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Fire detection and alarm systems —

Part 29: Video fire detectors

Systèmes de détection et d'alarme d'incendie —

Partie 29: Titre manque

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

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

Introduction

A video fire detection system differs from some point-type detectors (e.g. ISO 7240-6, ISO 7240-7) in that the detection is performed remotely from the actual fire and therefore does not involve sensor contact with the products of combustion. The fire detection is based on mathematical algorithm analysis of a video image. The video image from a camera might be processed by software to determine the presence of smoke and/or flame (depending on the capability of the system) which is visible in the image.

Video fire detectors consist of three elements: a sensor, an image processor, and a transmission path between the sensor and image processor. The elements can be in a single cabinet, or the sensor and processor can be in separate cabinets, interconnected by a transmission path.

The processor incorporates an alarm and fault signalling interface to connect to a compatible fire detection control and indicating equipment transmission path.

Two types of detectors are specified to differentiate equipment that sense smoke or flame. A single detector can also sense both smoke and flame.

Two enclosure protection ratings are specified for dust and water ingress protection.

Three environmental temperature ranges are specified, for detectors suitable for installation indoors or outdoors.

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

This document is not intended to place any other restrictions on the design and construction of such detectors.

Fire detection and alarm systems —

Part 29:
Video fire detectors

1 Scope

This document specifies requirements, test methods and performance criteria for video fire detectors (VFD), which operate in the visible spectrum, for use in fire detection and alarm systems installed in and around buildings (see ISO 7240-1). For the testing of other types of VFD working on different principles, this document can be used only for guidance.

Detectors developed for the protection of specific risks that incorporate special characteristics (including additional features or enhanced functionality for which this document does not define a test or assessment method) are beyond the scope of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 2560, *Welding consumables — Covered electrodes for manual metal arc welding of non-alloy and fine grain steels — Classification*

IEC 60064, *Tungsten filament lamps for domestic and similar general lighting purposes — Performance requirements*

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

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

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

IEC 60068-2-75, *Environmental testing — Part 2-75 Tests – Test Eh: Hammer tests*

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

IEC 60081, *Double-capped fluorescent lamps — Performance specifications*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

IEC 62599-2, *Alarm systems — Part 2: Electromagnetic compatibility — Immunity requirements for components of fire and security alarm systems*

3 Terms and definitions, and abbreviated terms

3.1 Definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
response threshold value
time it takes the detector to signal an alarm

Note 1 to entry: When tested as specified in 5.1.6.

Note 2 to entry: The response threshold value can depend on signal processing in the detector and in fire detection control and indicating equipment.

3.1.2
field of view
FOV
image captured by the video fire detector

Note 1 to entry: The FOV can be expressed as an angle or as a width and height, at a specified distance.

3.1.3
field of detecting
FOD
area in the *field of view* (3.1.2) in which smoke and/or flame can be detected by the *video fire detector* (3.1.5)

Note 1 to entry: The FOD may be determined based on type of fire, distance from fire source and manufacturer specifications.

3.1.4
illuminator
light source, internal or external to the *video fire detector* (3.1.5), that assists the equipment to operate in low ambient light conditions

3.1.5
video fire detector
VFD
self-contained device or distributed system in which analysis of video images is performed in order to detect the presence of smoke and/or flame within the images being analyzed

3.2 Abbreviated terms

EM	electromagnetic compatibility
FDCIE	fire detection control and indicating equipment
FOD	field of detecting
FOV	field of view

MIC measuring ionization chamber

IP ingress protection

VFD video fire detector

4 Requirements

4.1 Compliance

In order to comply with this document, the VFD shall meet the following requirements:

a) comply with the requirements of Clause 4, which shall be verified by visual inspection or engineering assessment;

b) be tested as specified in Clause 5, meeting the requirements of the tests;

c) be marked in accordance with Clause 6 and be accompanied by the documentation specified in Clause 7, which shall be verified by visual inspection.

4.2 Fire phenomena

The manufacturer shall declare, in the data presented in Clause 7, a phenomenon of fire in Table 1 to which the VFD is designed to respond.

