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Fire detection and alarm systems —

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

Systèmes de détection et d'alarme d'incendie —

Partie 8: Détecteurs de monoxyde de carbone pour la détection d'incendie utilisant une cellule électrochimique en combinaison avec un capteur 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 7240-8 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 26, dealing with oil mist detectors, and Part 28, dealing with fire protection control equipment, are under development.

Introduction

This part of ISO 7240 has been prepared by the Subcommittee ISO/TC 21/SC 3 and is based on both ISO 7240-5 for heat detectors and ISO 7240-6 for carbon monoxide fire detectors.

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. Some tests specified are intended to assess the performance of the 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.

Carbon monoxide (CO) fire detectors can react promptly to slow, smouldering fires involving carbonaceous materials. Although in the majority of fires the products of combustion are transported by convection, the gaseous nature of CO means that it also diffuses and, particularly in low energy fires, it can move ahead of the smoke plume and thus provide earlier detection.

CO fire detectors alone might not react quickly to flaming fires and the addition of a heat sensor as described in this part of ISO 7240 provides better detection to a broader spectrum of fires.

CO fire detectors based on electrochemical cells might be better suited to applications where smoke detectors can produce unwanted alarms due to the presence of dust, steam or cooking vapours, etc.

Whilst CO gas has greater mobility than smoke, it can be diluted by ventilation systems and be affected by convection currents. Hence, the same considerations as for point smoke detectors should be taken into account. Re-circulating systems confined to a single room have little effect on dilution, as this is similar to the natural diffusion of the CO gas.

It is important that the location of CO fire detectors take into account areas where false operation or non-operation is likely. Some typical locations where it is important to carefully evaluate the use of CO fire detectors are

a) areas where CO gas can be present from exhausts and normal manufacturing processes;

EXAMPLES Car parks, car-park return air plenums, loading docks.

b) confined areas where cigarette smoking is likely.

Fire detection and alarm systems —

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

1 Scope

This part of ISO 7240 specifies requirements, test methods and performance criteria for point multi-sensor fire detectors that incorporate an electrochemical cell for sensing carbon monoxide (CO) in combination with 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 CO multi-sensor fire detectors, or CO and heat multi-sensor fire detectors working on different principles, this part of ISO 7240 can be used for guidance. CO and heat multi-sensor fire detectors with special characteristics and 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*

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

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

IEC 60068-2-2, *Environmental testing — Part 2: Tests — Test 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 60068-2-30, *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, *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
CO response threshold value
CO concentration in the proximity of the specimen at the moment that it generates an alarm signal, when tested in accordance with 5.1.5

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

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 to 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

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.

4.3 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, at 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 means of adjustment 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 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 at the detector or at the control and indicating equipment.

4.7 Rate-sensitive 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 the circuit/software and/or physical tests and simulations.

The detector shall be deemed to meet the requirements of this subclause 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.

4.8 Marking

Each detector shall be clearly marked with the following information:

a) number of this part of ISO 7240 (i.e. ISO 7240-8);

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;

f) life-expectancy of the electro-chemical cell under normal operating conditions.

For detachable detectors, the detector head shall be marked with a), b), c), e) and f), 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.

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

4.10 Requirements for software controlled detectors

4.10.1 General

The requirements of 4.10.2, 4.10.3 and 4.10.4 shall apply to detectors that rely on software control in order to fulfil the requirements of this part of ISO 7240.

4.10.2 Software documentation

4.10.2.1 The manufacturer shall submit documentation that 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) functional description of the main program flow (e.g. as a flow diagram or schema) including the following:

   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) 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.

4.10.2.2 The manufacturer shall have available detailed design documentation, which is required to be provided 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 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 (e.g. CASE-Tools, Compilers, etc.).

4.10.3 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.

4.10.4 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 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, 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 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 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 CO response threshold value

5.1.5.1 Install the specimen for which the response threshold value is being measured in a gas test chamber, as specified in Annex A, in its normal operating position, by its normal means of attachment. 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 (5.3), unless otherwise specified in the test procedure.

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

5.1.5.3 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.

5.1.5.4 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.

5.1.5.5 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.

5.1.5.6 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.

5.1.5.7 Introduce carbon monoxide gas at a rate of between 1 µl/l/min and 6 µl/l/min until the specimen has entered an alarm state. 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.

To avoid an unnecessarily high level of CO, the test may be stopped when the CO concentration reaches 100 µl/l.

5.1.5.8 The rate of increase in CO concentration shall be similar for all measurements on a particular detector type.

5.1.5.9 Record the carbon monoxide concentration at the moment the specimen gives an alarm. This shall be taken as the CO response threshold value, S.

5.1.6 Measurement of heat sensor response value

5.1.6.1 Where detectors comply with ISO 7240-5, the response times measured in those tests may be used as the heat-response values for the purposes of this part of ISO 7240.

5.1.6.2 Install the specimen for which the temperature response value is being measured in a heat tunnel, as specified in Annex B, in its normal operating position, by its normal means of attachment. The orientation of the specimen relative to the direction of airflow shall be the least sensitive one, as determined in the directional dependence test (5.4), unless otherwise specified in the test procedure.

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

5.1.6.4 Before the test, stabilize the temperature of the air stream and the specimen to (25 ± 2) °C. Maintain the air stream at a constant mass flow equivalent to a velocity of (0,8 ± 0,1) m/s at 25 °C.

5.1.6.5 Raise the air temperature at a rate specified in the test and measure the heat-response value as specified in ISO 7240-5:2003, 5.1.5, until the signal specified by the manufacturer is produced by the heat sensor.

If the detector is not capable of giving an alarm signal from heat alone, it is the responsibility of the manufacturer to provide a special means by which the heat-response value can be measured. For example, it may be acceptable to provide a supplementary output that varies with temperature, or specially modified software to indicate when the air temperature has caused an internal threshold to be reached. In such cases the special means should preferably be chosen such that the nominal heat-response value corresponds to a response time between the minimum and maximum times given in ISO 7240-5:2003, Table 4, for a class A2 detector. It is essential that the output signal be routed through the amplification path.

5.1.6.6 Assess the heat-response value as

a) the time taken from the start of the temperature increase to the point at which the heat signal reaches a level specified by the manufacturer, or the detector gives an alarm signal, or

b) the change in signal level produced in a certain time.

NOTE In the case of a), a shorter time represents a higher sensitivity. In the case of b) a larger change represents a higher sensitivity.

5.1.6.7 Record the measured heat-response value as T.

5.1.7 Provision for tests

The following shall be provided for testing compliance with this part of ISO 7240:

a) for detachable detectors: 24 detector heads and bases; for non-detachable detectors: 24 specimens;

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.

b) the data required in 4.10;

c) means to enable a quantitative measurement of the heat-response value of the temperature sensing element(s) of the detector according to 5.1.6.

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 specimens found in the reproducibility test (5.6 and 5.7), should also represent the production mean, and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

5.1.8 Test schedule

The specimens shall be tested according to the following test schedule; see Table 1. After the reproducibility test, number the four least sensitive specimens (i.e. those with the highest CO response thresholds) 21 to 24, and number the remaining 1 to 20 arbitrarily.