



BSI Standards Publication

Fire detection and fire alarm systems

Part 31: Multi-sensor fire detectors —
Point detectors using a combination of
smoke, carbon monoxide and optionally
heat sensors

National foreword

This British Standard is the UK implementation of EN 54-31:2014+A1:2016. It supersedes BS EN 54-31:2014 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

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A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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English Version

Fire detection and fire alarm systems - Part 31: Multi-sensor fire detectors - Point detectors using a combination of smoke, carbon monoxide and optionally heat sensors

Systèmes de détection et d'alarme incendie - Partie 31:
DéTECTEURS d'incendie multicapteurs - DéTECTEURS
ponctuels combinant l'utilisation de capteurs de fumée,
de capteurs de monoxyde de carbone et
éventuellement de capteurs de chaleur

Brandmeldeanlagen - Teil 31: Mehrfachsensor-
Brandmelder - Punktförmige Melder mit kombinierten
Rauch-, CO- und optionalen Wärmesensoren

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

European foreword.....	6
Introduction	8
1 Scope	9
2 Normative references	9
3 Terms and definitions	10
4 Requirements	10
4.1 General.....	10
4.2 Categorization	10
4.3 Nominal activation conditions/sensitivity	11
4.3.1 Individual alarm indication.....	11
4.3.2 Response to slowly developing fires, aging and contamination	11
4.3.3 Rate sensitive CO response.....	11
4.3.4 Repeatability of smoke response	12
4.3.5 Directional dependence of smoke response	12
4.3.6 Repeatability of CO response	12
4.3.7 Directional dependence of CO response.....	12
4.3.8 Directional dependence of heat response.....	12
4.3.9 Lower limit of heat response	12
4.3.10 Reproducibility of smoke response.....	12
4.3.11 Reproducibility of CO response	12
4.3.12 Reproducibility of heat response	12
4.3.13 Air movement.....	12
4.3.14 Dazzling	12
4.4 Operational reliability.....	13
4.4.1 Connection of ancillary devices	13
4.4.2 Monitoring of detachable detectors	13
4.4.3 Manufacturer's adjustments.....	13
4.4.4 On-site adjustment of response behaviour.....	13
4.4.5 Protection against the ingress of foreign bodies	13
4.4.6 Software controlled detectors.....	13
4.4.7 Long term stability.....	15
4.5 Tolerance to supply parameters - Variation in supply parameters	15
4.6 Performance parameters under fire conditions - Fire sensitivity	15
4.7 Durability of nominal activation conditions/sensitivity	15
4.7.1 Temperature resistance	15
4.7.2 Humidity resistance	15
4.7.3 Shock and vibration resistance.....	16
4.7.4 Electrical stability - EMC, immunity (operational)	16
4.7.5 Resistance to chemical agents.....	16
4.8 Detector sensitivity to single fire phenomena.....	17
4.8.1 Sensitivity to smoke	17
4.8.2 Sensitivity to carbon monoxide	17
4.8.3 Sensitivity to heat.....	17
5 Testing, assessment and sampling methods	17

5.1	General	17
5.1.1	Atmospheric conditions for tests.....	17
5.1.2	Operating conditions for tests	17
5.1.3	Mounting arrangements.....	18
5.1.4	Tolerances.....	18
5.1.5	Measurement of smoke response value	18
5.1.6	Measurement of CO response value.....	19
5.1.7	Measurement of heat response value	20
5.1.8	Provision for tests	20
5.1.9	Test schedule.....	21
5.2	Nominal activation conditions/sensitivity	22
5.2.1	Individual alarm indication	22
5.2.2	Response to slowly developing fires, aging and contamination.....	22
5.2.3	Rate sensitive CO response	23
5.2.4	Repeatability of smoke response.....	23
5.2.5	Directional dependence of smoke response.....	24
5.2.6	Repeatability of CO response	24
5.2.7	Directional dependence of CO response	25
5.2.8	Directional dependence of heat response	25
5.2.9	Lower limit of heat sensitivity	26
5.2.10	Reproducibility of smoke response	26
5.2.11	Reproducibility of CO response.....	27
5.2.12	Reproducibility of heat response.....	27
5.2.13	Air movement.....	27
5.2.14	Dazzling.....	28
5.3	Operational reliability	29
5.3.1	Connection of ancillary devices.....	29
5.3.2	Monitoring of detachable detectors.....	29
5.3.3	Manufacturer's adjustments.....	29
5.3.4	On-site adjustment of behaviour	29
5.3.5	Protection against the ingress of foreign bodies.....	29
5.3.6	Software controlled devices	29
5.3.7	Long term stability	29
5.4	Tolerance to supply parameters	30
5.4.1	Variation in supply parameters	30
5.5	Performance parameters under fire conditions	31
5.5.1	Fire sensitivity	31
5.6	Durability of nominal activation conditions/sensitivity.....	33
5.6.1	Temperature resistance.....	33
5.6.2	Humidity resistance.....	36
5.6.3	Shock and vibration resistance	41
5.6.4	Electrical stability.....	46
5.6.5	Resistance to chemical agents.....	47
5.7	Non-response to single fire phenomena	50
5.7.1	Sensitivity to smoke.....	50
5.7.2	Sensitivity to carbon monoxide.....	51
5.7.3	Sensitivity to heat	51
6	Classification and designation	52
7	Marking, Labelling and Packaging.....	52
Annex A (normative)	Smoke tunnel for smoke response values	54
Annex B (normative)	Test aerosol for smoke response value measurements	55

Annex C (normative) Smoke measuring instruments.....	56
C.1 Obscuration meter	56
C.2 Measuring ionization chamber (MIC)	56
Annex D (normative) Gas test chamber for CO response threshold value and cross-sensitivity to chemical agents.....	60
Annex E (normative) Heat tunnel for heat response value.....	61
Annex F (normative) Measuring instruments for CO	62
F.1 General.....	62
F.2 CO measuring instrument	62
Annex G (informative) Establishing exposure levels of chemical agents.....	63
G.1 General.....	63
G.2 Establishing concentration of chemical agents for test gases 1 to 9 of 5.6.5.3	63
G.3 Verification of test chamber leakage	63
G.4 Establishing concentration of ozone.....	63
Annex H (normative) Apparatus for dazzling test.....	64
Annex I (informative) Apparatus for impact test.....	66
Annex J (normative) Fire test room.....	68
Annex K (normative) Open wood fire (TF1).....	70
K.1 Fuel.....	70
K.2 Arrangement.....	70
K.3 Method of ignition.....	70
K.4 Variables.....	70
K.5 End-of-test condition	70
K.6 Test validity criteria.....	70
Annex L (normative) Smouldering (pyrolysis) wood fire (TF2)	74
L.1 Fuel.....	74
L.2 Hotplate	74
L.3 Arrangement.....	74
L.4 Heating rate.....	74
L.5 End-of-test condition	74
L.6 Test validity criteria.....	74
Annex M (normative) Glowing smouldering cotton fire (TF3)	79
M.1 Fuel.....	79
M.2 Arrangement.....	79
M.3 Ignition.....	80
M.4 End-of-test condition	81
M.5 Test validity criteria.....	81
Annex N (normative) Open plastics (polyurethane) fire (TF4).....	84
N.1 Fuel.....	84
N.2 Conditioning.....	84
N.3 Arrangement.....	84
N.4 Ignition.....	84
N.5 Method of ignition.....	84
N.6 End-of-test condition	84
N.7 Test validity criteria.....	84
Annex O (normative) Liquid (heptane) fire (TF5)	87
O.1 Fuel.....	87