Table 1 — Fire phenomena types

Type	Fire phenomena
A	Smoke
B	Flame
AB	Smoke and Flame

NOTE 1 Type AB VFD can detect flame emitted by test fire for type A VFD, and can also detect smoke from a type B test fire. Thus type AB VFD is NOT required to detect the smoke emitted by test fire for type A but it can signal an alarm to all the test fires.

NOTE 2 VFD can have two types (i.e. Type A and B) if the flame detection and smoke detection algorithms within the VFD can be separately activated/monitored.

4.3 Immunity to unwanted alarms

4.3.1 Detectors shall be immune from phenomena that can cause unwanted alarms.

4.3.2 Optional tests shall be performed where the manufacturer claims immunity to the phenomena.

4.4 Detection range

The manufacturer shall declare the ranges at which the VFD shall detect a fire in the data supplied in Clause 7.

4.5 Camera lenses

4.5.1 VFD may use interchangeable or variable focal length lenses.

4.5.2 A change of focus of the camera lens that prevents the VFD from detecting a fire shall cause a fault signal.

4.6 Camera lens monitoring

4.6.1 Contamination of the camera lens that prevents the VFD from detecting a fire shall cause a fault signal.

4.6.2 Complete obscuration of the camera lens that inhibits fire detection in the operating FOV shall cause a fault signal.

4.7 Individual alarm indication

4.7.1 Where the VFD does not display an image of the FOV to the user, then each video fire detector shall be provided with an integral red visual indicator by which the individual detector signals 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.

4.7.2 Where the indicator is mounted on the camera, the visual indicator shall be visible from a distance of 6 m in an ambient light intensity up to 500 lx at an angle of up to:

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

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

4.8 Connection of ancillary devices

The detector may provide for connections to ancillary devices (remote indicators, control relays, etc.), but open- or short-circuit failures of these connections shall not prevent the correct operation of the detector.

4.9 Monitoring of detachable cameras

For detachable cameras, a means shall be provided to detect the disconnection of the camera, in order to give a fault signal.

4.10 Connection of more than one VFD to the FDCIE transmission path

4.10.1 Where a VFD is designed to share the transmission path to the FDCIE with other devices; connections shall be such that a single transmission fault does not prevent an alarm signal from more than one VFD.

4.10.2 Where more than one VFD share the transmission path to the FDCIE, connections shall be such that one VFD fault signal does not prevent the alarm signal from any other VFD.

4.11 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.

4.12 On-site adjustment of response behaviour

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

a) for all of the settings at which the manufacturer claims compliance, the detector shall comply with the requirements of this document and access to the adjustment means shall be possible only by the use of a code or special tool or by removing the detector from its base or mounting;

b) any setting or settings at which the manufacturer does not claim compliance with this document shall be accessible only by the use of a special code or tool, and it shall be clearly marked on the detector or in the associated data that if these setting or settings are used, the detector does not comply with this document.

4.12.2 Adjustments may be carried out at the VFD or at the fire detection control and indicating equipment.

4.13 Protection against the ingress of foreign bodies

4.13.1 The manufacturer shall declare, in the data presented in Clause 7, an enclosure protection rating (i.e. IP rating in accordance with IEC 60529) from Table 2 to which the VFD is designed to be protected against.

Table 2 — Video fire detector enclosure protection

Application	IP rating (see IEC 60529)
Indoor	30
Outdoor	54
Special	nominated by the manufacturer

4.13.2 Where the VFD includes more than one subassembly (e.g. a separate sensor and controller), some parts of the detector not designed to be installed in the environment to which the rating applies need not be assessed. In this case, the manufacturer's data shall declare the IP rating of each subassembly.

4.14 Ambient light operating level

The VFD shall operate over the range 15 lx to 10 000 lx.

NOTE In an installation, the light level range might need to be ensured by artificial illumination or shading if necessary.

4.15 Operating temperature

4.15.1 The manufacturer shall declare, in the data presented in Clause 7, the operating temperature specified in Table 3 to which the VFD is designed to operate.

