

— The sound output shall meet the requirements of 5.18 or 5.19 as applicable.

— The internal main power source requirements specified in 4.10 can still be met.

5.22 Smoke alarms using radio frequency links

5.22.1 General

This clause specifies the test methods and performance criteria for smoke alarms using radio frequency links for interconnection.

NOTE There is no requirement for a permanent monitoring of the transmission path.

5.22.2 Radio frequency range

5.22.2.1 Object of the test

To make sure that the radio frequency range is adequate for domestic/residential application, the system performance of the radio part shall be measured.

5.22.2.2 Calculation of the free field attenuation

The free field attenuation shall be calculated depending on the frequency used and the distance declared by the manufacturer and shall be calculated by the following formula:

$$D = 10\log\left(\frac{4\cdot\pi\cdot r}{\lambda}\right)$$

where

λ is wavelength in m; wavelength (m) = $\dfrac{300}{f\,(\mathrm{MHz})}$

r is distance in m;

D attenuation in dB.

The result D is recorded.

5.22.2.3 Transmission power test procedure

Five specimens shall be provided. The transmission power of each specimen is determined in the most unfavourable transmission direction according to the manufacturer's specification. This may be measured for example in an RF anechoic chamber or under field free conditions. Where the specimens use different frequencies, it is to be measured at the highest frequency. The specimen with the lowest transmission power is identified and marked as "S1". It will subsequently be used for reference measurements so it shall not be used for any of the environmental tests in the other sections of this document.

5.22.2.4 Receiver test

5.22.2.4.1 General

In the frequency band used in 5.22.2.2, the receiver sensitivity of all the specimens (apart from "S1") is tested under free field conditions. In this test specimen "S1" is used as the transmitter, orientated such that its most unfavourable transmitting direction faces the receiver. Then each of the other specimens, in turn, is positioned at a distance of 100 m or as specified by the manufacturer if it is greater than 100 m, orientated such that the least sensitive direction of the receiver faces the transmitter. An alarm signal is then transmitted by "S1".

5.22.2.4.2 Requirements

Each of the smoke alarms tested shall receive the signal from the transmitting smoke alarm "S1" and generate an audible alarm signal within 30 s. Radio frequency ancillary devices shall be tested as per 5.22.2.4.1.

5.22.3 Failure of radio link tests

5.22.3.1 General

The manufacturer shall provide a means of disabling the radio frequency transmission between two radio frequency linked smoke alarms.

5.22.3.2 Requirements

The disabling of the radio frequency transmission shall not result in change of state of either smoke alarm.

Each smoke alarm shall meet the response threshold value as specified in Table 1.

5.22.4 Identification codes verification

5.22.4.1 Object of the test

To demonstrate the ability of the smoke alarm to distinguish between the required amount of identification codes.

5.22.4.2 Test procedure

The manufacturer shall submit documentation describing how the coding operates for the assessment of the requirement. The manufacturer shall demonstrate either that there is a minimum of 65 000 identification codes or how the changeable 255 coding operates to fulfil the requirement.

5.22.4.3 Test requirement

A technical assessment shall be carried out to verify the requirements as specified in 5.22.3.2.

5.22.5 Environmental tests for radio frequency-interconnected smoke alarms

5.22.5.1 Object of the test

To show that a smoke alarm including radio module does not change significantly after environmental conditioning.

5.22.5.2 Test procedure

The smoke alarms including their radio modules are subjected to the environmental tests in accordance with the relevant clauses of this document.

After conditioning:

— Trigger the conditioned smoke alarm into the alarm condition and check that one interconnected sample goes into alarm as specified in 4.23.

— Trigger the unconditioned smoke alarm into the alarm condition and check that the conditioned one goes into alarm as specified in 4.23.

5.22.5.3 Test requirements

Apart from the specific requirements in other clauses of this document, the following additional requirements also apply:

— During the operational environmental tests, the smoke alarms shall not generate nor transmit any alarm or fault signal.

— Following the endurance tests, no alarm and no fault signal shall be generated or transmitted upon commissioning.

A technical assessment shall be carried out to verify the requirements as specified in 4.23.

5.23 Alarm-silence facility

5.23.1 Object of test

The object of the test is to demonstrate the ability of specimen with an alarm-silence facility to operate as intended and to ensure that the alarm-silence facility does not permanently impair the operation of the smoke alarm.

5.23.2 Test requirement

Generate smoke as specified in 5.1.6 in the smoke tunnel specified in Annex A, with an air velocity of (0,2 ± 0,04) m/s and an air temperature of (23 ± 5) °C, but increase the smoke density to three times ±10 % the response threshold (*m* or *y*) recorded for smoke alarm No. 16, when tested as specified in 5.3.2. Using smoke alarm No. 16, with a supply voltage corresponding to V_R, insert the smoke alarm into the smoke-filled tunnel while maintaining the required smoke density. After the smoke alarm enters the alarm condition, operate the manual alarm silence control, keeping the smoke alarm in the smoke-filled tunnel for at least 15 min.

a) Measure the time between the operation of the manual control and the reoccurrence of the audible alarm signal.

b) Repeat the test with the manual silence control operated continuously for (15 to 15,25) min.

c) Repeat the tests for each remote silence control.

5.23.3 Requirements

The time period specified in 5.23.2 shall be greater than 5 min and less than 15 min.

The audible alarm signal shall resound prior to the expiry of the time period specified for 5.23.2 b).

5.24 Temporary disablement facility

5.24.1 Object of test

The object of the test is to demonstrate the ability of specimens with a temporary disable control to operate as intended and to ensure that the temporary disable facility does not permanently impair the operation of the smoke alarm.

