International Standard

ISO 7240-27

Fire detection and alarm systems —

Part 27: Point type fire detectors using a smoke sensor in combination with a carbon monoxide sensor and, optionally, one or more heat sensors

Systèmes de détection et d'alarme d'incendie —

Partie 27: Détecteurs ponctuels d'incendie utilisant un capteur de fumée en combinaison avec un capteur de monoxyde de carbone (CO) et, optionnellement, un ou plusieurs capteurs de chaleur

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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).

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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 fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

This third edition cancels and replaces the second edition (ISO 7240-27:2018), which has been technically revised.

The main changes are as follows:

— the use of the threshold values of Band 1 and Band 2 (introduced in the previous edition) has been simplified, thereby avoiding unnecessary repetitions.

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

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

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

The performance of multi-sensor point fire detectors that incorporate a smoke sensor, a carbon monoxide (CO) sensor and, optionally, one or more heat sensors is assessed from results obtained in the tests specified in this document, This document is not intended to place any restrictions on the design and construction of such detectors.

Smoke detectors using ionization or optical sensors, and conforming to ISO 7240-7, are well established for the protection of life and property. Even so, they can respond to stimuli other than smoke and, in some circumstances, can be prone to false alarms. False alarm rates are usually minimized by careful application, giving some limitations in use, and occasionally with a reduction in protection provided.

It is generally accepted that fire detectors using carbon monoxide (CO) sensors alone, while suitable for the detection of smouldering fires involving carbonaceous fuels, can be relatively insensitive to free-burning fires supported by a plentiful supply of oxygen. This limitation can be largely overcome by the inclusion of a heat sensor whose output is combined in some way with that of the CO sensor. Performance requirements for CO fire detectors and for CO and heat detectors can be found in ISO 7240-6 and ISO 7240-8 respectively.

Although the CO and heat detector is capable of responding to free-burning fires, it can still be relatively insensitive to low-temperature fires that produce large amounts of visible smoke but low concentrations of CO and little heat. This limitation prevents the CO and heat detector from being a true replacement for a smoke detector in life safety applications.

Many false alarm sources that affect smoke detectors do not produce CO. It is therefore possible that, by adding a CO sensor to a smoke detector and combining its output in some way with that of the smoke sensor, the incidence of false alarms can be reduced. This reduction can be achieved while simultaneously providing the ability to respond to a broader range of fire types than is possible with either a smoke or CO detector alone.

It is possible to improve the performance even further by adding a heat sensor to assist in the response to clean-burning, high energy fires. This improvement is seen as secondary to the overall performance and for this reason the heat sensor is treated as optional for compliance with this document.

This document includes 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 of Band 1 or Band 2. This marking provides for a clearer choice of response values so that the risk of unwanted alarms can 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/TR 7240-9.

Fire detection and alarm systems —

Part 27:
Point type fire detectors using a smoke sensor in combination with a carbon monoxide sensor and, optionally, one or more heat sensors

1 Scope

This document specifies requirements, test methods and performance criteria for multi-sensor point fire detectors that incorporate a smoke sensor, a carbon monoxide (CO) sensor and, optionally, one or more heat sensors, for use in fire detection and alarm systems installed in buildings (see ISO 7240-1).

This document is not applicable to fire detectors using smoke, CO and, optionally heat sensors, which have special characteristics, and which have been developed for specific risks. For the testing of other types of fire detectors using smoke, CO and, optionally, heat sensors working on different principles, this document can therefore be used only for guidance.

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, *Wrought aluminium and aluminium alloys — Chemical composition*

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

ISO 7240-5, *Fire detection and fire alarm systems — Part 5: Point type heat detectors*

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

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

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

IEC 60068-2-2, *Environmental testing — Part 2-2: Tests — Test 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 60068-2-30, *Environmental testing — Part 2-30: Tests — Test Db: Damp, cyclic (12 h + 12 h cycle)*

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 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
response threshold value
magnitude of the reference parameter at which the detector enters an alarm state when subjected to changes in the smoke or carbon monoxide concentration or temperature

EXAMPLE Smoke response threshold value, CO response threshold value.

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

4 General requirements

4.1 Conformance

In order to conform to this document, the detector shall meet the requirements of:

— Clause 4, which shall be verified by visual inspection or engineering assessment, shall be tested as described in Clause 5 and shall meet the requirements of the tests;

— 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, giving the lower limit as the response threshold value in the smoke tunnel, and the upper limit as the end-of-test condition of the test fires specified in 5.31.

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 end-of-test conditions			
		TF2 dB/m	**TF3** dB/m	**TF4** dimensionless	**TF5** dimensionless
1	$m = 0,05$	$m = 2$	$m = 2$	$y = 6$	$y = 6$
2	$m = 0,2$	$m = 2$	$m = 2$	$y = 6,5$	$y = 7,5$

NOTE 1 The smaller the *m* value, the higher the sensitivity of the detectors.

NOTE 2 For details on *y*, see 5.1.5.

4.3 Individual alarm indication

Each detector shall be provided with an integral red visual indicator, by which the individual detector that released an alarm can be identified, until the alarm condition is reset. Where other conditions of the detector can 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 in an ambient light intensity up to 500 lx at an angle of up to:

— 5° from the axis of the detector in any direction;

— 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 (e.g. remote indicators, control relays), but open-circuit 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 equipment (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 conformance to this document, the detector shall conform to 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(s) at which the manufacturer does not claim conformance to 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 these setting(s) are used the detector does not conform to 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

The detector shall be so designed that a sphere of diameter (1,3 ± 0,05) mm cannot pass into the smoke sensing chamber of the detector, where such an ingress could affect its sensitivity.