O.2	Arrangement	87
O.3	Ignition	87
O.4	End-of-test condition	87
O.5	Test validity criteria	87
Annex P	(normative) Low temperature black smoke (decalene) liquid fire (TF8)	90
P.1	Fuel	90
P.2	Arrangement	90
P.3	Ignition	90
P.4	End-of-test condition	90
P.5	Test validity criteria	90
Annex Q	(informative) Information concerning the construction of the smoke tunnel	93
Annex R	(informative) Information concerning the construction of the gas test chamber	96
Annex S	(informative) Construction of the heat tunnel	98
Annex T	(informative) Information concerning test procedures and requirements for response to slowly developing fires, aging and contamination	101
Annex U	(informative) Information concerning the construction of the measuring ionization chamber	105
Bibliography		107

European foreword

This document (EN 54-31:2014+A1:2016) has been prepared by Technical Committee CEN/TC 72 “Fire detection and fire alarm systems”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2016, and conflicting national standards shall be withdrawn at the latest by December 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1 approved by CEN on 2016-01-31.

This document supersedes EN 54-31:2014.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**.

EN 54, *Fire detection and fire alarm systems*, consists of the following parts:

- *Part 1: Introduction*
- *Part 2: Control and indicating equipment*
- *Part 3: Fire alarm devices – Sounders*
- *Part 4: Power supply equipment*
- *Part 5: Heat detectors – Point detectors*
- *Part 7: Smoke detectors – Point detectors using scattered light, transmitted light or ionization*
- *Part 10: Flame detector – Point detectors*
- *Part 11: Manual call points*
- *Part 12: Smoke detectors – Line detector using an optical light beam*
- *Part 13: Compatibility assessment of system components*
- *Part 14: Technical Specification: Guidelines for planning, design, installation, commissioning, use and maintenance*
- *Part 16: Voice alarm control and indicating equipment*
- *Part 17: Short circuit isolators*
- *Part 18: Input/output devices*
- *Part 20: Aspirating smoke detectors*
- *Part 21: Alarm transmission and fault warning routing equipment*

- *Part 22: Resettable Line-type heat detectors*
- *Part 23: Fire alarm devices – Visual alarms*
- *Part 24: Components of voice alarm systems – Loudspeakers*
- *Part 25: Components using radio links and system requirements*
- *Part 26: Point fire detectors using carbon monoxide sensors*
- *Part 27: Duct smoke detectors*
- *Part 28: Non-resettable (digital) line type heat detectors*
- *Part 29: Point detectors using a combination of smoke and heat sensors*
- *Part 30: Point detectors using a combination of carbon monoxide and heat sensors*
- *Part 31: Point detectors using a combination of smoke, carbon monoxide and optionally heat sensors*
- *Part 32: Guidelines for the planning, design, installation, commissioning, use and maintenance of voice alarm systems*

NOTE This list includes standards that are in preparation and other standards may be added. For current status of published standards refer to www.cen.eu.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Multi-sensor fire detectors using a combination of smoke, carbon monoxide and optionally heat sensors complying with this document are general purpose fire detectors. Multi-sensor detectors can be used to achieve

- a high stability against deceptive phenomena,
- a response to a broad range of fires.

Compared to the standards for single phenomenon detectors, additional environmental requirements were included to demonstrate a higher stability.

Different categories are introduced to distinguish between different detector behaviour and to identify detectors or detector settings including the signal of an optional heat sensor.

For detectors or detector settings of the categories M (without heat sensor) and MT (with heat sensor) requirements apply to demonstrate that the detector is capable of withstanding the presence of a high level of a single fire phenomenon alone without giving a fire alarm.

For detectors or detector settings of the categories N (without heat sensor) and NT (with heat sensor) no requirements apply regarding the release of a fire alarm caused by the exposure to a single fire phenomenon alone.

The response to a broad range of fires is shown by including the test fires TF1 and TF8 in addition to the test fires TF2 to TF5 which are used for detectors complying with EN 54-7.

The performance of single sensor components of a multi-sensor detector need not comply with the standards for single phenomena fire detectors (EN 54-5, EN 54-7, EN 54-26) however the combined performance does need to meet the requirements of this standard.

1 Scope

This European Standard specifies requirements, test methods and performance criteria for point-type multi-sensor fire detectors for use in fire detection and fire alarm systems installed in and around buildings (see EN 54-1:2011), incorporating in one mechanical enclosure at least one optical or ionization smoke sensor and at least one carbon monoxide (CO) sensor and optionally one or more heat sensors, utilizing the combination of the detected phenomena. This European Standard covers only modes of operation, where at least the signals of both smoke and carbon monoxide sensors are continuously evaluated.

A1 *deleted text* **A1**

Point detectors using a combination of smoke, carbon monoxide and optionally heat sensors, which are having special characteristics suitable for the detection of specific fire risks are not covered by this European Standard. The performance requirements for any additional functions are beyond the scope of this standard (e.g. additional features or enhanced functionality for which this European Standard does not define a test or assessment method).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 54-1:2011, *Fire detection and fire alarm systems — Part 1: Introduction*

EN 54-5:2000, *Fire detection and fire alarm systems — Part 5: Heat detectors — Point detectors*

EN 54-5:2000/A1:2002, *Fire detection and fire alarm systems — Part 5: Heat detectors — Point detectors*

EN 50130-4:2011, *Alarm systems — Part 4: Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder, hold up, CCTV, access control and social alarm systems*

EN 60068-1:1994, *Environmental testing — Part 1: General and guidance (IEC 60068-1:1988)*

EN 60068-2-1:2007, *Environmental testing — Part 2-1: Tests — Test A: Cold (IEC 60068-2-1:2007)*

EN 60068-2-2:2007, *Environmental testing — Part 2-2: Tests — Test B: Dry heat (IEC 60068-2-2:2007)*

EN 60068-2-6:2008, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:2008)*

EN 60068-2-27:2009, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock (IEC 60068-2-27:2009)*

EN 60068-2-30:2005, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle) (IEC 60068-2-30:2005)*

EN 60068-2-42:2003, *Environmental testing — Part 2-42: Tests — Test Kc: Sulphur dioxide test for contacts and connections (IEC 60068-2-42:2003)*

EN 60068-2-78:2001, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state (IEC 60068-2-78:2001)*

ISO 209:2007, *Aluminium and aluminium alloys — Chemical composition*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 54-1:2011 and the following apply.

3.1

non-volatile memory

memory elements which do not require the presence of an energy source for the retention of their contents

3.2

site specific data

alterable data required for the detector to operate in a defined detector configuration

3.3

smoke response value

aerosol density in the proximity of a test specimen at the moment that it generates a reference signal in a smoke tunnel

3.4

heat response value

temperature in the proximity of a test specimen at the moment that it generates a reference signal in a heat tunnel

3.5

CO response value

CO concentration in the proximity of the specimen at the moment that it generates a reference signal in a gas test chamber

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

3.6

sensor

transducer, which is assigned to be receptive to one fire phenomenon and converts its information into an electrical output

4 Requirements

4.1 General

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

4.2 Categorization

The manufacturer shall state the category of the detector or of each setting of the detector, in case the detector has several settings to be tested.

The following four categories can be declared: M, N, MT, NT.