5.24.2 Test procedure

5.24.2.1 Generate smoke as specified in 5.1.6 in the smoke tunnel specified in Annex A, with an air velocity of (0,2 ± 0,04) m/s and an air temperature of (23 ± 5) °C, but increase the smoke density to three times ±10 % the response threshold (*m* or *y*) recorded for smoke alarm No. 16, when tested as specified in 5.3.2, maintaining the required smoke density for the duration of the test. Using smoke alarm No. 16, with a supply voltage corresponding to V_R:

a) Operate the manual control for temporary disablement then immediately insert the smoke alarm into the smoke-filled tunnel. Measure the time between the operation of the temporary disablement control and the reoccurrence of the audible alarm signal.

b) Repeat the test in a) with the temporary disablement control operated continuously for 15 to 15,25 min. Measure the time between operation of the control and the resounding of the audible alarm signal.

c) Repeat the tests for each remote temporary disablement control.

5.24.3 Requirements

The time period specified for 5.24.2.1 a) shall be greater than 5 min and less than 15 min.

The audible alarm signal shall resound prior to the expiry of the time period specified for 5.23.2 b).

The ratio of the response threshold measured during the test to the response threshold recorded for the same smoke alarm when tested as specified in 5.3.2 shall be not less than 0,625 and not greater than 1,6.

5.25 Variation in supply voltage

5.25.1 Object of test

The object of the test is to demonstrate that, within the specified range(s) of the supply voltage, the sensitivity of the specimen is not unduly dependent on these parameters.

5.25.2 Test procedure

Measure the response threshold value of the specimen to be tested as specified in 5.1.6, under the extremes of the specified supply conditions (e.g. maximum and minimum voltage).

Test smoke alarms intended to operate from mains supplies with supply voltages of 0,85 times the lower limit and 1,1 times the upper limit of the nominal supply voltage range specified in the manufacturer's requirements. If the smoke alarm is provided with a rechargeable battery, allow sufficient time for the battery voltage to stabilize before measuring the response threshold.

Where the main power source is internal, carry out the tests with a supply voltage corresponding to V_R, and also at the battery-low condition voltage (V_E) as specified in 5.17.2.

Where a standby power source is used, also test the smoke alarm with the main supply disconnected. The manufacturer shall specify a maximum and minimum voltage. Conduct the tests at the maximum and the minimum voltage.

Designate the maximum response threshold value as y_{max} or m_{max} and the minimum value as y_{min} or m_{min}.

5.25.3 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.

The lower response threshold value m_{min} shall be not less than:

— 0,05 dB/m for detectors with a declared response threshold value of band 1

— 0,2 dB/m for detectors with a declared response threshold value of band 2.

The higher response threshold value m_{max} shall be the value recorded prior to the end test conditions.

5.26 Polarity reversal

5.26.1 Object of test

The object of the test is to demonstrate the ability of battery powered or DC. externally powered smoke alarms to function properly after being misconnected with respect to polarity.

5.26.2 Test procedure

For battery-operated smoke alarms (including standby power source batteries or equivalent) intended to be connected to a polarized terminal arrangement, reverse the polarity for 10 s to 15 s, if it is possible to establish the reversed connection with the intended battery type without causing mechanical damage to the smoke alarm.

Unless a fault condition or alarm condition occurs, maintain this condition for 2 h.

For externally powered smoke alarms, reverse the polarity of the supply lines. Unless a fault condition or alarm condition occurs, maintain this condition for 2 h.

For interconnectable smoke alarms, connect the interconnect leads with the polarity reversed. Unless a fault condition or alarm condition occurs, maintain this condition for 2 h.

Following the reverse-polarity conditioning, connect the specimen to its power source as specified in 5.1.3 and measure its response threshold value as in 5.1.6.

Where the main power source is internal or a standby power source is included, determine the voltage (V_E) at which the battery-low condition occurs as specified in 5.17.2.

Of the two response threshold values for the specimen in this test and the initial sensitivity test, designate the greater as y_{max} or m_{max} and the lesser as y_{min} or m_{min}.

5.26.3 Requirements

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

Where the main power source is internal or a standby power source is included and the voltage V_E is applied, a battery-low condition shall occur after the polarity reversal test. The battery-low condition voltage (V_E) determined after the polarity reversal test shall be within 5 % of the battery-low condition voltage determined prior to the test.

5.27 Standby power source

5.27.1 Object of test

The object of the test is to demonstrate that the specimen will enter a fault condition when the standby power source is depleted, open-circuited and short-circuited.

5.27.2 Test procedure

Connect the specimen to the main power source and standby power source, then follow the test procedure specified in 5.17.

Restore the specimen to the normal condition, then disconnect the main power source and repeat the test procedure specified in 5.17.

Restore the specimen to the normal condition, then disconnect the standby power source.

Restore the specimen to the normal condition, then disconnect the standby power source and immediately apply a short-circuit between the standby power source terminals.

5.27.3 Requirements

The specimen shall enter the fault condition following each test step.

5.28 Electrical safety

5.28.1 Object of test

The object of the test is to demonstrate that the specimen provides adequate personal protection against hazardous currents passing through the human body (electric shock), excessive temperature and the start and spread of fire.

5.28.2 Test procedure

5.28.2.1 Heating under normal operating conditions

Assess the specimen in accordance with the requirements of IEC 60065:2005, Clause 7.

5.28.2.2 Shock hazard under normal operating conditions

Assess the specimen in accordance with the requirements of IEC 60065:2005, Clauses 8 and 9, when mounted in any orientation on a vertical surface and when mounted on the underside of a horizontal surface.

The requirement of IEC 60065:2005, 9.1.6, shall apply to the pins of an appliance inlet on the apparatus following withdrawal of the connector attached to the mains supply wires.

5.28.2.3 Insulation requirements

For a specimen intended to be operated from a supply greater than 34 V (peak or DC.), assess the apparatus in accordance with the requirements of IEC 60065:2005, Clause 10, disregarding the test specified in 10.1.

5.28.2.4 Fault conditions

Assess the specimen in accordance with the requirements of IEC 60065:2005, Clause 11.

5.28.2.5 Mechanical strength

Assess the specimen in accordance with the requirements of IEC 60065:2005, Clause 12, disregarding 12.1.1, 12.1.3 and 12.1.4.