Table 3 — Video fire detector operating environment

Application	Temperature
Indoor controlled	0 °C to 40 °C
Indoor	−10 °C to 55 °C
Outdoor 1	−25 °C to 70 °C
Outdoor 2	−40 °C to 55 °C
Special	nominated by the manufacturer and is an enhancement of the above

4.15.2 Where the VFD includes more than one subassembly (e.g. a separate sensor and controller i.e. a distributed system), some parts of the VFD not designed to be installed in the temperature to which the rating applies shall be assessed separately for their intended installation location. In this case, the manufacturer's data shall declare the environment suitable for each subassembly.

4.16 Software

4.16.1 General

The requirements of 4.16.2 and 4.16.3 shall be met for detectors which rely on software control in order to fulfil the requirements of this document.

4.16.2 Software design

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

4.16.3 Storage of programs and data

4.16.3.1 The program necessary to comply with this document 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.

4.16.3.2 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.

5 Tests

5.1 General

5.1.1 Atmospheric conditions for tests

5.1.1.1 Unless otherwise stated in a test procedure, carry out the testing after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as specified in IEC 60068-1 as follows.

Temperature:	(15 to 35) °C
Relative humidity:	(25 to 75) %
Air pressure:	(86 to 106) kPa

5.1.1.2 The temperature and humidity shall be substantially constant for each environmental test where the standard atmospheric conditions are applied.

5.1.2 Ambient light level for tests

5.1.2.1 Unless otherwise stated in a test procedure, carry out the testing as specified.

5.1.2.2 Ambient light level (15 to 500) lx.

The ambient light level shall be substantially constant for each environment test where the standard ambient light level is applied.

5.1.3 Mounting arrangements

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

5.1.4 Operating conditions for tests

5.1.4.1 If a test method requires a specimen to be operational, then connect the specimen to suitable supply and monitoring equipment having the characteristics required by the manufacturer's data. Allow the specimen to stabilize prior to commencing the test.

5.1.4.2 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.

5.1.4.3 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 equipment (e.g. through wiring to an end-of-line device for point detectors) to allow a fault signal to be recognized.

5.1.4.4 The details of the supply and monitoring equipment and the alarm criteria used shall be given in the test report (see 5.28).

5.1.4.5 Tests shall be conducted with the VFD at the default sensitivity unless otherwise specified. The tests shall be conducted without any masking of the image or field of view.

5.1.5 Tolerances

5.1.5.1 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).

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

5.1.6 Provision for tests

5.1.6.1 The following shall be provided for testing compliance with this document:

a) for a VFD utilizing detachable cameras, a minimum of one controller and a minimum of five cameras;

b) for a VFD that incorporates the camera and controller into a single unit, five samples of the VFD;

c) for a VFD where the camera employs interchangeable lenses, a minimum of one sample of each compatible lens declared by the manufacturer as part of equipment complying with this document;

d) the data specified by Clause 7;

e) multiple VFD specimens, beyond those specified in a) – c), utilizing different distances, lenses and focal lengths may be simultaneously tested at the same test fire.

5.1.6.2 The specimens submitted shall be deemed representative of the manufacturer's normal production with regard to their construction and calibration. This implies that the mean response threshold value of the specimens found in the reproducibility test (5.3), should also represent the production mean, and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

5.1.7 Measurement of response threshold value

5.1.7.1 General

5.1.7.1.1 Mount the specimen in accordance with 5.1.3 in the fire test room in the designated area (see Annex A) in accordance with the manufacturer's instructions.

5.1.7.1.2 Connect each specimen to its supply and monitoring equipment, as specified in 5.1.4, and allow it to stabilize in its quiescent condition before the start of each test.

5.1.7.1.3 Detectors which dynamically modify their sensitivity in response to varying ambient conditions may require special reset procedures and/or stabilization times. In such cases, the manufacturer shall provide data to ensure that the state of the detectors at the start of each test is representative of the normal quiescent state.

5.1.7.1.4 Subject the specimen to either of the tests specified in 5.1.7.2 or 5.1.7.3. The choice of test shall be nominated by the manufacturer.

