



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



This Australian Standard® was prepared by Committee FP-002, Fire Detection, Warning, Control and Intercom Systems. It was approved on behalf of the Council of Standards Australia on 21 July 2016.
This Standard was published on 22 August 2016.

The following are represented on Committee FP-002:

- Association of Hydraulic Services Consultants Australia
 - Australasian Fire and Emergency Service Authorities Council
 - Australian Chamber of Commerce and Industry
 - Australian Industry Group
 - Australian Institute of Building Surveyors
 - CSIRO
 - Deafness Forum of Australia
 - Department of Human Services, Vic.
 - Engineers Australia
 - Fire Protection Association Australia
 - National Electrical and Communications Association
 - National Fire Industry Association
 - Property Council of Australia
 - Society of Fire Safety
-

This Standard was issued in draft form for comment as DR AS ISO 7240.27:2016.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

Keeping Standards up-to-date

Australian Standards® are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments that may have been published since the Standard was published.

Detailed information about Australian Standards, drafts, amendments and new projects can be found by visiting www.standards.org.au

Standards Australia welcomes suggestions for improvements, and encourages readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at mail@standards.org.au, or write to Standards Australia, GPO Box 476, Sydney, NSW 2001.

Australian Standard[®]

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

First published as AS ISO 7240.27:2016.

COPYRIGHT

© Standards Australia Limited

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968.

Published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001, Australia

ISBN 978 1 76035 556 2

PREFACE

This Standard was prepared by Standards Australia Committee FP-002, Fire Detection, Warning, Control and Intercom Systems.

The objective of this Standard is to specify requirements, test methods and performance criteria for a point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor, for use in fire detection and alarm systems.

This Standard is identical with, and has been reproduced from ISO 7240-27:2009, *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*.

As this Standard is reproduced from an International Standard, the following applies:

- (a) In the source text 'this part of ISO 7240' should read 'this Australian Standard'.
- (b) A full point substitutes for a comma when referring to a decimal marker.

References to International Standards should be replaced by references to Australian Standards, as follows:

<i>Reference to International Standard</i>		<i>Australian Standard</i>	
ISO		AS	
7240	Fire detection and alarm systems	7240	Fire detection and alarm systems
7240-1	Part 1: General and definitions	7240.1	Part 1: General and definitions
7240-5	Part 5: Point-type heat detectors	7240.5	Part 5: Point type heat detectors (ISO 7240-5:2003, MOD)
7240-6	Part 6: Carbon monoxide fire detectors using electro-chemical cells	7240.6	Part 6: Carbon monoxide fire detectors using electro-chemical cells
7240-7	Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization	7240.7	Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization (ISO 7240-7:2003, MOD)
IEC			
60068	Environmental testing	60068	Environmental testing
60068-1	Part 1: General and guidance	60068.1	Part 1: General and guidance
60068-2-1	Part 2-1: Test—Test A: Cold	60068.2.1	Part 2.1: Tests—Tests A: Cold
60068-2-2	Part 2-2: Test—Test B: Dry heat	60068.2.2	Part 2.2: Tests—Tests B: Dry heat
60068-2-6	Part 2-6: Test—Test Fc: Vibration (sinusoidal)	60068.2.6	Part 2.6: Tests—Test Fc: Vibration (sinusoidal)
60068-2-27	Part 2-27: Tests—Test Ea and guidance: Shock	60068.2.27	Part 2.27: Tests—Test Ea and guidance: Shock
60068-2-30	Part 2-30: Tests—Test Db Damp heat, cyclic (12 h + 12 h cycle)	60068.2.30	Part 2.30: Tests—Test Db Damp heat, cyclic (12 h + 12 h cycle)
60068-2-42	Part 2-42: Tests—Test Kc: Sulphur dioxide test for contacts and connections	60068.2.42	Part 2.42: Tests—Test Kc: Sulphur dioxide test for contacts and connections
60068-2-78	Part 2-78: Tests—Test Cab: Damp heat, steady state	60068.2.78	Part 2.78: Tests—Test Cab: Damp heat, steady state

Only normative references that have been adopted as Australian Standards have been listed.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the annexes to which they apply. A 'normative' annex is an integral part of a Standard, whereas an 'informative' annex is only for information and guidance.