5.28.2.6 Clearances and creepage distances

Assess the specimen in accordance with the requirements of IEC 60065:2005, Clause 13.

5.28.2.7 Components

Assess the following components for conformance with the relevant requirements of IEC 60065:2005, Clause 14:

— resistors, capacitors, inductors and transformers (whose short-circuiting or disconnection would cause an infringement of the requirements for operation under fault conditions, with respect to overheating, fire or shock hazard);

— protective devices, switches, safety interlocks, voltage-setting devices and the housing arrangements for batteries; and

— power, voltage and current ratings, as appropriate, of all components for suitability for the application for which they are used.

Conformity shall be checked by circuit measurement, analysis of the circuit design, measurements on the components in question and by inspection, as appropriate.

5.28.2.8 Protection against the start and spread of fire

Assess the specimen in accordance with the requirements of IEC 60065:2005, Clause 20.

5.28.2.9 Wiring connections

Assess the specimen in accordance with the requirements of IEC 60950-1:2005, 3.2 and 3.3.

5.28.3 Requirements

The specimen shall satisfy the requirements of the tests.

5.29 Sequence timing for smoke alarms with voice

5.29.1 Object of the test

The object of the test is to verify that the signal sequence and timing of the voice message and the warning signal are within the requirements.

5.29.2 Test procedure

Connect the specimen to a suitable power supply and set it to the minimum voltage declared by the manufacturer.

Activate the following sound sequence:

— Measure the time differences between the signals at the start of the aural sequence and at the end of the aural sequence.

— Repeat the measurements six times at 5 min intervals.

— Repeat the procedure with the power supply set to the maximum voltage declared by the manufacturer.

5.29.3 Measurements during conditioning

For each sound sequence, measure the sequence and duration of the warning signal, silence periods and voice message.

5.29.4 Requirements

The measurements of 5.29.3 shall be within the limits specified in 4.24.

6 Test report

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

a) identification of the smoke alarm tested;

b) reference to this document (ISO 12239:2021) and any amendments;

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

d) conditioning period and the conditioning atmosphere;

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

f) details of the power source;

g) details of any deviation from this document or from the documents to which reference is made;

h) details of any operations regarded as optional;

i) any unusual features observed; and

j) the date of the test.

Annex A
(normative)

Smoke tunnel for response-threshold value measurement

This annex 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 may 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 document.

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 specified 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 air flow in the working volume. The board shall be of such dimensions that the edge or edges 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 ± 0,04) m/s or (1,0 ± 0,2) m/s] 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 K/min to 55 °C.

Both aerosol density measurements, m, expressed in decibels per metre (dB/m) for detectors using scattered or transmitted light, and y (dimensionless) for detectors using ionization, shall be made in the working volume in the proximity of the 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 polydispersive aerosol shall be used as the test aerosol to measure the response threshold values. The bulk of the particles comprising the aerosol shall have a particle diameter between 0,5 µm and 1 µm and a refractive index of approximately 1,4.

The test aerosol shall be reproducible and stable with regards to the following parameters:

— particle mass distribution;

— optical constants of the particles;

— particle shape;

— particle structure.

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

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

Annex C
(normative)

Smoke-measuring instruments

C.1 Obscuration meter

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

The absorbance index is designated m and expressed in decibels per metre (dB/m). The absorbance index, m, is given by the following equation:

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

where

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

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

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

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

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

The effective radiated power of the light beam shall be:

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

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

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

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

C.2 Measuring ionization chamber (MIC)

C.2.1 General

The response threshold of 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 condition.

C.2.2 Operating method and basic construction

The mechanical construction of the measuring ionization chamber is given in Annex L.

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 in a known manner by the aerosol or smoke particles. The ratio of the current in the aerosol-free chamber to that in the presence of an aerosol is a known function of the aerosol or smoke concentration. Thus, the non-dimensional quantity y, which is approximately proportional to the particle concentration for a particular type of aerosol or smoke, is used as a measure of the response threshold value for smoke detectors using ionization.

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

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

where

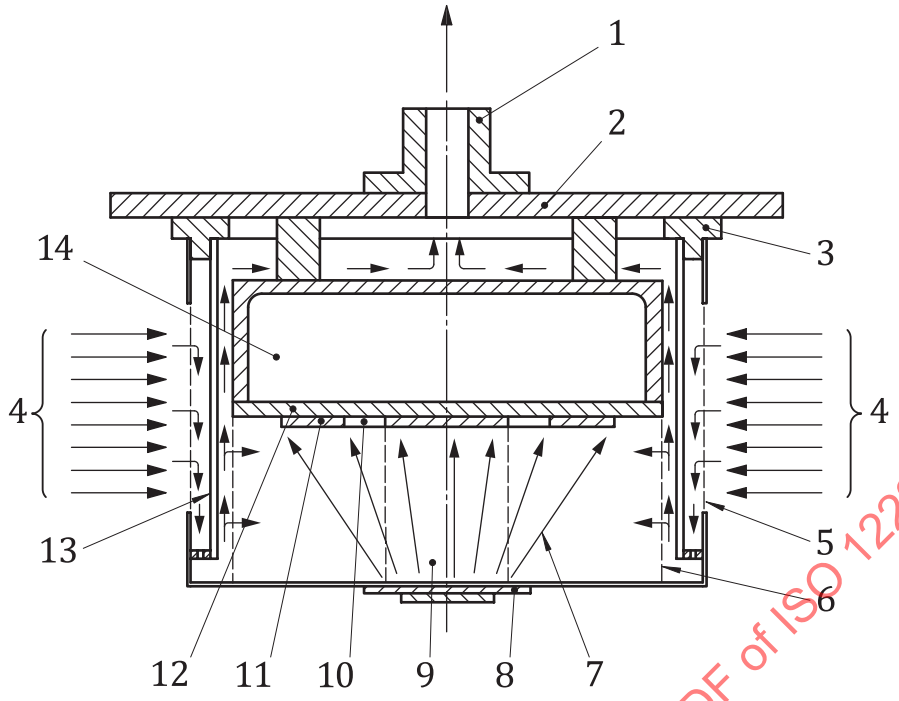
I_0 is the chamber current in air without test aerosol or smoke;