NOTE This will establish a sensitivity equivalent to the full-scale fire testing in 5.7.

5.1.7.1.5 Where interchangeable lenses are used the manufacturer shall specify the appropriate lens for the test distance.

5.1.7.1.6 Monitor the specimen during the conditioning period to detect alarm and fault signals.

5.1.7.1.7 Record the test conditions at the moment the specimen gives an alarm. Record the time it takes the VFD to signal alarm from the commencement of the test fire. This shall be taken as the response threshold value.

NOTE This might need to allow for the test fire to become established while the sensor is masked e.g. by a mirror looking away from the test fire. The time then start from when the mirror is removed.

5.1.7.2 Small scale test fire

Subject the specimen to a small-scale sensitivity test fire specified by the manufacturer and agreed by the test house. The specification shall include fuel type, size, and distance or other applicable stimulus.

5.1.7.3 Recorded fire video

5.1.7.3.1 Mount a video camera adjacent to the specimen. The camera and its adjustments can be specified by the manufacturer. The adjustments shall be the same for all tests and test fires.

5.1.7.3.1.1 Video camera minimum specifications

a) Resolution shall be equal to or greater than the specimen under test.

b) The video camera shall have the same aspect ratio as the specimen under test.

c) Some VSD's require specific camera settings (Exposure, Gain control, WDR). Camera settings of recording camera should be as required by manufacturer.

NOTE The manufacturer might need details of the camera used or can supply a camera, to enable detector settings to be adjusted to respond to a video image of the fire.

5.1.7.3.1.2 Record the test specified in 5.1.6.2 using a high quality video recorder.

5.1.7.3.1.3 For subsequent required tests, play back the recorded video through a high quality video display, with the video image in the specimen FOV. The monitor and its adjustments can be specified by the manufacturer. The adjustments shall be the same for all tests and test fires. The manufacturer can define the illumination conditions of the room in which the display and camera are mounted during the playback of the recorded videos.

5.1.7.3.2 Minimum specifications for video display.

5.1.7.3.2.1 Resolution shall be equal to or greater than the specimen under test.

5.1.7.3.2.2 Minimum 450 NIT combined with minimum 4 000:1 (fixed) contrast, not dynamic contrast.

5.1.7.3.2.3 Video display shall be equipped with anti-glare layer to eliminate reflections.

NOTE For the tests with the recorded video the display monitor and sample under test is to be in dark housing completely isolated from influences of environmental light.

5.1.8 Test schedule

Test the specimens in accordance with the test schedule in Table 4. After the reproducibility test, number the specimens in the order of their response threshold time (i.e. those with the lowest response threshold time is numbered 1).

Table 4 — Test schedule

Test	Subclause	Specimen No.(s)
Repeatability	5.2	One chosen arbitrarily
Reproducibility	5.3	All specimens
Detector lens monitoring	5.4	1
Detector lens blocking	5.5	1
Detector lens focus fault [a]	5.6	1
Fire sensitivity	5.7	All specimens
Ambient light (Indoor)	5.8	1
Ambient light (outdoor)	5.9	1
Non-uniform illumination	5.10	2
Light source immunity	5.11	3
Arc welding — Optional	5.12	4
Variation in supply parameters	5.13	2
Dry heat (operational)	5.14	3
Dry heat (operational) — Optional [b]	5.15	3
Cold (operational)	5.16	4
Cold (operational) — Optional [c]	5.17	4
Damp heat, steady state (operational)	5.18	5

[a] Only required for detectors with a field-adjustable variable focus lens.

[b] This test may be conducted in lieu of the dry heat test specified in 5.14.

[c] This test may be conducted in lieu of the cold test specified in 5.16.

Table 4 *(continued)*

Test	Subclause	Specimen No.(s)
Damp heat, steady state (endurance)	5.19	1
Protection against ingress of foreign bodies [c]	5.20	1
Sulfur dioxide (SO_2) corrosion (endurance)	5.21	2
Shock (operational)	5.22	3
Impact camera (operational)	5.23	4
Impact controllers (operational)	5.24	1
Vibration, sinusoidal (operational)	5.25	5
Vibration, sinusoidal (endurance)	5.26	1
Electromagnetic compatibility (EMC) immunity (operational)	5.27	5

[a] Only required for detectors with a field-adjustable variable focus lens.

