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**Fire detection and fire alarm systems —  
Smoke alarms**

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

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 12239 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

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## Introduction

This International Standard for smoke alarms is drafted on the basis of functions that are to be provided on all smoke alarms covered by this standard, and optional functions with requirements which may be provided. It is intended that the options shall 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 standard with different combinations of functions to conform to this International Standard.

Two optional sound output levels are specified in this International Standard. The options allow national regulators to specify minimum sound output levels [70 dB(A) or 85 dB(A)] as required under national regulations.

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.

Other functions may also be provided, even if not specified in this International Standard, if they do not jeopardize any function required by this document.

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# Fire detection and fire alarm systems — Smoke alarms

## 1 Scope

This International Standard specifies requirements, test methods, performance criteria, and manufacturer's 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 International Standard should be used only for guidance. Smoke alarms with special characteristics and developed for specific risks are not covered by this International Standard.

This International Standard 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 and/or accessories;
- alarm-silencing facility.

Where such facilities are included, this International Standard specifies applicable requirements.

This International Standard does not cover devices intended for incorporation in systems using separate control and indicating equipment.

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 International Standard. Such smoke alarms should, however, comply with the applicable national standards, which should be in line with the recommendations of the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD).

## 2 Normative references

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

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

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

ISO 8201, *Acoustics — Audible emergency evacuation signal*

EN 54-3, *Fire detection and fire alarm systems — Part 3: Fire alarm devices — Sounders*

EN 50130-4, *Alarm systems — Part 4: Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder and social alarm systems*

IEC 60065:2001, *Safety requirements for mains operated electronic and related apparatus for household and similar use*

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

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

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

IEC 60068-2-6, *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, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

IEC 60950-1:2001, *Information technology equipment — Safety — Part 1: General requirements*

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

OECD, *Recommendations for ionization chamber smoke detectors in implementation of radiation protection standards*. Nuclear Energy Agency, Organization for Economic Co-operation and Development, Paris, France. 1977

### 3 Terms and definitions

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For the purposes of this document, the following terms and definitions apply. For definitions of terms used in the clauses of IEC 60065:2001 or IEC 60950-1:2001 referred to in Annex A, reference shall be made to Clause 2 of IEC 60065:2001 or 1.2 of IEC 60950-1:2001, respectively.

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#### 3.1

##### **aerosol density**

smoke density

amount of particulates per volume as described operationally by one of two parameters:

- $m$  (3.8), an absorbance index, used in the testing of smoke alarms using scattered or transmitted light;
- $y$  (3.15), a dimensionless variable, used in the testing of smoke alarms using ionization

NOTE Note that these parameters are not concentrations *sensu stricto*, 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 disabling or desensitizing a smoke alarm

#### 3.4

##### **battery-low condition**

any combination of battery voltage and series resistance which results in a fault condition

#### 3.5

##### **fault condition**

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



**3.6****interconnectable smoke alarm**

smoke alarm which may be interconnected with other smoke alarms to provide a common alarm condition

**3.7****least sensitive orientation**

point of rotation, relative to air flow, about the vertical axis where a detector produces the maximum response threshold value

**3.8***m***absorbance index**

measured light attenuation characterizing the concentration of particulates in smoke or an aerosol

NOTE The equation for *m* is given in Annex D.

**3.9****most sensitive orientation**

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

**3.10****normal condition**

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

**3.11****primary power source**

the source of power intended to supply the smoke alarm

**3.12****response threshold** $A_{th}$ 

smoke concentration at which the smoke alarm changes to its alarm condition

**3.13****smoke alarm**

device containing within one housing all the components, except possibly the power source, necessary for detecting smoke and generating an alarm condition

**3.14****standby power source**

the source of power intended to supply the smoke alarm in the event of a failure of the primary power source

**3.15***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 The equation for *y* is given in Annex D.

**4 General requirements****4.1 Compliance**

In order to comply with this International Standard, the smoke alarm shall meet the requirements of this clause, shall be tested as specified in Clause 5 and shall meet the requirements of the tests.

## 4.2 Alarm-condition aural indicator

Where the smoke alarm is used to alert occupants to *evacuate* the area, the alarm condition shall be the emergency evacuation signal defined in ISO 8201.

Where the smoke alarm is used to alert occupants to *investigate* the area for the cause of the alarm condition, the alarm condition shall be the auditory danger signal defined in ISO 7731.

## 4.3 Alarm-condition visual indicator — Optional function

Alarm-condition indicators shall be red and shall be separate from other indicators. The indicator shall flash or be continuously illuminated when the alarm condition is present. The failure of any visual alarm-condition indicator shall not prevent the alarm condition.

Each interconnectable smoke alarm may be provided with an integral red visual indicator, by which the individual smoke alarm, when in alarm condition, may be identified. This visual indicator may also perform other additional functions, but the alarm indication needs to be distinct from any additional function.

## 4.4 Mains-on visual indicator

A smoke alarm intended for connection to the a.c. mains shall be provided with a mains-on visual indicator. The indicator shall be continuously illuminated when the mains power is present. The indicator shall be green and shall be separate from any other indicators.

## 4.5 Fault-condition visual indicator — Optional function

Fault condition indicators shall be amber or yellow and shall be separate from other indicators. The indicator shall flash or be continuously illuminated when the fault condition is present. The failure of any visual fault condition indicator shall not prevent the alarm condition.