Category M

Category M identifies detectors or detector settings not using a heat sensor. Category M detectors or detector settings are intended to withstand high levels of a single fire phenomenon without giving a fire alarm. The requirements of 4.8.1 and 4.8.2 apply to category M.

Category MT

Category MT identifies detectors or detector settings using a heat sensor. Category MT detectors or detector settings are intended to withstand high levels of a single fire phenomenon without giving a fire alarm. The requirements of 4.8.1, 4.8.2 and 4.8.3 apply to category MT.

Category N

Category N identifies detectors or detector settings not using a heat sensor, Category N detectors or detector settings may give a fire alarm in presence of a single fire phenomenon. The requirements of 4.8 do not apply.

Category NT

Category NT identifies detectors or detector settings using a heat sensor, Category NT detectors or detector settings may give a fire alarm in presence of a single fire phenomenon. The requirements of 4.8 do not apply.

NOTE Additional requirements related to the heat sensor apply for detectors or detector settings of the categories NT and MT. These requirements are defined in 4.3.8, 4.3.9 and 4.3.12.

4.3 Nominal activation conditions/sensitivity

4.3.1 Individual alarm indication

The 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, they 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 directly below the detector, in an ambient light intensity up to 500 lux when assessed as described in 5.2.1.

NOTE The alarm condition is reset manually at the control and indicating equipment (see EN 54.2:1997 as amended by EN 54-2:1997/A1:2006).

4.3.2 Response to slowly developing fires, aging and contamination

The detector may incorporate provision for “drift compensation”, for example to compensate for sensor drift due to the build up of dirt in the detector, If such drift compensation is included, then it shall not lead to a significant reduction in the detector's sensitivity to slowly developing fires when assessed as specified in 5.2.2.

4.3.3 Rate sensitive CO response

The CO response value of the detector may 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 levels 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 to a significant increase in the probability of false alarm when assessed as specified in 5.2.3.

4.3.4 Repeatability of smoke response

The detector shall have stable behaviour with respect to its sensitivity to smoke after a number of alarm conditions. To confirm this, the detector shall be assessed in accordance with 5.2.4.

4.3.5 Directional dependence of smoke response

The sensitivity of the detector to smoke shall not be unduly dependent on the direction of airflow around it. To confirm this, the detector shall be assessed in accordance with 5.2.5.

4.3.6 Repeatability of CO response

The detector shall have stable behaviour with respect to its sensitivity to CO after a number of alarm conditions. To confirm this, the detector shall be assessed in accordance with 5.2.6.

4.3.7 Directional dependence of CO response

The sensitivity of the detector to CO shall not be unduly dependent on the direction of airflow around it. To confirm this, the detector shall be assessed in accordance with 5.2.7.

4.3.8 Directional dependence of heat response

If categorized as category MT or NT detector, the heat sensitivity of the detector shall not be unduly dependent on the direction of airflow around it. To confirm this, the detector shall be assessed in accordance with 5.2.8.

4.3.9 Lower limit of heat response

If categorized as category MT or NT detector, the detector shall not be more sensitive to heat alone, without the presence of smoke or CO or both, than is permitted in EN 54-5:2000 as amended by EN 54-5:2000/A1:2002. To confirm this, the detector shall be assessed in accordance with 5.2.9.

4.3.10 Reproducibility of smoke response

The sensitivity of the detector to smoke shall not vary unduly from specimen to specimen. To confirm this, the detector shall be assessed in accordance with 5.2.10.

4.3.11 Reproducibility of CO response

The sensitivity of the detector to CO shall not vary unduly from specimen to specimen. To confirm this, the detector shall be assessed in accordance with 5.2.11.

4.3.12 Reproducibility of heat response

If classified as class MT or NT detector, the heat sensitivity of the detector shall not vary unduly from specimen to specimen. To confirm this, the detector shall be assessed in accordance with 5.2.12.

4.3.13 Air movement

The sensitivity of the detector shall not be unduly affected by the rate of the airflow and that it is not unduly prone to false alarms in draughts or in short gusts. To confirm this, the detector shall be assessed in accordance with 5.2.13.

4.3.14 Dazzling

The sensitivity of the detector shall not be unduly influenced by the close proximity of artificial light sources. To confirm this, the detector shall be assessed in accordance with 5.2.14. This test is only

applicable to detectors using optical smoke sensors, as ionization chamber detectors are considered unlikely to be influenced.

4.4 Operational reliability

4.4.1 Connection of ancillary devices

Where the detector provides for connections to ancillary devices (e.g. remote indicators, control relays), open- or short-circuit failures of these connections shall not prevent the correct operation of the detector.

4.4.2 Monitoring of detachable detectors

For detachable detectors, 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.

4.4.3 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.

4.4.4 On-site adjustment of response behaviour

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

- a) for each setting at which the manufacturer claims compliance with this standard, the detector shall comply with the requirements of this standard, and access to the adjustment means shall only be possible 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 standard, shall only be accessible 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 the standard.

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

4.4.5 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 sensor chamber(s).

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

4.4.6 Software controlled detectors

4.4.6.1 General

For detectors which rely on software control in order to fulfil the requirements of this standard, the requirements of 4.4.6.2, 4.4.6.3 and 4.4.6.4 shall be met.

4.4.6.2 Software documentation

4.4.6.2.1 Design overview

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

- a) a functional description of the main program flow (e.g. as a flow diagram or structogram) including:
 - 1) a brief description of the modules and the functions that they perform;
 - 2) the way in which the modules interact;
 - 3) the overall hierarchy of the program;
 - 4) the way in which the software interacts with the hardware of the detector;
 - 5) the way in which the modules are called, including any interrupt processing.
- b) a description of which areas of memory are used for the various purposes (e.g. the program, site specific data and running data);
- c) a designation, by which the software and its version can be uniquely identified.

4.4.6.2.2 Design detail

The manufacturer shall have available detailed design documentation, which only needs to be provided if required by the testing authority. It shall comprise at least the following:

- a) an overview of the whole system configuration, including all software and hardware components;
- b) a description of each module of the program, containing at least:
 - 1) the name of the module;
 - 2) a description of the tasks performed;
 - 3) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data.
- c) full source code listings, as hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized;
- d) details of any software tools used in the design and implementation phase (e.g. CASE-tools, compilers).

4.4.6.3 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.

4.4.6.4 The storage of programs and data

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

Site-specific data shall be held in memory which will retain data for at least two weeks without external power to the detector, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.

4.4.7 Long term stability

The detectors shall be stable over long periods of time. To confirm this, the detector shall be assessed in accordance with 5.3.7.

4.5 Tolerance to supply parameters - Variation in supply parameters

Within the specified range(s) of the supply parameters, the sensitivity of the detector shall not be unduly dependent on these parameters (e.g. voltage). To confirm this, the detector shall be assessed in accordance with 5.4.1.

4.6 Performance parameters under fire conditions - Fire sensitivity

The detector shall have adequate sensitivity to incipient type fires that may occur in buildings. To confirm this, the detector shall be assessed in accordance with 5.5.1.

4.7 Durability of nominal activation conditions/sensitivity

4.7.1 Temperature resistance

4.7.1.1 Dry heat (operational)

The detector shall function correctly at high ambient temperatures. To confirm this, the detector shall be assessed in accordance with 5.6.1.1.