[b] This test may be conducted in lieu of the dry heat test specified in 5.14.

[c] This test may be conducted in lieu of the cold test specified in 5.16.

5.1.9 Test report

Report the test results in accordance with 5.28.

5.2 Repeatability

5.2.1 Object of test

To demonstrate that the detector has stable behavior with respect to its sensitivity, even after a number of alarm conditions.

5.2.2 Test procedure

5.2.2.1 Measure the response threshold value of the specimen to be tested six times as specified in 5.1.7.

5.2.2.2 Designate the maximum response threshold value as t_{max}, the minimum value as t_{min}.

5.2.3 Requirements

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

5.3 Reproducibility

5.3.1 Object of test

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

5.3.2 Test procedure

5.3.2.1 Measure the response threshold value of each specimen as specified in 5.1.7.

5.3.2.2 Calculate the mean of these response threshold values, which shall be designated $\bar{t}$.

5.3.2.3 Designate the maximum response threshold value as t_{max}, the minimum response threshold value as t_{min}.

5.3.3 Requirements

The ratio of the response threshold values $t_{max} : \bar{t}$ shall not be greater than 1,33, and the ratio of the response threshold values $\bar{t} : t_{min}$ shall not be greater than 1,5.

5.4 Detector lens monitoring

5.4.1 Object of test

To demonstrate the ability of the detector to enter a fault state when contaminants on the sensing lens reduce the response threshold value of the detector.

To demonstrate the detector is still able to detect before that point of going into fault signal.

5.4.2 Test procedure

5.4.2.1 Mount the specimen to be tested as specified in 5.1.3 and connect to the supply and monitoring equipment specified in 5.1.4.

5.4.2.2 Place a variable attenuation filter as specified by Annex S in front of the camera lens such that the lens FOV is completely covered. The attenuation filter shall not distort or pixelate the image.

5.4.2.3 Place the attenuation filter for maximum attenuation of the FOV, density 100 and verify that the specimen releases a fault condition within 300 s.

5.4.2.4 Remove the attenuation filter and allow the specimen to return to the quiescent condition.

5.4.2.5 Place the attenuation filter of density 10 for minimum 300 s and check if the specimen releases a fault condition.

5.4.2.6 If the specimen doesn't release a fault condition, remove the current filter and replace it directly and smoothly with the density filter 10 steps higher, without letting the specimen return to quiescent condition. Leave the filter again for 300 s. Check if the specimen releases a fault condition.

Repeat this step in increasing steps of density 10 until there is a density filter D_{fault} at which the specimen releases a fault signal.

NOTE For D_{fault}, all density values within the range 10 –100 % density are acceptable.

5.4.2.7 Remove the density filter D_{fault} and replace it by the density filter D_{fault} – 10 being the last density filter which doesn't create a fault signal. Allow the specimen to return to the quiescent condition.

5.4.2.8 Conduct the sensitivity test as specified in 5.1.6.

5.4.2.9 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.4.3 Requirements

5.4.3.1 The specimen shall release a fault signal within 300 s when tested in accordance with 5.4.2.3. If the specimen doesn't raise a fault condition, but it does raise a fault condition in accordance with 5.5.3.1,

then the filter is not opaque enough and a higher quality print of all filters should be used, until a fault condition is reached. All filters used in all tests under 5.4.2 should be printed with this latest high quality print causing a fault signal at density 100.

5.4.3.2 The ratio of the response threshold values t_{max} : t_{min} shall not be greater than 1,6.

5.5 Detector lens blocking

5.5.1 Object of test

To demonstrate that the VFD is able to detect complete blockage of its FOV.

