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Fire detection and alarm systems —

Part 7:
Point-type smoke detectors using scattered light, transmitted light or ionization

Systèmes de détection et d'alarme d'incendie —

Partie 7: Détecteurs de fumée ponctuels utilisant le principe de la diffusion de la lumière, de la transmission de la lumière ou de l'ionisation

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

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

This edition cancels and replaces the previous edition (ISO 7240:2018), which has been technically revised.

The main change compared to the previous edition is the revised response threshold values of Band 1 and Band 2 in Clause 4.2.

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

Introduction

A fire detection and alarm system is required to function satisfactorily not only in the event of fire, but also during and after exposure to conditions likely to be met in practice, including corrosion, vibration, direct impact, indirect shock and electromagnetic interference. Specific tests are intended to assess the performance of the smoke detectors under such conditions.

This document is not intended to place any other restrictions on the design and construction of such detectors.

This edition of this document introduces a requirement for smoke detectors that operate on the scattered or transmitted light principle to be marked with one of two possible nominal response threshold value bands. This marking provides for a clearer choice of response values so that the risk of unwanted alarms may be decreased in installations where unfavourable environmental conditions are present.

NOTE For some test fires, smoke detectors that operate on the scattered or transmitted light principle and that have been factory set to the upper response threshold value band can fall outside one of the classification limits given in ISO/TS 7240-9.

Fire detection and alarm systems —

Part 7:
Point-type smoke detectors using scattered light, transmitted light or ionization

1 Scope

This document specifies requirements, test methods and performance criteria for point-type smoke detectors that operate using scattered light, transmitted light or ionization, for use in fire detection and alarm systems installed in buildings (see ISO 7240-1). This document also covers point-type smoke detectors that incorporate more than one smoke sensor operating on these principles. Additional requirements and test methods for such detectors are given in Annex N.

For the testing of other types of smoke detectors, or smoke detectors working on different principles, this document is only intended to be used for guidance. This document is not applicable to smoke detectors with special characteristics, developed for specific risks.

NOTE Certain types of detectors contain radioactive materials.

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 209:2007, *Aluminium and aluminium alloys — Chemical composition*

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

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

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

3 Terms and definitions

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

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

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

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

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

— *m* (3.3), an absorbance index, used in the testing of smoke detectors using scattered or transmitted light;

— *y* (3.7), a dimensionless variable, used in the testing of smoke detectors using ionization

Note 1 to entry: 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
least sensitive orientation
point of rotation, relative to air flow, about the vertical axis where a detector produces the maximum response threshold value

3.3
absorbance index
m
measured light attenuation characterizing the concentration of particulates in smoke or an aerosol

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

3.4
closed detector
optical or ionization smoke detector with the sensing volume(s) inside the enclosure

Note 1 to entry: Smoke needs to enter the detector's enclosure to be detected.

3.5
open detector
optical smoke detector with the sensing volume(s) outside the enclosure

Note 1 to entry: Smoke is detected outside the detector's enclosure.

3.6
response threshold value
A_{th}
<smoke detector> aerosol density in the proximity of the specimen at the moment that it generates an alarm signal, when tested as specified in 5.1.5

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

3.7
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 Compliance

In order to comply with the provisions of this document, the detector shall meet the requirements of:

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

b) the tests as described in Clause 5;

c) Clauses 7 and 8, which shall be verified by visual inspection.

4.2 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 5.18.

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

Band	**Response threshold value lower limit in smoke tunnel (aerosol)** dB/m	**Test Fires (TF) 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 1 The smaller the *m* value, the higher the sensitivity of the detectors.					

4.3 Individual alarm indication

Each detector shall be provided with an integral red visual indicator by which the individual detector releasing an alarm can be identified, until the alarm condition is reset. Where other conditions of the detector may be visually indicated, these shall be clearly distinguishable from the alarm indication, except when the detector is switched into a service mode. For detachable detectors, the indicator may be integral with the base or the detector head.

NOTE The alarm condition is reset manually at the control and indicating equipment (see ISO 7240-2).