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.

4.9 Rate-sensitive CO response behaviour

The response threshold value of the detector can depend on the rate of change of CO concentration in the vicinity of the detector. Such behaviour may be incorporated in the detector design to improve the discrimination between ambient CO concentrations and those generated by a fire. If such rate-sensitive behaviour is included, then it shall not lead to a significant reduction in the sensitivity of the detector to fires, nor shall it lead to a significant increase in the probability of unwanted alarms.

Since it is not practical to make tests with all possible rates of increase in CO concentration, an assessment of the rate sensitivity of the detector shall be made by analysis of either the circuit or software or physical tests and simulations, or all three.

The detector shall be deemed to meet the requirements of 4.9 if this assessment shows that:

a) for any rate of increase in CO concentration less than 1 µl/l per min, the detector will signal an alarm condition before the CO concentration reaches 60 µl/l; and

b) the detector does not produce an alarm condition when subjected to a step change in CO concentration of 10 µl/l, superimposed on a background concentration of between 0 µl/l and 5 µl/l.

4.10 Smoke response to slowly developing fires

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

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

The detector shall be deemed to meet the requirements of 4.10 if this assessment shows that:

a) for any rate of increase in smoke density, R, which is greater than $\frac{A}{4}$ per hour (where A is the detector's initial uncompensated response threshold value), the time for the detector to give an alarm does not exceed $1{,}6 \times \frac{A}{R}$ by more than 100 s, and

b) the range of compensation is limited such that, throughout this range, the compensation does not cause the response threshold value of the detector to exceed its initial value by a factor greater than 1,6.

4.11 Requirements for software-controlled detectors

4.11.1 General

The requirements of 4.11.2 and 4.11.3 shall apply to detectors that rely on software control in order to fulfil the requirements of this document.

4.11.2 Software design

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

— The software shall have a modular structure.

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

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

4.11.3 Storage of programs and data

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

Site-specific data shall be held in memory that 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 Test methods

5.1 General

5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as 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 the specimen shall be connected to suitable supply and monitoring equipment with characteristics as required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range. If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices (e.g. through wiring to an end-of-line device for collective (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 (see Clause 6).

5.1.3 Mounting arrangements

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

5.1.4 Tolerances

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

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

5.1.5 Measurement of smoke response threshold value

Measure the smoke response threshold value of the specimen using the method described in ISO 7240-7. The CO level in the smoke tunnel throughout the test shall not exceed 1,5 µl/l.

Record the aerosol density at the moment that the specimen gives an alarm signal, or a signal specified by the manufacturer, as m (dB/m) for detectors using scattered or transmitted light, or as y for detectors using ionization. This shall be taken as the smoke response threshold value.

If the detector is not capable of giving an alarm signal from smoke alone, the manufacturer shall provide special means by which the smoke response threshold value can be measured. For example, it can potentially be acceptable to provide a supplementary output that varies with the aerosol density, or specially modified software to indicate when the aerosol density has caused an internal threshold to be reached. In such cases

the special means should be chosen such that the nominal smoke response threshold value is in the range (0,05 to 0,7) dB/m for detectors using scattered or transmitted light, or (0,2 to 2,0) y for detectors using ionization.

NOTE Detectors for which the manufacturer claims conformance to ISO 7240-7 are subjected to the tests required in that document. In such cases, the response threshold values measured in those tests can be used as the smoke response threshold values for the purposes of this document.

5.1.6 Measurement of CO response threshold value

Install the specimen for which the response threshold value is to be measured in a gas test chamber, as specified in Annex A and as described in 5.1.3. The orientation of the specimen, relative to the direction of gas 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, the gas test chamber shall be purged to ensure that the carbon monoxide concentration is less than 1,5 µl/l.

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 gas test chamber shall be (23 ± 5) °C and shall not vary by more than 5 K 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.

Increase the carbon monoxide gas concentration at a rate of between 1 µl/l/min and 6 µl/l/min until either the specimen has entered an alarm state or the concentration has reached 100 µl/l. Record the time and carbon monoxide concentration at the moment the specimen gives an alarm. This shall be taken as the response threshold value, S.

If the detector is not capable of giving an alarm signal from CO alone, the manufacturer shall provide special means by which the CO response threshold value can be measured. For example, it can potentially be acceptable to provide a supplementary output that varies with the CO concentration, or specially modified software to indicate when the CO concentration has caused an internal threshold to be reached. In such cases the special means should be chosen such that the nominal CO response threshold value is in the range 30 µl/l to 60 µ/l.

NOTE 1 Detectors for which the manufacturer claims conformance to ISO 7240-6 or ISO 7240-8 are subjected to the tests required in those documents. In such cases, the response threshold values measured in those tests can be used as the CO response threshold values for the purposes of this document.

For detectors whose response is rate sensitive, the manufacturer may specify a rate of increase within this range to ensure that the measured response threshold value is representative of the static response threshold value of the detector. The rate of increase in CO concentration shall be similar for all measurements on a particular detector type.

5.1.7 Measurement of heat response value

Where detectors conform to ISO 7240-5, the response times measured in those tests may be used as the heat response values for the purposes of this document.

Install the specimen for which the temperature response value is to be measured in a heat tunnel, as specified in Annex B and mounted as described in 5.1.3. The orientation of the specimen, relative to the direction of airflow, shall be the least sensitive one, as determined in the directional dependence test (5.6), unless otherwise specified in the test procedure.

Connect the specimen to its supply and monitoring equipment as specified in 5.1.2, and allow it to stabilize for at least 15 min.