4.7.1.2 Dry heat (endurance)

The detector shall be capable of withstanding long term exposure to high temperature. To confirm this, the detector shall be assessed in accordance with 5.6.1.2.

4.7.1.3 Cold (operational)

The detector shall function correctly at low ambient temperatures. To confirm this, the detector shall be assessed in accordance with 5.6.1.3.

4.7.2 Humidity resistance

4.7.2.1 Damp heat, cyclic (operational)

The detector shall function correctly at a high level of relative humidity with short period of condensation. To confirm this, the detector shall be assessed in accordance with 5.6.2.1.

4.7.2.2 Damp heat steady-state (operational)

The detector shall function correctly at high relative humidity (without condensation) as specified in 5.6.2.2.

4.7.2.3 Damp heat steady-state (endurance)

The detector shall be capable of withstanding long term exposure to a high level of continuous humidity. To confirm this, the detector shall be assessed in accordance with 5.6.2.3.

4.7.2.4 Low humidity, steady-state (operational)

The detector shall function correctly at low relative humidity. To confirm this, the detector shall be assessed in accordance with 5.6.2.4.

4.7.3 Shock and vibration resistance

4.7.3.1 Shock (operational)

The detector shall function correctly when submitted to mechanical shocks which are likely to occur in the service environment. To confirm this, the detector shall be assessed in accordance with 5.6.3.1.

4.7.3.2 Impact (operational)

The detector shall function correctly when submitted to mechanical impacts which it may sustain in the normal service environment. To confirm this, the detector shall be assessed in accordance with 5.6.3.2.

4.7.3.3 Vibration, sinusoidal (operational)

The detector shall function correctly when submitted to vibration at levels appropriate to its normal service environment. To confirm this, the detector shall be assessed in accordance with 5.6.3.3.

4.7.3.4 Vibration, sinusoidal (endurance)

The detector shall be capable of withstanding long exposure to vibration at levels appropriate to the service environment. To confirm this, the detector shall be assessed in accordance with 5.6.3.4.

4.7.4 Electrical stability - EMC, immunity (operational)

The detector shall operate correctly when submitted to electromagnetic interference. To confirm this, the detector shall be assessed in accordance with 5.6.4.1.

4.7.5 Resistance to chemical agents

4.7.5.1 SO₂ corrosion (endurance)

The detector shall be capable of withstanding the corrosive effects of sulphur dioxide as an atmospheric pollutant. To confirm this, the detector shall be assessed in accordance with 5.6.5.1.

4.7.5.2 Exposure to high level of carbon monoxide

The detector shall respond appropriately when exposed to high levels of CO. To confirm this, the detector shall be assessed in accordance with 5.6.5.2.

4.7.5.3 Exposure to chemical agents at environmental concentrations (endurance)

The detector shall be capable of withstanding the effects of exposure to atmospheric pollutants or chemicals which may be encountered in the service environment. To confirm this, the detector shall be assessed in accordance with 5.6.5.3.

4.8 Detector sensitivity to single fire phenomena

4.8.1 Sensitivity to smoke

If categorized as category M or MT detector, the detector shall be capable of withstanding the presence of smoke alone without giving an alarm. To confirm this, the detector shall be assessed in accordance with 5.7.1.

4.8.2 Sensitivity to carbon monoxide

If categorized as category M or MT detector, the detector shall be capable of withstanding the presence of carbon monoxide alone without giving an alarm. To confirm this, the detector shall be assessed in accordance with 5.7.2.

4.8.3 Sensitivity to heat

If categorized as category MT detector, the detector shall be capable of withstanding the presence of heat alone without giving an alarm. To confirm this, the detector shall be assessed in accordance with 5.7.3.

5 Testing, assessment and sampling methods

5.1 General

5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as described in EN 60068-1:1994 as follows:

- temperature: (15 to 35) °C;
- relative humidity: (25 to 75) %;
- air pressure: (86 to 106) kPa.

If variations in these parameters have a significant effect on a measurement, then such variations should be kept to a minimum during a series of measurements carried out as part of one test on one specimen.

The ambient concentration of CO shall not exceed 3 µl/l.

5.1.2 Operating conditions for tests

If a test method requires a specimen to be operational, then the specimen shall be connected to a 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 an alarm or 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.

5.1.3 Mounting arrangements

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

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 EN 60068).

If a requirement or test procedure does not specify a tolerance or deviation limits, then deviation limits of $\pm 5\%$ shall be applied.

5.1.5 Measurement of smoke response value

The specimen, for which the smoke response value is to be measured, shall be installed in the smoke tunnel, described in Annex A, in its normal operating position, by its normal means of attachment. The orientation of the specimen, relative to the direction of airflow, shall be the least sensitive orientation, as determined in the directional dependence test (5.2.5), unless otherwise specified in the test procedure.

Before commencing each measurement the smoke tunnel shall be purged to ensure that the tunnel and the specimen are free from the test aerosol.

The air velocity in the proximity of the specimen shall be $(0,2 \pm 0,04) \text{ m s}^{-1}$ during the measurement, unless otherwise specified in the test procedure.

Unless otherwise specified in the test procedure, the air temperature in the tunnel shall be $(23 \pm 5)^\circ\text{C}$ and shall not vary by more than 5 K for all the measurements on a particular detector type.

Unless otherwise specified in the test procedure, the CO concentration in the tunnel shall be less than $3 \mu\text{l/l}$ during the entire test.

The specimen shall be connected to its supply and monitoring equipment as described in 5.1.2, and shall be allowed to stabilize for a period of at least 15 min, unless otherwise specified by the manufacturer.

The test aerosol, as described in Annex B, shall be introduced into the tunnel such that the rate of increase of aerosol density is as follows:

$$0,015 \leq \frac{\Delta m}{\Delta t} \leq 0,1 \quad \text{dB m}^{-1} \text{ min}^{-1}$$

for detectors using scattered or transmitted light, or

$$0,05 \leq \frac{\Delta y}{\Delta t} \leq 0,3 \quad \text{min}^{-1}$$

for detector using ionization.

NOTE 1 These ranges are intended to allow the selection of a convenient rate, depending upon the detector's sensitivity, to get a response in a reasonable time.

NOTE 2 The formulae for m and y are given in Annex C.

The rate of increase in aerosol density shall be similar for all measurements on a particular detector type.

The aerosol density shall be increased until either an alarm signal has been generated or a designated signal specified by the manufacturer is produced by the smoke sensor. This designated smoke signal shall be obtained after having been routed via any applicable amplification circuit and signal processing unit.

If the detector is not capable of giving an alarm signal from smoke alone, it will be necessary for the manufacturer to provide special means by which the designated smoke response signal can be evaluated. For example, it may be acceptable to provide a supplementary output that varies with smoke density, or specially modified software to indicate when the smoke 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 value is in the range of 0,05 to 1,0 dB m⁻¹ (m) for detectors using scattered or transmitted light, or 0,2 to 2,0 (y) for detectors using ionization. The tests require smoke response values m not less than 0,05 dB m⁻¹ for detectors using scattered or transmitted light, or y not less than 0,2 for detectors using ionization.

The measured aerosol density shall be recorded as m (dB m⁻¹) for detectors using scattered or transmitted light, or as y for detectors using ionization (see Annex C). For detectors using both optical and ionization smoke sensors, the measured aerosol density shall be recorded as m (dB m⁻¹). This shall be taken as the smoke response value.