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

η is the chamber constant;

Z is the particle concentration in particles per cubic metre;

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



Key

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

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

C.2.3 Technical data

a) Radiation source

Isotope:	americium ^{241}Am
Activity:	(130 ± 6,5) kBq
Average energy:	(4,5 ± 0,225) MeV
Mechanical construction:	Americium oxide embedded in gold between two layers of gold, covered with a hard gold alloy. The source is in the form of a circular disc with a diameter of 27 mm, which is mounted in a holder such that no cut edges are accessible.

b) Ionization chamber

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

pressure:	(101,3 ± 1) kPa;

temperature: (25 ± 2) °C;

relative humidity: (55 ± 20) %;

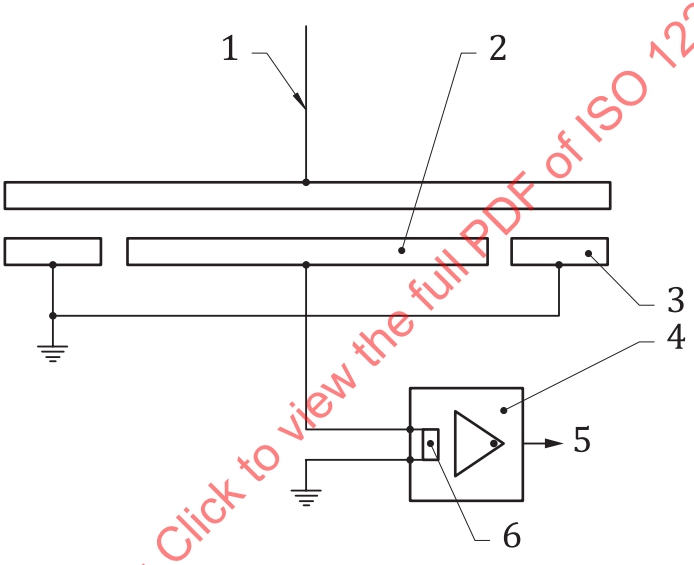
with the potential of the guard ring within ±0,1 V of the voltage of the measuring electrode.

c) Current measuring amplifier

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

d) Suction system

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



Key

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

Figure C.2 — Measuring ionization chamber — Operating circuit

Annex D
(normative)

Apparatus for dazzling test

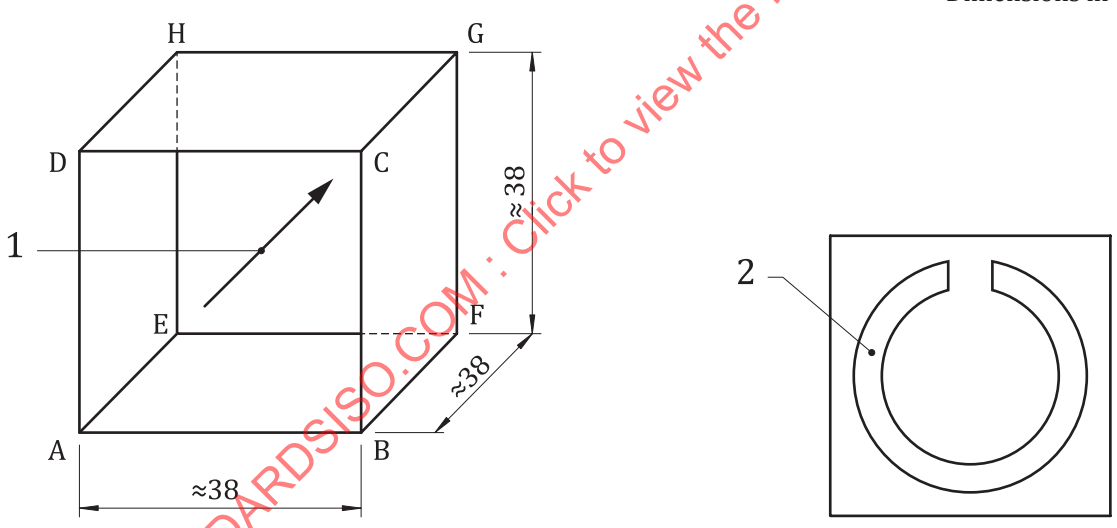
The dazzling apparatus [see Figure D.1 a)] shall be constructed so that it can be inserted in the working section of the smoke tunnel. The apparatus is cube-shaped, with four of the cube faces (ABFE, AEHD, BFGC and EFGH) closed and lined on the inside with high-gloss aluminium foil. The other two opposing cube faces (ABCD and EFGH) are open to allow for the flow of test aerosol through the device.

A circular fluorescent lamp [32 W, "warm white", approximate colour temperature: 2 800 K; see Figure D.1 b)] with a diameter of approximately 30 cm is mounted on each of the four closed surfaces of the cube. The lights should not cause turbulence in the tunnel. To obtain a stable light output, the tubes should be aged for 100 h and discarded at 2 000 h.

The smoke detector to be tested shall be installed in the centre of the upper cube face [see Figure D.1 a)] so that light can play on it from all directions.

The electrical connections to the fluorescent lamps shall be such that there can be no interference with the detection system through electrical signals.

Dimensions in centimetres



a) Apparatus **b) Lamp**

Key

1 stream of aerosol

2 fluorescent lamp

Figure D.1 — Dazzling apparatus (a) and lamp (b)

Annex E
(normative)

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 has overall dimensions of 76 mm (width) × 50 mm (depth) × 94 mm (length) and is manufactured from aluminium alloy (Al Cu4SiMg as specified in ISO 209), which has been solution- and precipitation-treated. It has a plane-impact face chamfered at (60 ± 1)° to the long axis of the head. The tubular steel shaft has an outside diameter of (25 ± 0,1) mm with a wall thickness of (1,6 ± 0,1) mm.

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.