5.5.2 Test procedure

5.5.2.1 Mount the specimen as specified in 5.1.3 and connect to the supply and monitoring equipment specified in 5.1.4.

5.5.2.2 Configure the specimen and the monitoring equipment such that the alarm signal is non-latching.

5.5.2.3 Monitor the specimen for alarm and fault signals.

5.5.2.4 Place a white surface 10 cm from the VFD lens to block the entire FOV.

5.5.2.5 Maintain the blockage for 300 s.

5.5.2.6 Remove the blockage and allow the VFD to reset and stabilize.

5.5.2.7 Place a black surface 10 cm from the VFD lens to block the entire FOV.

5.5.2.8 Maintain the blockage for 300 s.

5.5.2.9 Remove the blockage and allow the VFD to reset and stabilize.

5.5.3 Requirements

5.5.3.1 A fault signal shall be given during 5.5.2.5 and 5.5.2.8.

5.5.3.2 No alarm signal shall be given.

5.6 Detector lens focus fault — Optional

5.6.1 Object of test

To demonstrate the ability of the detector to enter a fault state when the camera lens miss-focus reduces the sensitivity of the detector to a level less than that required to satisfy the sensitivity response threshold value declared by the manufacturer.

5.6.2 Test procedure

5.6.2.1 Mount the specimen to be tested as specified in 5.1.3 and connect to the supply and monitoring equipment specified in 5.1.4.

5.6.2.2 Slowly defocus the camera lens until a fault signal is released. Record the setting. Where a fault signal is not released, even when the camera lens is fully defocused, 5.6.2.6 shall be conducted at the extreme of the focus adjustment range.

NOTE The rate of change in the focus should be slower than any automatic compensation that might be occurring within the specimen.

5.6.2.3 Restore the lens focus and allow the specimen to return to the quiescent condition.

5.6.2.4 Slowly defocus the VFD lens to a point just prior to the setting obtained in 5.6.2.2.

5.6.2.5 Measure the response threshold value of the specimen as specified in 5.1.7.

5.6.2.6 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.6.3 Requirements

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

5.7 Fire sensitivity

5.7.1 Object of test

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

5.7.2 Test procedure

5.7.2.1 Mount the specimen as specified in 5.1.3 and connect to the supply and monitoring equipment specified in 5.1.4.

NOTE 1 Detectors which dynamically modify their sensitivity in response to varying ambient conditions could require special reset procedures and/or stabilization times. The manufacturer's guidance can 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.

NOTE 2 In the interests of economy, the manufacturer can supply sufficient samples to allow simultaneous assessment of VFD and lens.

5.7.2.2 For type A VFD, where the declared range is ≤ 9 m, subject the specimens to test fires TF2, TF3, TF4, TF5, and TF8 specified in Annexes B to F in the fire test room specified in Annex A.

5.7.2.3 For type A VFD, where the declared range is > 9 m, subject the specimens to test fires TF2c, TF3c, TF4a, TF5c, and TF8a specified in Annexes G to K in a fire test room at least as long as the declared range.

5.7.2.4 For type B VFD, where the declared range is ≤ 9 m, subject the specimens to test fires TF1, TF4 and TF6 specified in Annexes L and M in the fire test room specified in Annex A.

5.7.2.5 For type B VFD, where the declared range is > 9 m, subject the specimens to test fires TF1a, TF4 and TF6a specified in Annexes N, O and P in a fire test room at least as long as the declared range.

5.7.2.6 For type AB VFD all test fire for type A and B for the appropriate declared range shall be applied.

5.7.2.6.1 For type AB VFD where the declared range is ≤ 9 m, subject the specimens to test fires TF1, TF2, TF3, TF4, TF5, TF6 and TF8 specified in Annexes B to F, L, and M in the fire test room specified in Annex A.

5.7.2.6.2 For type AB VFD where the declared range is > 9 m, subject the specimens to test fires TF1a, TF2c, TF3c, TF4a, TF5c, TF6a, TF8a specified in Annexes G to K, N, O, and P in a fire test room at least as long as the declared range

5.7.2.7 For test fire TF2, TF2c, TF3 and TF3c the fire background shall be white. If required by the manufacturer, contrast marks can be added to the white background to facilitate correct operation of the detector under test. If such marks are required then the detector instruction shall include a requirement that backgrounds shall include equivalent and sufficient contrast features in the field of view to ensure correct operation.