5.1.6 Measurement of CO response value

The specimen, for which the CO response value is to be measured, shall be installed in the gas test chamber, described in Annex D, 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 orientation, as determined in the directional dependence test, unless otherwise specified in the test procedure.

Before commencing each measurement, the gas test chamber shall be purged with clean air to ensure that the concentration of CO in the gas test chamber is less than 1,5 µl/l.

The air velocity in the proximity of the specimen shall be (0,2 ± 0,04) m/s during the measurement, unless otherwise specified in the test procedure.

Unless otherwise specified in the test procedure, the air temperature in the gas test chamber shall be (23 ± 5)°C and shall not vary by more than 5 K for all the measurements.

The specimen shall be connected to its supply and monitoring equipment as described in 5.1.2, and shall be allowed to stabilize for a period of at least 15 min, unless otherwise specified by the manufacturer.

CO shall be introduced into the gas test chamber such that the rate of increase of CO concentration is between 1 µl/l per minute and 6 µl/l per minute, unless otherwise specified in the test procedure. For detectors with a rate sensitive behaviour, the manufacturer may specify a rate of increase within this range to ensure that the measured CO response value is representative of the static CO response value of the detector.

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

The CO concentration shall be increased until either an alarm signal has been generated a designated signal specified by the manufacturer is produced by the CO sensor. This designated CO signal shall be obtained after having been routed via any applicable amplification circuit and signal processing unit.

If the detector is not capable of giving an alarm signal from CO alone, it will be necessary for the manufacturer to provide special means by which the designated CO response signal can be evaluated. For example, it may be acceptable to provide a supplementary output that varies with 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 CO response value is in the range 25 µl/l to 60 µl/l. The tests require CO response value S not less than 25 µl/l.

The measured CO concentration shall be recorded as S (µl/l). This shall be taken as the CO response value.

5.1.7 Measurement of heat response value

The specimen for which the heat response value is to be measured shall be installed in a heat tunnel, as specified in Annex E, 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.

The specimen shall be connected to its supply and monitoring equipment as specified in 5.1.2, and be allowed to stabilize for at least 15 min, unless otherwise specified by the manufacturer.

Before the test, the temperature of the air stream and the specimen shall be stabilized to (25 ± 2) °C. The air stream shall be maintained at a constant mass flow equivalent to a velocity of $(0,8 \pm 0,1)$ m/s at 25 °C.

The air temperature shall be increased at a rate specified in the test until either an alarm signal has been generated or a designated signal specified by the manufacturer is produced by the heat sensor. This designated heat signal shall be obtained after having been routed via any applicable amplification circuit and signal processing unit.

If the detector is not capable of giving an alarm signal from heat alone, it will be necessary for the manufacturer to provide special means by which the designated heat response signal can be evaluated. 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 EN 54-5:2000, Table 4, as amended by EN 54-5:2000/A1:2002 for a class A2 detector.

The heat response value shall be assessed as the time taken from the start of the temperature increase to the point at which the heat response signal specified by the manufacturer is produced, or the detector gives an alarm signal.

The measured heat response value shall be recorded as T (s).

5.1.8 Provision for tests

The following shall be provided for testing compliance with this standard:

- a) for detachable class N detectors; 29 detector heads and bases; for non-detachable class N detectors; 29 specimens;
- b) for detachable class NT detectors; 30 detector heads and bases; for non-detachable class NT detectors; 30 specimens;
- c) for detachable class M detectors; 32 detector heads and bases; for non-detachable class M detectors; 32 specimens;
- d) for detachable class MT detectors; 33 detector heads and bases; for non-detachable class MT detectors; 33 specimens;

e) The data required in 4.4.6.2.

NOTE Detachable detectors comprise at least two parts; a base (socket) and a head (body). If the specimens are detachable detectors, then the two, or more, parts together are regarded as a complete detector.

The specimens submitted shall be deemed representative of the manufacturer's production limits with regard to their construction and calibration.

The upper and lower limits of the response values of all the specimens found in the reproducibility tests, 5.2.10, 5.2.11 and, if applicable, 5.2.12 shall also represent the upper and lower limit of the production.

In conjunction with the shipment of the testing samples the manufacturer should provide sufficient data, which show the declaration of the upper and lower production limits defined for the response values for smoke, CO and, if applicable, heat.

5.1.9 Test schedule

The specimens shall be tested according to the following test schedule (see Table 1). After the reproducibility test, the three least sensitive specimens to smoke (i.e. those with the highest smoke response values) shall be numbered 5 to 7, by decreasing sensitivity. Of the remaining specimens, the three least sensitive specimens to CO (i.e. those with the highest CO response values) shall be numbered 8 to 10, by decreasing sensitivity and the others shall be numbered 1 to 4 and 11 to 33 arbitrarily.

Table 1 — Test schedule

Test	Clause	Specimen No(s)
Repeatability of smoke response	5.2.4	one chosen arbitrarily
Directional dependence of smoke response	5.2.5	one chosen arbitrarily
Repeatability of CO response	5.2.6	one chosen arbitrarily
Directional dependence of CO response	5.2.7	one chosen arbitrarily
Directional dependence of heat response	5.2.8 ^a	one chosen arbitrarily
Lower limit of heat response	5.2.9 ^a	30
Reproducibility of smoke response	5.2.10	all specimens
Reproducibility of CO response	5.2.11	all specimens
Reproducibility of heat response	5.2.12 ^a	all specimens
Air movement	5.2.13	1
Dazzling	5.2.14	2
Long term stability	5.3.7	3
Variation in supply parameters	5.4.1	4
Fire sensitivity	5.5.1	5, 6, 7, 8, 9, 10
Dry heat (operational)	5.6.1.1	11
Dry heat (endurance)	5.6.1.2	12
Cold (operational)	5.6.1.3	13
Damp heat, cyclic (operational)	5.6.2.1	14
Damp heat, steady-state (operational)	5.6.2.2	15

Test	Clause	Specimen No(s)
Damp heat, steady-state (endurance)	5.6.2.3	16
Low humidity steady-state (operational)	5.6.2.4	17
Shock (operational)	5.6.3.1	18
Impact (operational)	5.6.3.2	19
Vibration, sinusoidal (operational)	5.6.3.3	20
Vibration, sinusoidal (endurance)	5.6.3.4	21
Electrostatic discharge (operational)	5.6.4.1	22 ^b
Radiated electromagnetic fields (operational)		23 ^b
Conducted disturbances induced by electromagnetic fields (operational)		24 ^b
Fast transient bursts (operational)		25 ^b
Slow high energy voltage surge (operational)		26 ^b
Sulphur dioxide SO ₂ corrosion (endurance)	5.6.5.1	27
Exposure to high levels of carbon monoxide	5.6.5.2	28
Exposure to chemical agents at environmental concentrations	5.6.5.3	29
Sensitivity to smoke	5.7.1	31 ^c
Sensitivity to carbon monoxide	5.7.2	32 ^c
Sensitivity to heat	5.7.3 ^a	33 ^c
^a Test applied only to class MT and NT detectors incorporating heat sensor(s). ^b In the interests of test economy, it is permitted to use the same specimen for more than one EMC test. In that case, intermediate functional test(s) on the specimen(s) used for more than one test can be deleted, and the functional test conducted at the end of the sequence of tests. However it should be noted that in the event of a failure, it may not be possible to identify which test exposure caused the failure (see EN 50130-4:2011, Clause 4). ^c Test applied only to class M and class MT detectors.		