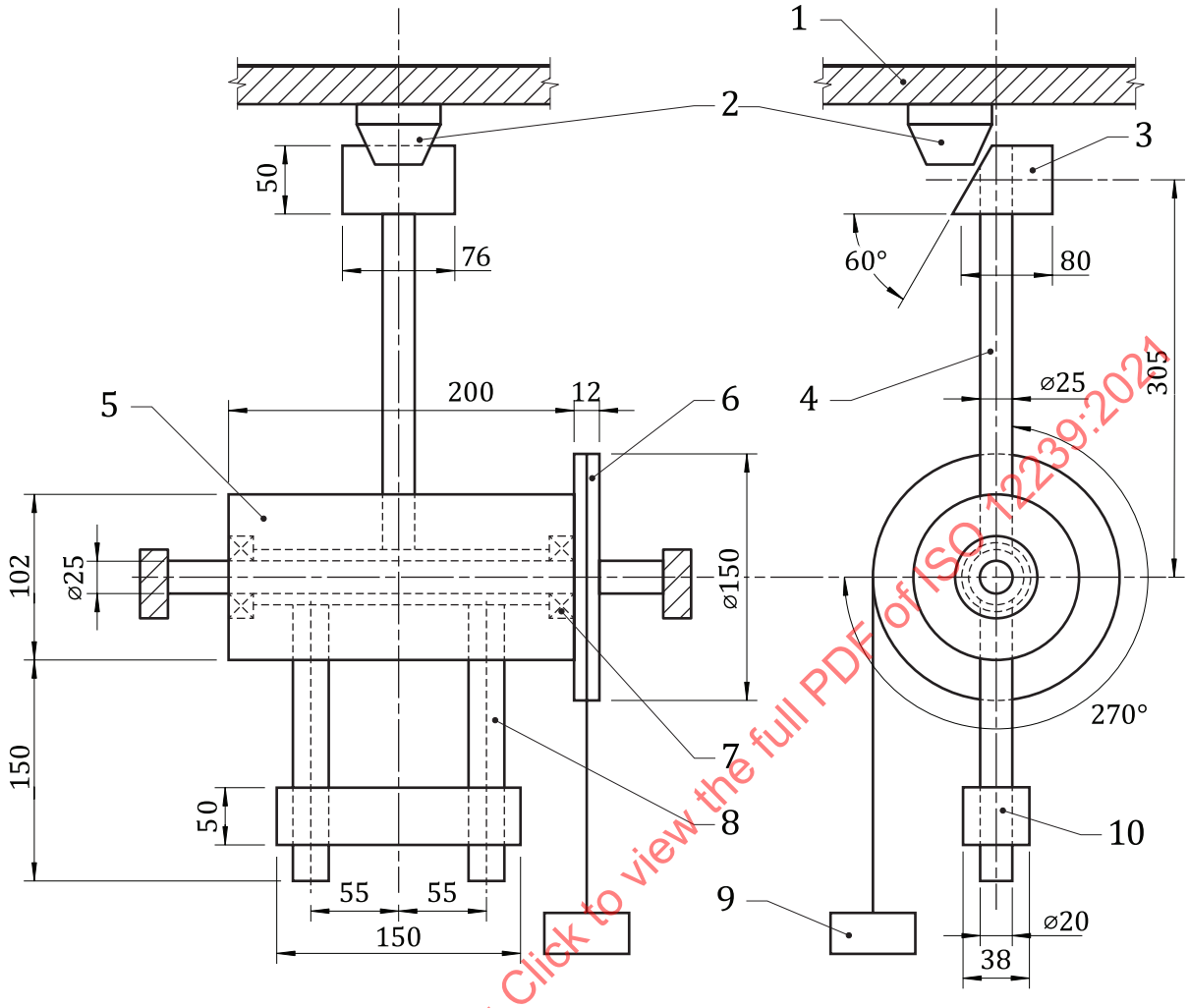
Diametrically opposite the hammer shaft are two steel counter-balance arms, each 20 mm in outside diameter and 185 mm long. These arms are screwed into the boss so that the length of 150 mm protrudes. A steel counter-balance weight is mounted on the arms so that its position can be adjusted to balance the mass of the striker and arms, as in Figure E.1. On the end of the central boss is mounted a 150 mm-diameter aluminium alloy pulley, 12 mm wide, and around this is wound an inextensible cable, with one end 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 mounting board with the specimen 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 $3\pi/2$ rad to strike the specimen. The mass, in kilograms, of the operating weight to produce the required impact energy of 1,9 J equals $0{,}388/(3\pi r)$ kg, where r is the effective radius of the pulley, in metres. This equals approximately 0,55 kg for a pulley radius of 75 mm.

As this document requires a hammer velocity at impact of (1,5 ± 0,13) m/s, the mass of the hammer head will need to be reduced by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0,79 kg will be required to obtain the specified velocity, but this will have to be determined by trial and error.

Dimensions in millimetres



Key

1	mounting board	6	pulley
2	detector	7	ball bearings
3	striker	8	counter-balance arms
4	striker shaft	9	operating weight
5	boss	10	counter-balance weight
a	Angle of movement.		