5.7.2.8 For test fires TF1, TF1a, TF4, TF4a, TF5, TF5c, TF8 and TF8a the fire background shall be black. If required by the manufacturer, contrast marks can be added to the black background to facilitate correct operation of the detector under test. If such marks are required then the detector instruction shall include a requirement that backgrounds shall include equivalent and sufficient contrast features in the field of view to ensure correct operation.

5.7.2.9 Acceptable contrast marks are of a size occupying not more than 5% of the area of the background.

5.7.2.10 Conduct tests TF1, TF2, TF3, TF4, TF5, TF6, and TF8 at the minimum distance specified by the manufacturer.

5.7.2.11 Conduct tests TF1a, TF2c, TF3c, TF4a, TF5c, TF6a, and TF8a at the maximum distance specified by the manufacturer.

5.7.2.12 For VFD that use interchangeable camera lenses, conduct the test fires for each camera/lens combination at the minimum and maximum distances specified by the manufacturer.

NOTE It should be possible to mount multiple specimens in minimum and maximum distance per lens specified by the manufacturer to conduct only one test for each specified test fire for all camera/lens combinations specified by the manufacturer.

5.7.2.13 For VFD that use a variable focal length camera lenses, conduct the test fires at the maximum, middle and minimum focal lengths.

NOTE 1 It is possible to mount multiple specimens in minimum and maximum distance per lens specified by the manufacturer to conduct only one test for each specified test fire for all camera/lens combinations specified by the manufacturer.

NOTE 2 The tests specified in 5.7.2.10 and 5.7.2.11 can be combined. Therefore one test of each test fire is sufficient to test all camera/lens/focal length combinations if the manufacturer provides enough specimens for all combinations.

5.7.2.14 In order for test fires TF1, TF2, TF3, TF4, TF5, TF6, and TF8 to be valid, the development of the fires shall be such that the profile curves of m against y and m 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 can be necessary, to adjust the quantity, condition (e.g. moisture content) and arrangement of the fuel to obtain valid test fires.

5.7.2.15 In order for test fires TF1a, TF2c, TF3c, TF4a, TF5c, TF6a, and TF8a to be valid, fuel used shall be from the same batch or lot as fuel known to be successful for TF1, TF2, TF3, TF4, TF5, TF6, and TF8.

IMPORTANT — The stability of the air and temperature affects the smoke flow within the room. This is particularly important for the test fires which produce low thermal lift for the smoke (e.g. TF2 and TF3). Therefore, the difference between the temperature near the floor and the ceiling should be < 2 °C, and 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.

5.7.2.16 Before each test fire, ventilate the room with clean air until it is free from smoke, so that the conditions given below can be obtained.

5.7.2.17 Switch off the ventilation system and close all doors, windows and other openings. Then allow the air in the room to stabilize and the following conditions to be obtained before the test is started.

Air movement: negligible

Smoke density (ionization): $y \leq 0{,}05$

Smoke density (optical): $m \leq 0{,}02$ dB/m

5.7.2.18 Monitor the specimen during the conditioning period to detect alarm and fault signals.

5.7.2.19 During each test fire, record the fire parameters in Table 5 as a function of time from the start of the test. Record each parameter continuously or at least once per second.

Table 5 — Fire parameters

Parameter	Symbol	Units
Temperature change	ΔT	°C
Smoke density (ionization)	y	(dimensionless)
Smoke density (optical)	m	dB/m
Time	t	seconds (s)

5.7.2.20 The alarm signal given by the supply and monitoring equipment shall be taken as the indication that a specimen has responded to the test fire.

5.7.2.21 Record the time of response (alarm signal) of each specimen, along with ΔT_a, y_a and m_a, fire parameters at the moment of response. A response of the specimen after the end of test condition is ignored.

5.7.3 Requirements

5.7.3.1 No fault signals shall be given.

5.7.3.2 All specimens shall generate an alarm signal in each test fire, before the specified end-of-test condition is reached.

