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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 — Détecteurs 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.

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 7240-7 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

ISO 7240 consists of the following parts, under the general title *Fire detection and alarm systems*:

— *Part 1: General and definitions*

— *Part 2: Control and indicating equipment*

— *Part 4: Power supply equipment*

— *Part 5: Point-type heat detectors*

— *Part 6, Point-type fire detectors for detection of carbon monoxide*

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

— *Part 11: Manual call points*

— *Part 14: Guidelines for drafting codes of practice for design, installation and use of fire detection and fire alarm systems in and around buildings* [Technical Report]

— *Part 15: Multisensor fire detectors*

Compatibility assessment of system components and carbon monoxide point-type fire detectors using electrochemical cells are to form the subjects of future Parts 13 and 16.

Introduction

This part of ISO 7240, drawn up by ISO/TC 21/SC 3, is based on a draft prepared by the European Committee for Standardization's CEN/TC 72, *Automatic fire detection systems*.

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 part of ISO 7240 is not intended to place any other restrictions on the design and construction of such detectors.

Fire detection and alarm systems —

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

1 Scope

This part of ISO 7240 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.

For the testing of other types of smoke detectors, or smoke detectors working on different principles, this part of ISO 7240 can be used only for guidance. Smoke detectors with special characteristics, developed for specific risks, are not covered.

NOTE Certain types of detector contain radioactive materials. The national requirements for radiation protection differ from country to country and are not specified in this part of ISO 7240.

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 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: Tests. Tests A: Cold*

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

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

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

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

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

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

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 alarms using scattered or transmitted light;

— y (3.5), 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
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
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 C.

3.4
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 The response threshold value may depend on signal processing in the detector and in the control and indicating equipment.

3.5
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 C.

4 General requirements

4.1 Compliance

In order to comply with this part of ISO 7240, the detector shall meet the requirements of this clause, which shall be verified by visual inspection or engineering assessment, shall be tested as specified in Clause 5 and shall meet the requirements of the tests.

4.2 Individual alarm indication

Each detector shall be provided with an integral red visual indicator by which the individual detector releasing an alarm may 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. The visual indicator shall be visible from a distance of 6 m at up to 5° from the axis of the detector in any direction, in an ambient light intensity up to 500 lx.

4.3 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.

4.4 Monitoring of detachable detectors

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

4.5 Manufacturer's adjustments

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

4.6 On-site adjustment of response behaviour

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

a) for all of the settings at which the manufacturer claims compliance, the detector shall comply with the requirements of this part of ISO 7240 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 part of ISO 7240 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 these setting or settings are used, the detector does not comply with this part of ISO 7240.

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

4.7 Protection against the ingress of foreign bodies

The detector shall be so designed that a sphere of diameter greater than (1,3 ± 0,05) mm cannot pass into the sensor chamber or chambers.

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

4.8 Response to slowly developing fires

The provision of “drift compensation” (e.g. to compensate for sensor drift due to the build up of dirt in the detector), shall not lead to a significant reduction in the 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 $1{,}6 \times (A_{th,u}/R)$ 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.

4.9 Marking

Each detector shall be clearly marked with the following information:

a) a reference to this part of ISO 7240 (i.e. ISO 7240-7);

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

c) the model designation (type or number);

d) the wiring terminal designations;

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

For detachable detectors, the detector head shall be marked with a), b), c) and e), and the base shall be marked with, at least, c) and d).

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

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

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

4.10 Data

Either detectors shall be supplied with sufficient technical, installation and maintenance data to enable their correct installation and operation or, if all of these data are not supplied with each detector, reference to the appropriate data sheet shall be given on, or with, each detector.

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

Installation and maintenance data shall include reference to an *in situ* test method to ensure that detectors operate correctly when installed.

NOTE Additional information could be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this part of ISO 7240.

4.11 Requirements for software-controlled detectors

4.11.1 General

The requirements of 4.11.2, 4.11.3 and 4.11.4 shall be met for detectors which rely on software control in order to fulfil the requirements of this part of ISO 7240.

4.11.2 Software documentation

4.11.2.1 The manufacturer shall submit documentation which gives an overview of the software design. This documentation shall be in sufficient detail for the design to be inspected for compliance with this part of ISO 7240 and shall include at least the following:

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

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

   2) the way in which the modules interact,

   3) the overall hierarchy of the program,

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

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

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

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

4.11.2.2 The manufacturer shall have available detailed design documentation, but which is to be provided to the testing authority only when required by that authority. It shall comprise at least the following:

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

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

   1) the name of the module,

   2) a description of the tasks performed,

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

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

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

4.11.3 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.

4.11.4 Storage of programs and data

The program necessary to comply with this part of ISO 7240 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 will retain data for at least two weeks without external power to the detector, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.

5 Tests

5.1 General

5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, 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 $(0{,}2 \pm 0{,}04)$ 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 ± 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: $0{,}015 \leqslant \frac{\Delta m}{\Delta t} \leqslant 0{,}1$;

— for detectors using ionization, per minute: $0{,}05 \leqslant \frac{\Delta y}{\Delta t} \leqslant 0{,}3$.

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 part of ISO 7240:

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

b) the data specified by 4.10.

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 1. 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 1 — 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
Dry heat (operational)	5.8	4
Cold (operational)	5.9	5
Damp heat, steady state (operational)	5.10	6
Damp heat, steady state (endurance)	5.11	7
Sulfur dioxide (SO_2) corrosion (endurance)	5.12	8
Shock (operational)	5.13	9
Impact (operational)	5.14	10
Vibration, sinusoidal (operational)	5.15	11
Vibration, sinusoidal (endurance)	5.16	11
Electrostatic discharge (operational)	5.17	12[b]
Radiated electromagnetic fields (operational)	5.17	13[b]
Conducted disturbances induced by electromagnetic fields (operational)	5.17	14[b]
Fast transient bursts (operational)	5.17	15[b]
Slow high-energy voltage surge (operational)	5.17	16[b]
Fire sensitivity	5.18	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.

5.1.8 Test report

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

5.2 Repeatability

5.2.1 Object of test

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

5.2.2 Test procedure

Measure the response threshold value of the specimen to be tested six times as specified in 5.1.5.

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}, the minimum value as y_{min} or m_{min}.

5.2.3 Requirements

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

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

5.3 Directional dependence

5.3.1 Object of test

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

5.3.2 Test procedure

Measure the response threshold value of the specimen to be tested eight times as specified in 5.1.5, 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 as y_{max} or m_{max}; the minimum value as y_{min} or m_{min}.

Record the least sensitive and the most sensitive orientations. 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.

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

5.4 Reproducibility

5.4.1 Object of test

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

5.4.2 Test procedure

Measure the response threshold value of each of the test specimens as specified in 5.1.5.

Calculate the mean of these response threshold values which shall be designated $\overline{y}$ or $\overline{m}$.

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