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

Figure E.1 — Impact apparatus

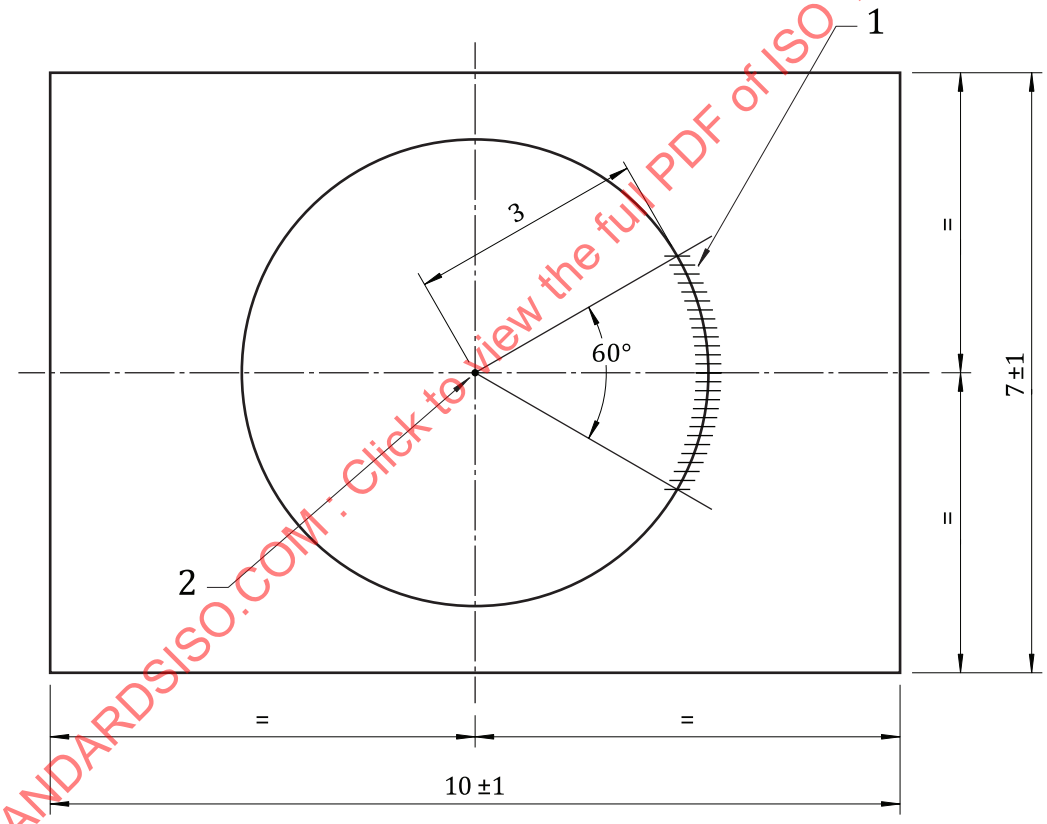
Annex F
(normative)

Fire test room

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

Dimensions in metres



Key

1 specimens and measuring instruments (see Figure F.2)

2 position of test fire

Figure F.1 — Plan view of fire test room and position of specimens and monitoring instruments

The dimensions of the test room shall be within the following limits:

Length: (10 ± 1) m;

Width: (7 ± 1) m;

Height: (4 ± 0,2) m.

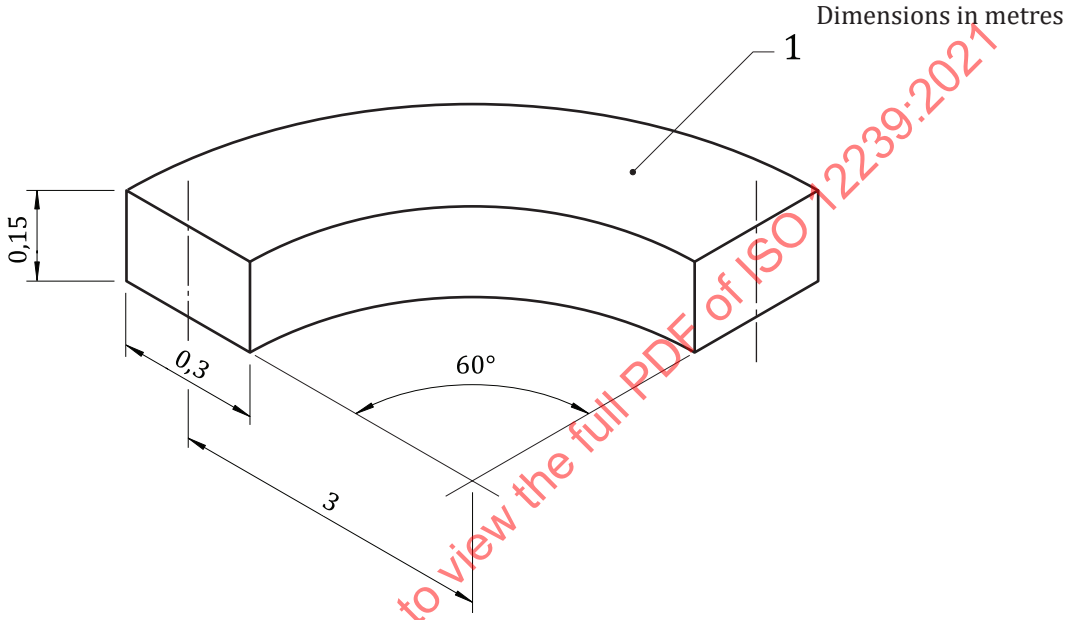
The ceiling and walls shall be flat with no obstructions between the fire source and the detectors and instrumentation. The fire source shall be centred as much as possible with respect to the four walls to minimize reflection of smoke.

The fire test room shall be equipped with the following measuring instruments:

— measuring ionization chamber (MIC);

— obscuration meter;

— temperature probe.

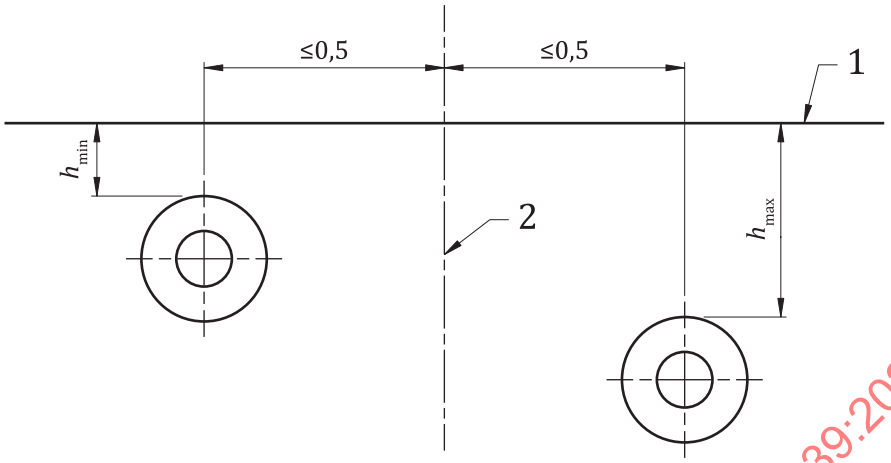


Key

1 ceiling

Figure F.2 — Mounting position for instruments and specimens

Dimensions in metres



Key

1	position of specimens of wall-mounted smoke alarms
h_{min}	least distance to the ceiling according to manufacturer's specifications
h_{max}	greatest distance to the ceiling according to manufacturer's specification