5.2 Nominal activation conditions/sensitivity

5.2.1 Individual alarm indication

A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for individual alarm indication as specified in 4.3.1.

The specimen shall be checked for adequate visibility in an ambient light intensity of 500 lux.

5.2.2 Response to slowly developing fires, aging and contamination

The behaviour of the multi-sensor fire detector to slowly developing fires, aging and contamination shall be assessed to meet the requirements of 4.3.2.

Since it is not practical to make tests with very slow increases in smoke density or CO concentration, an assessment of the detector's response to slow increases in smoke density or CO concentration 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 4.3.2 if this assessment shows that:

- 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 smoke response value), the time for the detector to give an alarm

or reach the compensated smoke response value (see 5.1.5) 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 smoke response value of the detector to exceed its initial value by a factor greater than 1,6.
- c) for any rate of increase in CO concentration R_{CO} , which is greater than $A_{CO}/4$ per hour (where A_{CO} is the detector's initial uncompensated CO response value), the time for the detector to give an alarm or reach the compensated CO response value (see 5.1.6) does not exceed $1,6 \times A_{CO}/R_{CO}$ by more than 100 s; and
- d) for any rate of increase in CO concentration R_{CO} , which is greater than $A_{CO}/4$ per hour (where A_{CO} is the detector's initial uncompensated CO response value), the time for the detector to give an alarm or reach the compensated CO response value (see 5.1.6) is not less than $0,625 \times A_{CO}/R_{CO}$ minus 100 s; and
- e) the range of compensation is limited such that, throughout this range, the compensation does not cause the CO response value of the detector to change from its initial value by a factor greater than 1,6 and less than 0,625.

NOTE Further information about the assessment is given in Annex T for smoke and CO.

5.2.3 Rate sensitive CO response

The behaviour of the CO fire detector to rate sensitive CO response shall be assessed to meet the requirements in 4.3.3 by analysis of the circuit/software, and/or by physical tests and simulations.

NOTE This approach is used as it is not practical to make tests with all possible rates of increase in CO concentration.

The detector shall be deemed to meet the requirements of this clause if this assessment shows that for constant smoke levels and constant temperatures, the detector does not signal an alarm condition or reach the CO response value (see 5.1.6) when subjected to a step change in CO concentration of 10 $\mu\text{l/l}$, superimposed on a background level between 0 $\mu\text{l/l}$ and 3 $\mu\text{l/l}$.

5.2.4 Repeatability of smoke response

5.2.4.1 Object

To show that the detector has stable behaviour with respect to its sensitivity to smoke even after the smoke response value was reached several times.

5.2.4.2 Test procedure

The smoke response value of the specimen to be tested shall be measured as described in 5.1.5 six times.

The specimen's orientation relative to the direction of airflow is arbitrary, but it shall be the same for all six measurements.

The maximum smoke response value shall be designated $y_{\max}$ or $m_{\max}$, the minimum value shall be designated $y_{\min}$ or $m_{\min}$.

5.2.4.3 Requirements

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

- b) The lower smoke response value $y_{\min}$ shall be not less than 0,2 or $m_{\min}$ shall be not less than 0,05 dB m⁻¹.

5.2.5 Directional dependence of smoke response

5.2.5.1 Object

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

5.2.5.2 Test procedure

The smoke response value of the specimen to be tested shall be measured eight times as described in 5.1.5, the specimen being rotated 45° about its vertical axis between each measurement, so that the measurements are taken for eight different orientations relative to the direction of air flow.

The maximum smoke response value shall be designated $y_{\max}$ or $m_{\max}$, the minimum value shall be designated $y_{\min}$ or $m_{\min}$.

The orientations, for which the maximum and minimum smoke response values were measured, shall be noted.

In the following tests the orientation for which the maximum smoke response value was measured is referred to as the least sensitive orientation for smoke, and the orientation for which the minimum smoke response value was measured is referred to as the most sensitive orientation for smoke.

5.2.5.3 Requirements

- a) The ratio of the smoke response values $y_{\max} : y_{\min}$ or $m_{\max} : m_{\min}$ shall be not greater than 1,6.
- b) The lower smoke response value $y_{\min}$ shall be not less than 0,2 or $m_{\min}$ shall be not less than 0,05 dB m⁻¹.

5.2.6 Repeatability of CO response

5.2.6.1 Object

To show that the detector has stable behaviour with respect to its sensitivity to CO even after the CO response value was reached several times.

5.2.6.2 Test procedure

The CO response value of the specimen to be tested shall be measured as described in 5.1.6 six times.

The specimen's orientation relative to the direction of airflow is arbitrary, but it shall be the same for all six measurements.

The maximum response threshold value shall be designated $S_{\max}$, the minimum value shall be designated $S_{\min}$.

5.2.6.3 Requirements

- a) The ratio of the CO response values $S_{\max} : S_{\min}$ shall be not greater than 1,6.
- b) The lower CO response value $S_{\min}$ shall be not less than 25 µl/l.

5.2.7 Directional dependence of CO response

5.2.7.1 Object

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

5.2.7.2 Test procedure

The CO response value of the specimen to be tested shall be measured eight times as described in 5.1.6, the specimen being rotated 45° about its vertical axis between each measurement, so that the measurements are taken for eight different orientations relative to the direction of air flow.

The maximum CO response value shall be designated $S_{\max}$, the minimum value shall be designated $S_{\min}$.

The orientations, for which the maximum and minimum CO response values were measured, shall be noted.

In the following tests the orientation for which the maximum CO response value was measured is referred to as the least sensitive orientation for CO, and the orientation for which the minimum CO response value was measured is referred to as the most sensitive orientation for CO.

5.2.7.3 Requirements

- a) The ratio of the CO response values $S_{\max} : S_{\min}$ shall be not greater than 1,6.
- b) The lower CO response value $S_{\min}$ shall be not less than 25 µl/l.

5.2.8 Directional dependence of heat response

5.2.8.1 Object of test

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

5.2.8.2 Test procedure

The heat response value of the specimen shall be tested eight times as specified in 5.1.7 at a rate of rise of air temperature of 10 K/min, the specimen being rotated about a vertical axis by 45 ° between each measurement, so that the measurements are taken for eight different orientations relative to the direction of airflow. The specimen shall be stabilized at 25 °C before each measurement.

The heat response value at each of the eight orientations shall be recorded.

The maximum heat response value shall be designated as $T_{\max}$; the minimum value as $T_{\min}$.

The maximum heat response value and the minimum heat response value orientations shall be recorded. The orientation for which the maximum response time was measured is referred to as the least sensitive orientation for heat. The orientation for which the minimum response time was measured is referred to as the most sensitive orientation for heat.

5.2.8.3 Requirements

The ratio of the heat response values $T_{\max} : T_{\min}$ shall be not greater than 1,6.

5.2.9 Lower limit of heat sensitivity

5.2.9.1 Object of the test

To confirm that detectors are not more sensitive to heat alone, without the presence of smoke or CO or both, than is permitted in EN 54-5:2000 as amended by EN 54-5:2000/A1:2002. This test is only applicable to detectors able to provide an alarm on heat only.

5.2.9.2 Test procedure

Measure the heat response value of the specimen to be tested, in its most sensitive orientation, using the methods described in EN 54-5:2000, 5.3 and 5.4 as amended by EN 54-5:2000/A1:2002. For the purposes of these tests, the test parameters for Class A1 detectors according to EN 54-5:2000 as amended by EN 54-5:2000/A1:2002 shall be used.