## 4.6 Connection of external ancillary devices

The smoke alarm may provide for connections to external ancillary devices (e.g. remote indicators, control relays, transmitters). Open- or short-circuit failure of these connections shall not prevent the correct operation of the smoke alarm.

## 4.7 Means of calibration

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

## 4.8 User-replaceable components

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

## 4.9 Primary power source

### 4.9.1 General

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

### 4.9.2 Internal

Where the 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 of 10 s for at least 1 year before the battery-low condition is given;

- b) provide a distinctive battery-low condition before the battery is incapable of operating for alarm-condition purposes (see 5.17);
- c) at the point when a battery-low condition commences, 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, followed by a battery-low condition for at least 20 d;
- d) at the point when the battery-low condition commences, have sufficient capacity for the smoke alarm to produce a battery-low condition for at least 30 d;
- e) be replaceable by the user, unless the power-source 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 submitted to indicate that the above requirement can be met.

#### 4.9.3 External

Where the power source is external to the smoke alarm, an internal or external standby power source shall be provided (see 4.10).

### 4.10 Standby power source

#### 4.10.1 General

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

- a) Primary-cell standby power source: the standby power source shall be capable of meeting the requirements of 4.9.2.
- b) Rechargeable-cell 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 a fire, a fault condition for at least 24 h.

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 submitted to indicate that the above requirements can be met.

#### 4.10.2 Monitoring of standby power source

##### 4.10.2.1 General

The standby power source shall be monitored for fault conditions. These conditions shall include battery-low condition, open- and short-circuit failure of the standby power source.

##### 4.10.2.2 Standby battery-low condition

A battery-low condition shall be obtained both with mains power to the unit and without mains power to the unit.

The test procedure set out in 5.17 shall be used to simulate the depletion of the standby power source to the point where a battery-low condition is given.

##### 4.10.2.3 Open circuit

The standby power supply shall be disconnected or removed as appropriate and mains power applied to the unit.

The smoke alarm shall give an audible fault condition.

#### 4.10.2.4 Short-circuit

The standby power supply shall be disconnected and replaced with a short-circuit between the standby power source terminals and the mains power applied to the unit.

The smoke alarm shall give an audible fault condition.

#### 4.11 Electrical safety requirements

The apparatus shall be designed and constructed so as to present no danger, either in normal use or under fault conditions, as determined by the tests in Annex A.

#### 4.12 Test facility

A test facility shall be provided to simulate either mechanically or electrically the presence of smoke in the sensing assembly. The test facility shall be accessible from outside the smoke alarm when installed as specified in the installation instructions.

#### 4.13 Terminals for external conductors

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.

For mains-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.

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If terminals are provided, they shall allow the connection of conductors having nominal cross-sectional areas of between 0,4 mm<sup>2</sup> and 1,5 mm<sup>2</sup>. 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.

#### 4.14 Smoke-alarm signals

The following conditions shall apply to smoke alarms which employ features in addition to the requirements of this International Standard.

- a) The alarm condition shall take precedence over any other signal, even when such other signal is initiated first.
- b) The 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 aural fault condition is provided, it shall be distinctive from alarm-condition signals but may be common to all functions employed.
- c) Any fault condition associated with features in addition to the requirements of this International Standard shall not interfere with the operation and supervision of the smoke alarm.

#### 4.15 Battery removal indication

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

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.

#### 4.16 Battery connections

Lead or terminal connections to batteries shall be identified with the correct polarity (plus or minus). The polarity may be indicated on the unit adjacent to the battery terminals or leads.

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 Protection against the ingress of foreign bodies

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

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 may introduce the danger of clogging by dust etc. It may therefore be necessary to take other measures.

#### 4.18 Interconnectable smoke alarms — Optional function

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 condition 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 condition 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 or sound-output requirements (see 5.17 and 5.18 or 5.19 as applicable).
- 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.

This requirement does not apply to mains- or mains/battery-supplied smoke alarms for which the supply and interconnect wiring should be installed in accordance with the appropriate national regulations.

#### 4.19 Alarm-silence facility — Optional function

If means of temporarily disabling or desensitizing a smoke alarm are provided, the following shall apply.

- a) The initiation of the alarm-silence period shall require the operation of a manual control on the smoke alarm. This control may be the same as a manual control provided for the test facility.
- b) Operation of the alarm-silence control shall disable or desensitize the smoke alarm for at least 5 min. The sensitivity of the smoke alarm shall be restored within 15 min 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 min or to more than 15 min.
- c) Continuous operation of the alarm-silence control shall not lead to the smoke alarm being disabled or desensitized for more than 15 min without an alarm condition, a fault condition or a battery-low condition occurring.

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

### 5 Tests

#### 5.1 General

##### 5.1.1 Optional functions

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

NOTE 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 standard with different combinations of functions to conform to this International Standard.

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

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.

Other functions may also be provided, even if not specified in this International Standard. 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.

##### 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 as described in IEC 60068-1 as follows:

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

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

### 5.1.3 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 (Clause 7).

### 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  $\pm 5\%$  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 B, 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  $(0,2 \pm 0,04)$  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  $(23 \pm 5)$  °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 min.

Introduce the test aerosol, as specified in Annex C, 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.