Figure F3 — Side view of fire test room and position of wall mount smoke alarms

Annex G
(normative)

Smouldering pyrolysis wood fire (TF2)

G.1 Fuel

Approximately 10 dried beechwood sticks (moisture content ≈ 5 %), each stick having dimensions of 75 mm × 25 mm × 20 mm, are usually found sufficient.

G.2 Hotplate

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

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

G.4 Heating rate

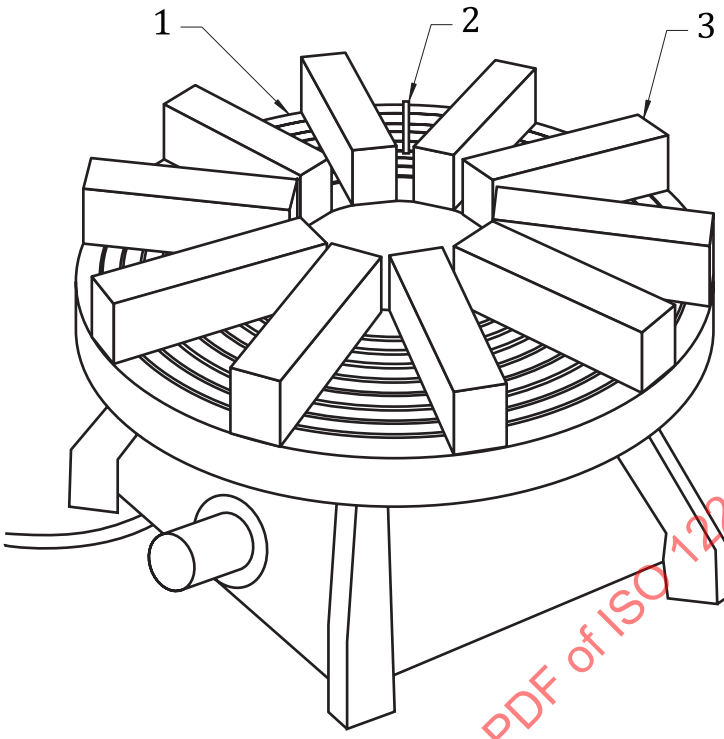
The hotplate shall be powered such that its temperature rises from ambient to 600 °C in approximately 11 min.

G.5 End-of-test condition

The end-of-test condition, m_E, shall be when m = 2 dB/m or when all of the specimens have generated an alarm signal, whichever occurs first.

G.6 Test validity criteria

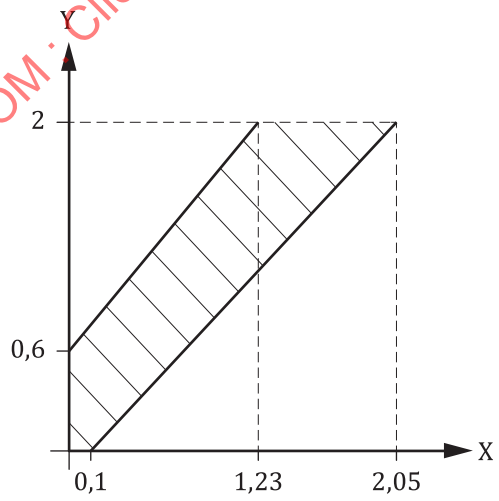
No flaming shall occur before the end-of-test condition has been reached. The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the hatched areas shown in Figures G.2 and G.3, respectively. That is, 1,23 ≤ y ≤ 2,05 and 570 ≤ t ≤ 840 at the end-of-test condition m_E = 2 dB/m.



Key

1 grooved hotplate
2 temperature sensor
3 wooden sticks

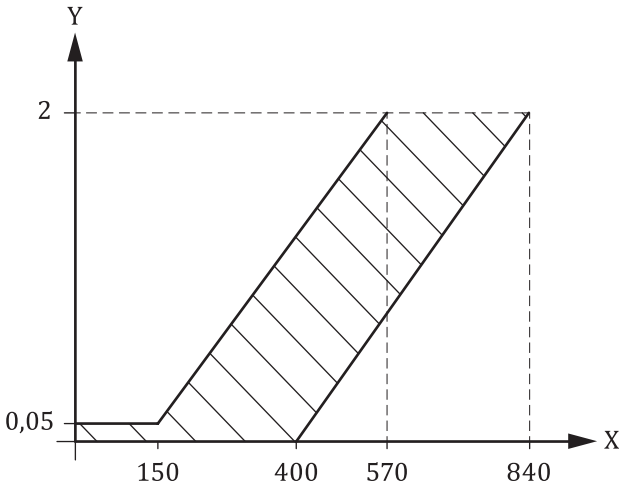
Figure G.1 — Arrangement of sticks on hotplate



Key

Y *m*-value, dB/m
X *y*-value

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



Key

Y *m*-value, dB/m

X *t*-value, s

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

Annex H
(normative)

Glowing smouldering cotton fire (TF3)

H.1 Fuel

Approximately 90 pieces of braided cotton wick, each of length approximately 80 cm and weighing approximately 3 g, are usually found sufficient. 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.