NOTE The minimum static response temperature needs to be greater than that which is required to comply with the operational heat test (5.6.1.1.2).

5.2.9.3 Requirements

In the test for static response temperature (EN 54-5:2000, 5.3 as amended by EN 54-5:2000/A1:2002), the specimen shall not give an alarm signal at a temperature less than the minimum static response temperature specified in EN 54-5:2000, Table 1, as amended by EN 54-5:2000/A1:2002 for a Class A1 detector according to EN 54-5:2000 as amended by EN 54-5:2000/A1:2002.

The specimen shall not give an alarm signal at each rate of rise of air temperature in a time less than the lower response time limits specified in EN 54-5:2000, Table 4, as amended by EN 54-5:2000/A1:2002 for a Class A1 detector according to EN 54-5:2000 as amended by EN 54-5:2000/A1:2002.

5.2.10 Reproducibility of smoke response

5.2.10.1 Object

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

5.2.10.2 Test procedure

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

The mean of these smoke response values shall be calculated and shall be designated $\bar{y}$ or $\bar{m}$.

The maximum smoke response value shall be designated $y_{\max}$ or $m_{\max}$, the minimum value shall be designated $y_{\min}$ or $m_{\min}$.

5.2.10.3 Requirements

- The ratio of the smoke response values $y_{\max} : \bar{y}$ or $m_{\max} : \bar{m}$ shall be not greater than 1,33 and the ratio of the smoke response values $\bar{y} : y_{\min}$ or $\bar{m} : m_{\min}$ shall be not greater than 1,5.
- The lower smoke response value $y_{\min}$ shall be not less than 0,2 or $m_{\min}$ shall be not less than 0,05 dB m⁻¹.

5.2.11 Reproducibility of CO response

5.2.11.1 Object

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

5.2.11.2 Test procedure

The CO response value of each of the test specimens shall be measured as described in 5.1.6.

The mean of these CO response values shall be calculated and shall be designated $\bar{S}$.

The maximum CO response value shall be designated $S_{\max}$ and the minimum value shall be designated $S_{\min}$.

5.2.11.3 Requirements

- a) The ratio of the CO response values $S_{\max} : \bar{S}$ shall be not greater than 1,33 and the ratio of the CO response threshold values $\bar{S} : S_{\min}$ shall be not greater than 1,5.
- b) The minimum CO response value $S_{\min}$ shall be not less than 25 µl/l.

5.2.12 Reproducibility of heat response

5.2.12.1 Object of the test

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

5.2.12.2 Test procedure

Measure the heat response value of each of the test specimens as specified in 5.1.7 at a rate of rise of air temperature of 20 K/min and record the heat response value.

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

5.2.12.3 Requirements

The ratio of the heat response values $T_{\max} : T_{\min}$ shall be not greater than 1,3.

5.2.13 Air movement

5.2.13.1 Object of test

To show that the sensitivity of the detector is not unduly affected by the rate of the air flow, and that it is not unduly prone to false alarms in draughts or in short gusts.

5.2.13.2 Test procedure

The smoke response value of the specimen to be tested shall be measured as described in 5.1.5 in the most and least sensitive orientations, and shall be appropriately designated as $y_{(0,2)\max}$ and $y_{(0,2)\min}$ or $m_{(0,2)\max}$ and $m_{(0,2)\min}$.

The measurements shall then be repeated but with an air velocity in the proximity of the detector of $(1 \pm 0,2) \text{ ms}^{-1}$. The smoke response values in these tests shall be designated $y_{(1,0)\text{max}}$ and $y_{(1,0)\text{min}}$ or $m_{(1,0)\text{max}}$ and $m_{(1,0)\text{min}}$.

Additionally, for detectors using ionization, the specimen to be tested shall be subjected, in its most sensitive orientation, to an aerosol-free air flow at a velocity of $(5 \pm 0,5) \text{ m s}^{-1}$ for a period of not less than 5 min and not more than 7 min, and then, at least 10 min later, to a gust at a velocity of $(10 \pm 1) \text{ ms}^{-1}$ for a period of not less than 2 s and not more than 4 s. The specimen shall be monitored during the exposure to aerosol-free air to detect any alarm or fault signals.

The CO response value of the specimen to be tested shall be measured as described in 5.1.6 in the most and least sensitive orientations, and shall be appropriately designated $S_{(0,2)\text{min}}$ and $S_{(0,2)\text{max}}$.

These measurements shall then be repeated but with an air velocity, in the proximity of the detector, of $(1 \pm 0,2) \text{ ms}^{-1}$. The CO response values in these tests shall be designated $S_{(1,0)\text{min}}$ and $S_{(1,0)\text{max}}$.

NOTE These exposures can be generated by plunging the specimen to be tested into an airflow with the appropriate velocity for the required time.

5.2.13.3 Requirements

For detectors using ionization the following shall apply:

$$0,625 < \frac{[y_{(0,2)\text{max}} + y_{(0,2)\text{min}}]}{[y_{(1,0)\text{max}} + y_{(1,0)\text{min}}]} < 1,6.$$

And the detector shall emit neither a fault signal nor an alarm during the test with aerosol-free air.

For detectors using optical smoke sensors the following shall apply:

$$0,625 < \frac{[m_{(0,2)\text{max}} + m_{(0,2)\text{min}}]}{[m_{(1,0)\text{max}} + m_{(1,0)\text{min}}]} < 1,6;$$

For the CO response value shall apply:

$$\text{a) } 0,625 \leq \frac{S_{(0,2)\text{max}} + S_{(0,2)\text{min}}}{S_{(1,0)\text{max}} + S_{(1,0)\text{min}}} \leq 1,6$$

b) the lowest CO response values from $S_{(0,2)\text{min}}$ and $S_{(1,0)\text{min}}$ shall be not less than 25 $\mu\text{l/l}$.

5.2.14 Dazzling

5.2.14.1 Object of test

To show that the sensitivity of the detector is not unduly influenced by the close proximity of artificial light sources. This test is only applicable to detectors using optical smoke sensors, as ionization chamber detectors are considered unlikely to be influenced.

5.2.14.2 Test procedure

Install the dazzling apparatus, described in Annex H in the smoke tunnel described in Annex A. Install the specimen in the dazzling apparatus in the least sensitive orientation and connect it to its supply and monitoring equipment. Then apply the following test procedure:

a) measure the smoke response value as described in 5.1.5;

- b) Switch the four lamps simultaneously ON for 10 s and then OFF for 10 s, 10 times;
- c) switch the four lamps ON again and after at least 1 min measure the smoke response value, as described in 5.1.5, with the lamps ON;
- d) then switch the four lamps OFF.

Repeat the above procedure but with the detector rotated 90°, in one direction (either direction can be chosen), from the least sensitive orientation for smoke as measured in 5.3.

For each orientation, the maximum smoke response value shall be designated $m_{\max}$ and the minimum smoke response value shall be designated $m_{\min}$.

5.2.14.3 Requirements

During the periods when the switching sequences are being conducted and when the lamps are all ON for at least 1 min, the specimen shall not emit either an alarm or fault signal.

For each orientation, the ratio of the smoke response values $m_{\max} : m_{\min}$ shall be not greater than 1,6.