CONTENTS

1	Scope	1
2	Normative references	1
3	Definitions	2
4	General requirements	2
4.1	Compliance	2
4.2	Individual alarm indication	2
4.3	Connection of ancillary devices	3
4.4	Monitoring of detachable detectors	3
4.5	Manufacturer's adjustments	3
4.6	On-site adjustment of response behaviour	3
4.7	Protection against the ingress of foreign bodies	3
4.8	Rate-sensitive CO response behaviour	3
4.9	Smoke response to slowly developing fires	4
4.10	Marking	4
4.11	Data	5
4.12	Requirements for software controlled detectors	5
5	Tests	6
5.1	General	6
5.2	Repeatability of smoke response	11
5.3	Repeatability of CO response	11
5.4	Directional dependence of smoke response	11
5.5	Directional dependence of CO response	12
5.6	Directional dependence of heat response (optional function)	12
5.7	Lower limit of heat response (optional function)	13
5.8	Reproducibility of smoke response	13
5.9	Reproducibility of CO response	14
5.10	Reproducibility of heat response (optional function)	14
5.11	Exposure to chemical agents at environmental concentrations	15
5.12	Long-term stability of CO response	16
5.13	Saturation	16
5.14	Exposure to chemical agents associated with a fire	17
5.15	Variation in supply parameters	18
5.16	Air movement	19
5.17	Dazzling	20
5.18	Dry heat (operational)	20
5.19	Cold (operational), smoke	21
5.20	Cold (operational), CO	23
5.21	Damp heat cyclic (operational)	24
5.22	Damp heat, steady state (endurance)	25
5.23	Low humidity, steady state (endurance)	26
5.24	Sulfur dioxide SO ₂ corrosion (endurance)	27
5.25	Shock (operational)	28
5.26	Impact (operational)	29
5.27	Vibration, sinusoidal (operational)	30
5.28	Vibration, sinusoidal (endurance)	32
5.29	Electromagnetic compatibility (EMC) immunity tests (operational)	33
5.30	Fire sensitivity	34
6	Test report	36

Annex A (normative) Gas test chamber for response threshold value and cross sensitivity measurements	37
Annex B (informative) Construction of the heat tunnel	38
Annex C (normative) Apparatus for impact test.....	41
Annex D (normative) Fire test room	43
Annex E (normative) Smouldering (pyrolysis) wood fire (TF2)	45
Annex F (normative) Glowing, smouldering cotton fire (TF3)	48
Annex G (normative) Open plastics (polyurethane) fire (TF4).....	51
Annex H (normative) Liquid (heptane) fire (TF5).....	53
Annex I (normative) Low-temperature, black-smoke (decalin) liquid fire (TF8).....	55
Annex J (informative) Information concerning the construction of the gas test chamber.....	57

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.

NOTES

AUSTRALIAN STANDARD

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 $(1,3 \pm 0,05)$ 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 $1 \mu\text{l/l/min}$, the detector signals an alarm condition before the CO concentration reaches $60 \mu\text{l/l}$, and
- b) the detector does not produce an alarm condition when subjected to a step change in CO concentration of $10 \mu\text{l/l}$, superimposed on a background concentration of between $0 \mu\text{l/l}$ and $5 \mu\text{l/l}$.

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 $\pm 5\%$ 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 $3\ \mu\text{l/l}$.

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 $0,05\ \text{dB/m}$ to $0,7\ \text{dB/m}$ 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 $1\ \mu\text{l/l}$.

5.1.6.3 The air velocity in the proximity of the specimen shall be $(0,2 \pm 0,04)\ \text{m/s}$ 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 $(23 \pm 5)\ ^\circ\text{C}$ and shall not vary by more than $5\ \text{K}$ 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 $15\ \text{min}$, unless otherwise specified by the manufacturer.

5.1.6.6 Increase carbon monoxide gas concentration at a rate of between 1 $\mu\text{l/l}/\text{min}$ and 6 $\mu\text{l/l}/\text{min}$ until either the specimen has entered an alarm state or the concentration has reached 100 $\mu\text{l/l}$. 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 .

Detectors for which the manufacturer claims compliance with ISO 7240-6 or ISO 7240-8 shall be subjected to the tests required in the respective part of ISO 7240. In such cases, the response threshold values measured in those tests may be used as the CO 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 CO alone, it is necessary for the manufacturer to provide special means by which the CO response threshold value can be measured. For example, it can 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 preferably be chosen such that the nominal CO response threshold value is in the range of 30 $\mu\text{l/l}$ to 60 $\mu\text{l/l}$.

5.1.6.7 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 sensor response value

5.1.7.1 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.

5.1.7.2 Install the specimen for which the temperature response value is being measured as described in 5.1.3 in a heat tunnel, as specified in Annex B. The orientation of the specimen, relative to the direction of airflow, shall be the least sensitive one, as determined in the directional dependence test (see 5.5), unless otherwise specified in the test procedure.

5.1.7.3 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.

5.1.7.4 Before the test, stabilize the temperature of the air stream and the specimen to $(25 \pm 2)^\circ\text{C}$. Maintain the air stream at a constant mass flow equivalent to a velocity of $(0,8 \pm 0,1) \text{ m/s}$ at 25°C .