Dimensions in metres

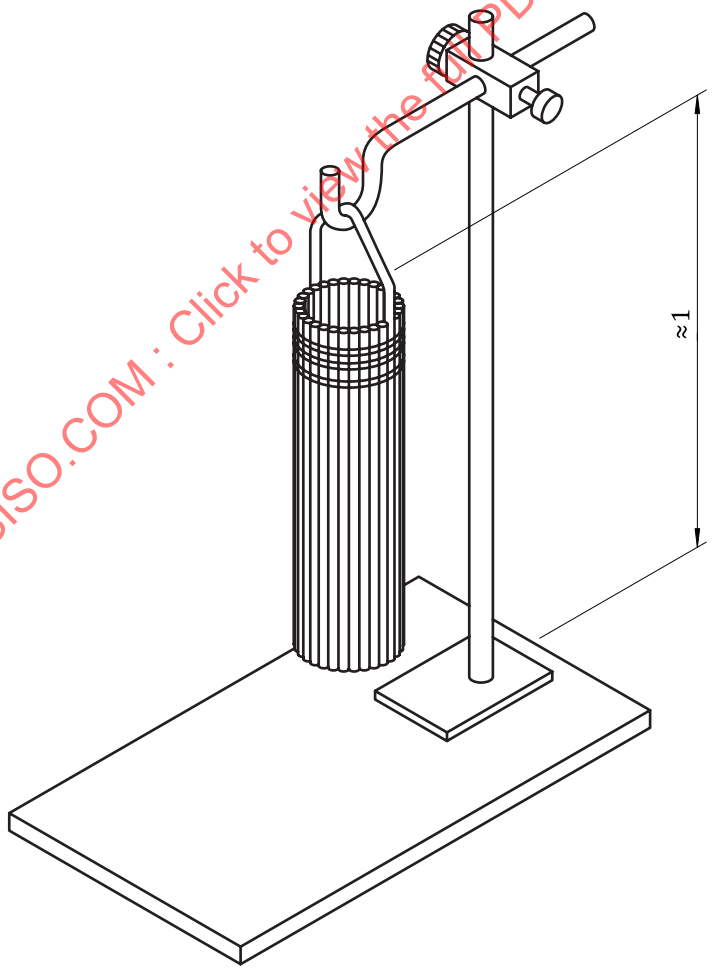


Figure H.1 — Arrangement of cotton wicks

H.3 Ignition

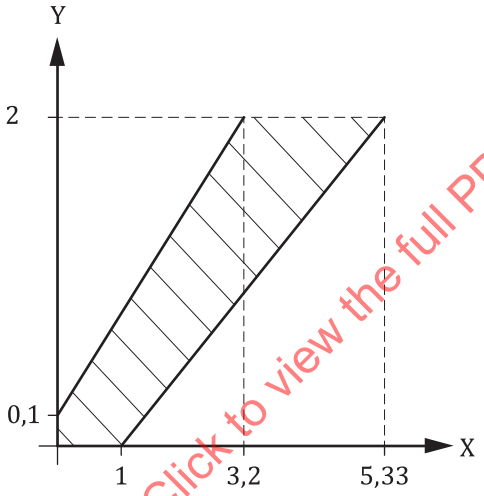
The lower end of each wick shall be ignited so that the wicks continue to glow. Any flaming shall be blown out immediately. The test time shall start when all wicks are glowing.

H.4 End-of-test condition

The end-of-test condition, m_E, shall be when m = 2 dB/m or when all of the specimens have generated an alarm condition, whichever occurs first.

H.5 Test validity criteria

The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the hatched areas shown in Figures H.2 and H.3, respectively. That is, at the end-of-test condition m_E = 2 dB/m, 3,2 ≤ y ≤ 5,33 and 280 ≤ t ≤ 750.

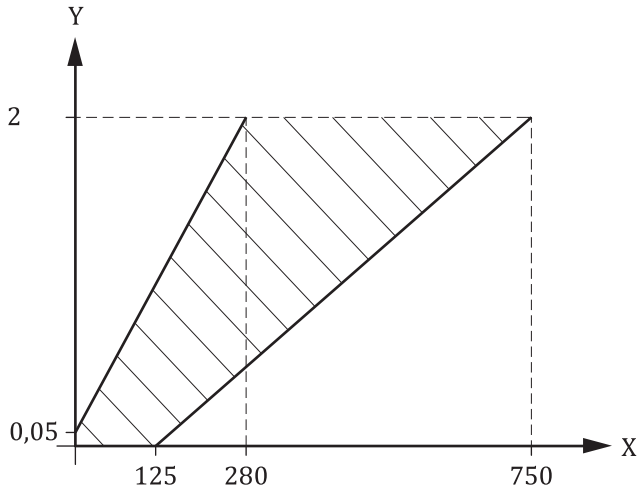


Key

Y m-value, dB/m

X y-value

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



Key

Y *m*-value, dB/m

X *t*-value, s

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

Annex I
(normative)

Flaming plastics (polyurethane) fire (TF4)

I.1 Fuel

Three mats, approximately 50 cm × 50 cm × 2 cm, of soft polyurethane foam, without flame-retardant additives and having a density of approximately 20 kg/m^3, are usually found sufficient. However, the exact quantity of fuel 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 a valid test. A small quantity of a clean burning material (e.g. 5 cm^3 of methylated spirit) may be used to assist the ignition.

I.4 End-of-test condition

The end-of-test condition, y_E, shall be:

— y_E = 6,0 for ionization detectors and detectors using scattered or transmitted light with a declared response threshold value of band 1, or

— y_E = 6,5 for detectors using scattered or transmitted light, with a declared response threshold value of band 2, or

— all of the specimens have generated an alarm condition,

whichever occurs first.

I.5 Test validity criteria

The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the hatched areas shown in Figures I.1 and I.2, respectively. That is, at the end-of-test condition:

— y_E = 6,0 and 1,27 ≤ m ≤ 1,73 for ionization detectors and detectors using scattered or transmitted light with a declared response threshold value of band 1 and 140 ≤ t ≤ 180, or

— y_E = 6,5 and 1,38 ≤ m ≤ 1,86 for detectors using scattered or transmitted light, with a declared response threshold value of band 2 and 150 ≤ t ≤ 193.