5.3 Operational reliability

5.3.1 Connection of ancillary devices

A1 A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for the connection of ancillary devices specified in 4.4.1. **A1**

5.3.2 Monitoring of detachable detectors

A1 A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for the monitoring of detachable detectors specified in 4.4.2. **A1**

5.3.3 Manufacturer's adjustments

A1 A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for manufacturer's adjustments specified in 4.4.3. **A1**

5.3.4 On-site adjustment of behaviour

A1 A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for on-site adjustment of response behaviour specified in 4.4.4. **A1**

5.3.5 Protection against the ingress of foreign bodies

A1 An inspection of a specimen shall be conducted to verify that the detector meets the requirements for the protection against the ingress of foreign bodies specified in 4.4.5. **A1**

5.3.6 Software controlled devices

For detectors that rely on software for their operation, an assessment of the documentation provided by the manufacturer shall be conducted to verify that the device complies with the requirements specified in 4.4.6.

5.3.7 Long term stability

5.3.7.1 Object

To confirm that the detectors are stable over long periods of time.

5.3.7.2 Test procedure

During the duration of the test the detector shall be connected to suitable supply and monitoring equipment and shall be placed in laboratory atmospheric conditions (see 5.1.1).

The CO response value shall be measured without any reset or restart, as described in 5.1.6, after 84 days from the start of the test.

The highest of the values measured in this test and that measured for the same detector in the reproducibility test shall be designated as $S_{\max}$. The lowest of the values measured in this test and that measured for the same detector in the reproducibility test shall be designated as $S_{\min}$.

5.3.7.3 Requirements

- a) The detector shall not generate an alarm or fault signals when in normal atmospheric conditions (5.1.1);
- b) The ratio of the CO response values $S_{\max} : S_{\min}$ shall be not greater than 1,6.
- c) The lowest CO response value $S_{\min}$ shall be not less than 25 $\mu\text{l/l}$.

5.4 Tolerance to supply parameters

5.4.1 Variation in supply parameters

5.4.1.1 Object

To show that, within the specified range(s) of the supply parameters (e.g. voltage), the sensitivity of the detector is not unduly dependent on these parameters.

5.4.1.2 Test procedure

The smoke response value of the specimen shall be measured as described in 5.1.5, at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

The maximum smoke response value shall be designated $y_{\max}$ or $m_{\max}$, the minimum value shall be designated $y_{\min}$ or $m_{\min}$.

The CO response threshold value of the specimen shall be tested as specified in 5.1.6, at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

The maximum CO response value shall be designated as $S_{\max}$; the minimum value as $S_{\min}$.

The heat response value of the specimen shall be tested as specified in 5.1.7 at a rate of rise of air temperature of 20 K/min at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

The maximum heat response value shall be designated as $T_{\max}$; the minimum value as $T_{\min}$.

NOTE For conventional detectors the supply parameter is the DC voltage applied to the detector. For other types of detector (e.g. analogue addressable) signal levels and timing might need to be considered. If necessary the manufacturer may be requested to provide suitable supply equipment to allow the supply parameters to be changed as required.

5.4.1.3 Requirements

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

- b) The lower smoke response value $y_{\min}$ shall be not less than 0,2 or $m_{\min}$ shall be not less than 0,05 dB m^{-1} .
- c) The lower CO response value $S_{\min}$ shall be not less than 25 $\mu l/l$.
- d) The ratio of the CO response values $S_{\max} : S_{\min}$ shall be not greater than 1,6.
- e) The ratio of the heat response values $T_{\max} : T_{\min}$ shall be not greater than 1,3.

5.5 Performance parameters under fire conditions

5.5.1 Fire sensitivity

5.5.1.1 Object

To show that the detector has adequate sensitivity to a broad spectrum of fire types as required for general application in fire detection systems for buildings.

5.5.1.2 Principle

The specimens are mounted in a standard fire test room (see Annex J) and are exposed to a series of test fires designed to produce smoke, CO and heat.

5.5.1.3 Test procedure

5.5.1.3.1 Fire test room

The fire sensitivity tests shall be conducted in a rectangular room with a flat horizontal ceiling, and the following dimensions:

- Length: 9 m to 11 m;
- Width: 6 m to 8 m;
- Height: 3,8 m to 4,2 m.

The fire test room shall be equipped with the following measuring instruments arranged as indicated in Annex J:

- a) Measuring ionization chamber (MIC);
- b) Obscuration meter;
- c) Temperature probe;
- d) CO monitor.

5.5.1.3.2 Test Fires

The specimens shall be subjected to six test fires, TF1, TF2, TF3, TF4, TF5 and TF8 as described in Annexes K, L, M, N, O and P including the type, quantity and arrangement of the fuel and the method of ignition along with the end of test condition and the required profile curve limits.

In order to be a valid test fire, the development of the fire shall be such that the profile curves of m against y , m against time t and S against time t fall within the specified limits, up to the time when all of the specimens have generated an alarm signal or the end of test condition is reached, whichever is the earlier. If these conditions are not met then the test is invalid and shall be repeated. It is permissible,

and may be necessary, to adjust the quantity, condition (e.g. moisture content) and arrangement of the fuel to obtain valid test fires.

5.5.1.3.3 Mounting of the specimens

The six specimens (Nos. 5, 6, 7, 8, 9 and 10) shall be mounted on the fire test room ceiling in the designated area (see Annex J). The specimens shall be mounted in accordance with the manufacturer's instructions. The specimens 5, 6 and 7 shall be mounted in the least sensitive orientation for smoke and the specimens 8, 9 and 10 in the least sensitive orientation for CO relative to an assumed airflow from the centre of the room to the specimen.

Each specimen shall be connected to its supply and monitoring equipment, as described in 5.1.2, and shall be allowed to stabilize in its quiescent condition before the start of each test fire.

Detectors which dynamically modify their sensitivity in response to varying ambient conditions, may require special reset procedures and/or stabilization times. The manufacturer's guidance should be sought in such cases to ensure that the state of the detectors at the start of each test is representative of their normal quiescent state.

5.5.1.3.4 Initial conditions

Before each test fire the room shall be ventilated with clean air until it is free from smoke and so that the conditions listed below can be obtained.

The ventilation system shall then be switched off and all doors, windows and other openings shall be closed. The air in the room shall then be allowed to stabilize, and the following conditions shall be obtained before the test is started:

- Air temperature: $T = (23 \pm 5) ^\circ\text{C}$;
- Air movement: negligible;
- Smoke density (ionization): $y \leq 0,05$;
- Smoke density (optical): $m \leq 0,02 \text{ dB m}^{-1}$;
- CO concentration $S \leq 3 \text{ }\mu\text{l/l}$

The stability of the air and temperature gradients affect the flow of smoke within the room. This is particularly important for test fires, which produce low thermal lift for the smoke (e.g. TF2, TF3 and TF8). It is therefore recommended that the difference between the temperature near the floor and the ceiling is $< 2 \text{ K}$, and that local heat sources that can cause convection currents (e.g. lights and heaters) should be avoided. If it is necessary for people to be in the room at the beginning of a test fire, they should leave as soon as possible, taking care to produce the minimum disturbance to the air.

5.5.1.3.5 Recording of the fire parameters and response values

During each test fire the following fire parameters shall be recorded continuously or at least once per second.

Parameter	Symbol	Units
Temperature change	ΔT	K
Smoke density (ionization)	y	Dimensionless
Smoke density (optical)	m	dB m^{-1}
CO concentration	S	$\mu\text{l/l}$