5.1.7.5 Raise the air temperature at a rate of rise specified by the manufacturer (within the range of $3^\circ\text{C}/\text{min}$ to $20^\circ\text{C}/\text{min}$) 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.

The signal may be an alarm, but may also be a signal that is combined with the CO and/or smoke sensor(s) signal before an alarm is generated. For this purpose, the manufacturer may supply a detector with special outputs. However, it is essential that the output signal be routed through the amplification path.

NOTE If the detector is not capable of giving an alarm signal from temperature change alone, it is necessary for the manufacturer to provide special means by which the response of the heat sensor(s) can be measured. For example, a supplementary output that varies with temperature, or specially modified software to indicate when an internal temperature threshold has been reached, can be acceptable.

5.1.7.6 Assess the heat response value as

- a) the time taken from the start of the temperature increase to the point at which either 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 amount of time.

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

5.1.7.7 Record the measured heat response value as T .

5.1.8 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 are composed of 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) data required in 4.11;
- c) means to enable a quantitative measurement of
 - 1) the smoke response threshold value of the detector in accordance with 5.1.5,
 - 2) the CO response threshold value of the detector in accordance with 5.1.6,
 - 3) the heat response value of the temperature sensing element(s) of the detector in accordance with 5.1.7.

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 24 specimens found in the reproducibility test (5.8, 5.9 and 5.10), should also represent the production mean, and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

5.1.9 Test schedule

The specimens shall be tested according to the following test schedule (see Table 1). After the reproducibility tests, the two specimens with the lowest CO sensitivity (i.e. those with the highest CO response threshold values) shall be numbered 21 and 22, and the two specimens with the lowest smoke sensitivity (i.e. those with the highest smoke response threshold values) shall be numbered 23 and 24. The others shall be numbered 1 to 20 arbitrarily.

5.1.10 Test report

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

Table 1 — Test schedule

Test	Subclause	Specimen number(s)
repeatability of smoke response	5.2	one chosen arbitrarily
repeatability of CO response	5.3	one chosen arbitrarily
directional dependence of smoke response	5.4	one chosen arbitrarily
directional dependence of CO response	5.5	one chosen arbitrarily
directional dependence of heat response	5.6	one chosen arbitrarily ^a
lower limit of heat response	5.7	1 ^a
reproducibility of smoke response	5.8	all specimens
reproducibility of CO response	5.9	all specimens
reproducibility of heat response	5.10	all specimens ^a
exposure to chemical agents at environmental concentrations	5.11	1
long-term stability of CO response	5.12	4
saturation	5.13	2
exposure to chemical agents associated with a fire	5.14	3
variation in supply parameters	5.15	5
air movement	5.16	6
dazzling	5.17	6 ^b
dry heat (operational)	5.18	7
cold (operational), smoke	5.19	8
cold (operational), CO	5.20	8
damp heat, cyclic (operational)	5.21	9
damp heat, steady state (endurance)	5.22	10
low humidity, steady state (endurance)	5.23	11
sulfur dioxide SO ₂ corrosion (endurance)	5.24	12
shock (operational)	5.25	13
impact (operational)	5.26	14
vibration, sinusoidal (operational)	5.27	15
vibration, sinusoidal (endurance)	5.28	15
electromagnetic compatibility (EMC) immunity tests (operational)	5.29	16 ^c 17 ^c 18 ^c 19 ^c 20 ^c
fire sensitivity	5.30	21, 22, 23, 24
^a Test applied only to detectors incorporating heat sensor(s). ^b Test applied only to detectors using scattered or transmitted light. ^c 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 may be deleted, and the full functional test may be conducted at the end of the sequence of tests. However, it should be noted that in the event of a failure, it might not be possible to identify which test exposure caused the failure [see EN 50130-4:1995 (as amended), Clause 4].		

5.2 Repeatability of smoke response

5.2.1 Object of the test

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

5.2.2 Test procedure

Measure the smoke response threshold value of the specimen being tested six times as described in 5.1.5. The orientation of the specimen relative to the direction of airflow is arbitrary, but it shall be the same for all six measurements.

The maximum smoke response threshold value shall be designated as $m_{\max}$ for detectors using scattered or transmitted light, or as $y_{\max}$ for detectors using ionization. The minimum smoke response threshold value shall be designated as $m_{\min}$ for detectors using scattered or transmitted light, or as $y_{\min}$ for detectors using ionization.

