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Fire detection and alarm systems —

Part 27:
Point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor

Systèmes de détection et d'alarme d'incendie —

Partie 27: Détecteurs d'incendie ponctuels utilisant un détecteur de fumée basé sur le principe de la diffusion de la lumière, de la transmission de la lumière ou de l'ionisation, un détecteur de monoxyde de carbone à cellule électrochimique et un détecteur 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.

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 7240-27 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: Carbon monoxide fire detectors using electro-chemical cells*

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

— *Part 8: Carbon monoxide fire detectors using an electro-chemical cell in combination with a heat sensor*

— *Part 9: Test fires for fire detectors* (Technical Specification)

— *Part 10: Point-type flame detectors*

— *Part 11: Manual call points*

— *Part 12: Line type smoke detectors using a transmitted optical beam*

— *Part 13: Compatibility assessment of system components*

— *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: Point type fire detectors using scattered light, transmitted light or ionization sensors in combination with a heat sensor*

— *Part 16: Sound system control and indicating equipment*

— *Part 19: Design, installation, commissioning and service of sound systems for emergency purposes*

— *Part 21: Routing equipment*

— *Part 22: Smoke-detection equipment for ducts*

— *Part 27: Point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor*

— *Part 28: Fire protection control equipment*

The following parts are under development:

— Part 17, dealing with short-circuit isolators;

— Part 18, dealing with input/output devices;

— Part 20, dealing with aspirating smoke detectors;

— Part 24, dealing with sound-system loudspeakers;

— Part 25, dealing with components using radio links;

— Part 26, dealing with oil mist detectors.

Introduction

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

The performance of fire detectors is assessed from results obtained in specific tests; this part of ISO 7240 is not intended to place any other restrictions on the design and construction of such detectors.

Smoke detectors using ionization or optical sensors, and complying with 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-detector — heat-detector combination 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 possible, therefore, 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 can be 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 part of ISO 7240.

Fire detection and alarm systems —

Part 27: Point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor

1 Scope

This part of ISO 7240 specifies requirements, test methods and performance criteria for multi-sensor point-type fire detectors that incorporate an optical or ionization smoke sensor, an electro-chemical cell for sensing carbon monoxide (CO) and, optionally, one or more heat sensors, for use in fire detection and alarm systems installed in buildings (see ISO 7240-1).

For the testing of other types of fire detectors using smoke, CO and, optionally, heat sensors working on different principles, this part of ISO 7240 can be used only for guidance. Fire detectors using smoke, CO and, optionally, heat sensors which have special characteristics and which have been developed for specific risks are not covered by 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*

ISO 7240-5:2003, *Fire detection and alarm systems — Part 5: Point-type heat detectors*

ISO 7240-6, *Fire detection and alarm systems — Part 6: Carbon monoxide fire detectors using electro-chemical cells*

ISO 7240-7:2003, *Fire detection and alarm systems — Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

ISO 7240-8, *Fire detection and alarm systems — Part 8: Carbon monoxide fire detectors using an electro-chemical cell in combination with a heat sensor*

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 heat, 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*

EN 50130-4:1995 (as amended), *Alarm Systems — Part 4: Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder and social alarm systems*

3 Definitions

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

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, as described in 5.1.5, 5.1.6 or 5.1.7 (as applicable)

EXAMPLES Smoke response threshold value, CO response threshold value.

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

3.2
sensing assembly
those parts of the detector that are required in order to produce an electrical change in response to changes in the concentration of one of the sensed inputs

EXAMPLES Smoke sensing assembly, CO sensing assembly.

4 General requirements

4.1 Compliance

In order to comply with this part of ISO 7240 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.

4.2 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 of up to 500 lx and at an angle of up to

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

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

4.3 Connection of ancillary devices

The detector may provide for connections to ancillary devices (e.g. 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 for which the manufacturer claims compliance with this part of ISO 7240, 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(s) for 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(s) are used, the detector does not comply with this part of ISO 7240.

These adjustments may be carried out on the detector or on 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 (1,3 ± 0,05) mm cannot pass into the smoke sensing chamber of the detector, where such an ingress can 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.

4.8 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's 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 detector's sensitivity to fires, nor shall it lead to a significant increase in the probability of unwanted alarms.

Since it is not practical to conduct 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 the circuit/software and/or physical tests and simulations.

The detector shall be deemed to meet the requirements of 4.8 if this assessment shows that

a) for any rate of increase in CO concentration less than 1 µl/l/min, the detector signals 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.

4.9 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 conduct 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 the circuit/software, and/or physical tests and simulations.

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

a) for any rate of increase in smoke density, R, which is greater than $A/4$ 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 $1{,}6 \times A/R$ 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.

4.10 Marking

Each detector shall be clearly marked with the following information:

a) number of this part of ISO 7240 (i.e. ISO 7240-27);

b) name or trademark of the manufacturer or supplier;

c) model designation (type or number);

d) 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), i.e. its own model designation, and d).

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

The marking 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.

4.11 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 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 can be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this part of ISO 7240.

4.12 Requirements for software controlled detectors

4.12.1 General

The requirements of 4.12.2, 4.12.3 and 4.12.4 shall apply to detectors that rely on software control in order to fulfil the requirements of this part of ISO 7240.

4.12.2 Software documentation

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

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

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

   2) way in which the modules interact,

   3) overall hierarchy of the program,

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

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

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

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

4.12.2.2 The manufacturer shall have available detailed design documentation, which it is necessary to provide only if required by the testing authority. It shall comprise at least the following:

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

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

   1) name of the module,

   2) description of the tasks performed,

   3) 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 a hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment to recognize the program flow;

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

4.12.3 Software design

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

4.12.4 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 that can 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, 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:

a) temperature: (15 to 35) °C;

b) relative humidity: (25 to 75) %;

c) 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 that a specimen 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 that a specimen 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 the recognition of a fault signal].

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

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 IEC 60068).

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

5.1.5.1 Measure the smoke response threshold value of the specimen using the method described in ISO 7240-7:2003, 5.1.5. The CO level in the smoke tunnel throughout the test shall not exceed 3 µl/l.

5.1.5.2 Record the aerosol density at the moment that the specimen gives an alarm signal, or a signal specified by the manufacturer, as m, expressed in decibels per metre, for detectors using scattered or transmitted light, or as y for detectors using ionization. This shall be taken as the smoke response threshold value.

Detectors for which the manufacturer claims compliance with ISO 7240-7 shall be subjected to the tests required in that part of ISO 7240. In such cases, the response threshold values measured in those tests may be used as the smoke response threshold values for the purposes of this part of ISO 7240.

NOTE If the detector is not capable of giving an alarm signal from smoke alone, it is necessary for the manufacturer to provide special means by which the smoke response threshold value can be measured. For example, it can 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 preferably be chosen such that the nominal smoke response threshold value is in the range 0,05 dB/m to 0,7 dB/m for detectors using scattered or transmitted light, or $y = 0{,}2$ to $y = 2{,}0$ for detectors using ionization.

5.1.6 Measurement of CO response threshold value

5.1.6.1 Install the specimen for which the response threshold value is being measured as described in 5.1.3 in a gas test chamber, as specified in Annex A. 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.

5.1.6.2 Before commencing each measurement, the gas test chamber shall be purged to ensure that the carbon monoxide concentration is less than 1 µl/l.

5.1.6.3 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.

5.1.6.4 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.

5.1.6.5 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.