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

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

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

4.4 Connection of ancillary devices

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

4.5 Monitoring of detachable detectors

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

4.6 Manufacturer's adjustments

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

4.7 On-site adjustment of response behaviour

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

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

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

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

4.8 Protection against the ingress of foreign bodies

4.8.1 Closed detectors

Closed detectors shall be designed so that a sphere of diameter (1,3 ± 0,05) mm cannot pass into the sensor chamber(s).

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

4.8.2 Open detectors

The open detector shall be designed such that

a) a sphere of (1,3 ± 0,05) mm diameter cannot pass into any enclosure containing active optoelectronic components;

b) a total block of the detector surface shall not cause an alarm but shall signal a fault;

c) an object moving with minimum distance of 6 mm ± 1 mm to the nearest point of the surface of the detector shall not cause an alarm but shall signal a fault.

4.9 Response to slowly developing fires

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

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

The detector shall be deemed to meet the requirements of this clause if this assessment shows 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 detector, $A_{th,u}$, per hour, the time for the detector 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.

4.10 Requirements for software-controlled detectors

4.10.1 General

The requirements of 4.10.2 and 4.10.3 shall be met for detectors which rely on software control in order to fulfil the requirements of this document.

4.10.2 Software design

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

a) the software shall have a modular structure;

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

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

4.10.3 Storage of programs and data

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

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

5 Tests

5.1 General

5.1.1 Atmospheric conditions for tests

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

Temperature:	(15 to 35) °C
Relative humidity:	(25 to 75) %
Air pressure:	(86 to 106) kPa

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

5.1.2 Operating conditions for tests

If a test method requires a specimen to be operational, then connect the specimen to suitable supply and monitoring equipment having the characteristics required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the

tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range. If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices (e.g., through wiring to an end-of-line device for conventional detectors) to allow a fault signal to be recognized.

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

5.1.3 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 most unfavourable for each test.

5.1.4 Tolerances

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

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

5.1.5 Measurement of response threshold value

Install the specimen for which the response threshold value, A_{th}, 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 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 detector type.

Connect the specimen to its supply and monitoring equipment as specified in 5.1.2, and allow it to stabilize for a period of at least 15 min, unless otherwise specified by the manufacturer.

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

— for detectors 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 detector, so that a response can be obtained in a reasonable time.

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

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

5.1.6 Provision for tests

Provide the following for testing compliance with this document:

a) for detachable detectors, 20 detector heads and bases; for non-detachable detectors, 20 specimens;

b) the data specified in 8.1.

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

The specimens submitted shall be 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 twenty specimens found in the reproducibility test (5.4), should also represent the production mean, and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

5.1.7 Test schedule

Test the specimens in accordance with the test schedule in Table 2. After the reproducibility test, number the four least sensitive specimens (i.e. those with the highest response thresholds) 17 to 20 and the others 1 to 16 arbitrarily.

Table 2 — Test schedule

Test	Subclause	Specimen No.(s)
Repeatability	5.2	One chosen arbitrarily
Directional dependence	5.3	One chosen arbitrarily
Reproducibility	5.4	All specimens
Variation of supply parameters	5.5	1
Air movement	5.6	2
Dazzling[a]	5.7	3
Additional test for open detectors	5.8	3
Dry heat (operational)	5.9	4
Cold (operational)	5.10	5
Damp heat, steady state (operational)	5.11	6
Damp heat, steady state (endurance)	5.12	7
Sulfur dioxide (SO_2) corrosion (endurance)	5.13	8
Shock (operational)	5.14	9
Impact (operational)	5.15	10
Vibration, sinusoidal (operational)	5.16	11
Vibration, sinusoidal (endurance)	5.17	11
Electrostatic discharge (operational)	5.18	12[b]
Radiated electromagnetic fields (operational)	5.18	13[b]
Conducted disturbances induced by electromagnetic fields (operational)	5.18	14[b]
Fast transient bursts (operational)	5.18	15[b]
Slow high-energy voltage surge (operational)	5.18	16[b]
Fire sensitivity	5.19	17, 18, 19 and 20

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

[b] In the interests of test economy, it is permitted to use the same specimen for more than one EMC test. In that case, intermediate functional test(s) on the specimen(s) used for more than one test can be deleted, and the full functional test conducted at the end of the sequence of tests. However it should be noted that in the event of a failure, it may not be possible to identify which test exposure caused the failure.