5.2.3 Requirements

The specimen shall meet the requirements of 5.2 if

- the ratio of the smoke response threshold values $y_{\max}:y_{\min}$ or $m_{\max}:m_{\min}$ is not greater than 1,6, and
- the minimum response threshold value $y_{\min}$ is not less than 0,2 or $m_{\min}$ is not less than 0,05 dB/m.

5.3 Repeatability of CO response

5.3.1 Object of the test

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

5.3.2 Test procedure

Measure the response threshold value of the specimen being tested six times as specified in 5.1.6. The orientation of the specimen relative to the direction of airflow is arbitrary, but it shall be the same for all six measurements.

Designate the maximum response threshold value as $S_{\max}$ and the minimum value as $S_{\min}$.

5.3.3 Requirements

The specimen shall meet the requirements of 5.3 if the ratio of the response threshold values $S_{\max}:S_{\min}$ is not greater than 1,6.

5.4 Directional dependence of smoke response

5.4.1 Object of the test

To confirm that the smoke sensitivity of the detector is not unduly dependent on the direction of airflow around the detector.

5.4.2 Test procedure

Measure the smoke response threshold value of the specimen being tested eight times as described in 5.1.5. Rotate the specimen 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 smoke response threshold value as $m_{\max}$ or $y_{\max}$ and the minimum smoke response threshold value as $m_{\min}$ or $y_{\min}$.

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.

5.4.3 Requirements

The specimen shall meet the requirements of 5.4 if

- the ratio of the smoke response threshold values $y_{\max}:y_{\min}$ or $m_{\max}:m_{\min}$ is not greater than 1,6, and
- the minimum response threshold value $y_{\min}$ is not less than 0,2 or $m_{\min}$ is not less than 0,05 dB/m.

5.5 Directional dependence of CO response

5.5.1 Object of the test

To confirm that the CO sensitivity of the detector is not unduly dependent on the direction of airflow around the detector.

5.5.2 Test procedure

Measure the CO response threshold value of the specimen being tested eight times as specified in 5.1.5. Rotate the specimen 45° about its vertical axis between each measurement, so that the measurements are taken for eight different orientations relative to the direction of airflow.

Designate the maximum response threshold value as $S_{\max}$ and the minimum value as $S_{\min}$.

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.

5.5.3 Requirements

The specimen shall meet the requirements of 5.5 if the ratio of the response threshold values $S_{\max}:S_{\min}$ is not greater than 1,6.

5.6 Directional dependence of heat response (optional function)

5.6.1 Object of the test

To confirm that the heat sensitivity of the detector is not unduly dependent on the direction of airflow around the detector.

5.6.2 Test procedure

Measure the heat response value of the specimen being tested eight times as specified in 5.1.7 at a rate of rise of air temperature of 10 K/min. Rotate the specimen 45° about its vertical axis between each

measurement, so that the measurements are taken for eight different orientations relative to the direction of airflow. Stabilize the specimen at 25 °C before each measurement.

Record the heat response value at each of the eight orientations.

Designate the maximum heat response value as $T_{\max}$ and the minimum value as $T_{\min}$.

Record the maximum heat response value and the minimum heat response value orientations. The orientation for which the maximum response time, or the minimum change in signal level was measured is referred to as the least sensitive heat orientation. The orientation for which the minimum response time, or the maximum change in signal level was measured is referred to as the most sensitive heat orientation.

5.6.3 Requirements

The specimen shall meet the requirements of 5.6 if the ratio of the heat response values $T_{\max}:T_{\min}$ is not greater than 1,3, or is not greater than the value for which the manufacturer can demonstrate that the resulting change in the CO response threshold value is not more than a factor of 1,6.

5.7 Lower limit of heat response (optional function)

5.7.1 Object of the test

To confirm that detectors are not more sensitive to heat alone, without the presence of smoke and/or CO, than is permitted in ISO 7240-5.

5.7.2 Test procedure

Measure the heat response value of the specimen being tested, in its most sensitive orientation, using the methods described in ISO 7240-5:2003, 5.3 and 5.4, but with the test being terminated when an air temperature of 55 °C has been reached. For the purposes of these tests, the test parameters for Class A1 detectors shall be used.

NOTE It is important to limit the temperature of the detector to 55 °C to prevent possible damage to the electro-chemical cell.

5.7.3 Requirements

The specimen shall meet the requirements of 5.7 if

- in the test for static response temperature, the specimen does not give an alarm signal at a temperature less than 54 °C, and
- the specimen does not give an alarm signal at any rate of rise of air temperature in a time less than the lower response time limits specified in ISO 7240-5:2003, Table 4, for a Class A1 detector.

5.8 Reproducibility of smoke response

5.8.1 Object of the test

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

5.8.2 Test procedure

The smoke response threshold value of each of the specimens being tested shall be measured as described in 5.1.5.