5.8 Ambient light (indoor)

NOTE Due to technical limitations, the test is separated into an indoor test performed in the fire test room with bright illumination and an outdoor test to archive the necessary maximum illumination level.

5.8.1 Object of test

To demonstrate the ability of the detector to operate in minimum and maximum ambient light conditions.

5.8.2 Test procedure

5.8.2.1 Mount the specimen to be tested as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.4. This test is conducted by the method described in section 5.1.7.2.

5.8.2.2 Adjust the ambient light level to a minimum of 2 000 lx.

5.8.2.3 Measure the response threshold value of the specimen as specified in 5.1.7 method 5.1.7.2.

5.8.2.4 Adjust the ambient light level to the minimum absolute light level specified in 4.14.

5.8.2.5 Measure the response threshold value of the specimen as specified in 5.1.7 method 5.1.7.2.

5.8.2.6 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.8.3 Requirements

5.8.3.1 No fault signals shall be given.

5.8.3.2 All response values shall be lower than the maximum value specified by the manufacturer.

5.8.3.3 The ratio of the response threshold values $t_{max} : t_{min}$ shall not be greater than 1,6.

5.9 Ambient light (outdoor)

NOTE Due to technical limitations the test is separated into an indoor test performed in the fire test room with bright illumination and an outdoor test to archive the necessary maximum illumination level.

5.9.1 Object of test

To demonstrate the ability of the detector to operate in minimum and maximum ambient light conditions.

5.9.2 Test procedure

5.9.2.1 Mount the specimen to be tested in an outdoor location as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.4 This test shall be conducted as specified in 5.1.7.2.

5.9.2.2 Perform the test only if the illumination level is at least 20 000 lx.

5.9.2.3 Measure the response threshold value of the specimen as specified in 5.1.7 method 5.1.7.2.

5.9.2.4 Compare the response threshold values measured in 5.8. and 5.9. and designate the greatest of all the response threshold value t_{max} and the lowest as t_{min}.

5.9.3 Requirements

5.9.3.1 No fault signals shall be given.

5.9.3.2 All response values shall be smaller than the maximum value specified by the manufacturer.

5.9.3.3 The ratio of the response threshold values t_{max} : t_{min} shall not be greater than 1,6.

5.10 Non uniform illumination

5.10.1 Object of test

To demonstrate the ability of the specimen to detect fires when the FOV includes a highly illuminated area that saturates the camera chip while concurrently the rest of the scene is minimally illuminated.

The difference between maximum and minimum shall be at least the dynamic range specified in 4.14.

5.10.2 Test procedure

5.10.2.1 Mount the specimens as specified in 5.1.3 and Annex P and connect to the supply and monitoring equipment as specified in 5.1.4.

NOTE Detectors which dynamically modify their sensitivity in response to varying ambient conditions can 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.

5.10.2.2 Subject the specimens to test fires TF2, then TF5.

5.10.2.3 The test procedure shall be as described in 5.7.2.

5.10.3 Requirements

5.10.3.1 No fault signals shall be given during the conditioning period.

5.10.3.2 The ratio of the response point values t_{max} : t_{min} shall not be greater than 1,6 of the values recorded for the test specimens in 5.7 for the same test fires.

5.11 Light source immunity

5.11.1 Object of test

To demonstrate the immunity of the VFD to artificial light sources.

5.11.2 Test procedure

5.11.2.1 Mount the specimen to be tested as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.4.

5.11.2.2 Centre the test light sources within the FOV at a distance of 10 m from the specimen.

5.11.2.3 Adjust the specimen to the default sensitivity.

5.11.2.4 Do not manually mask the FOV.

5.11.2.5 Adjust the ambient light to 250 lx +/− 20 % and colour temperature of 5 000 K.

5.11.2.6 Conduct the procedures specified in 5.11.3 to 5.11.13.

NOTE Optional tests are only required where the manufacturer claims unwanted alarm immunity.

5.11.2.7 During each test, monitor the specimen for alarm and fault conditions.

5.11.3 Fluorescent light

5.11.3.1 Use fluorescent lights complying with IEC 60081 with a colour temperature of 5 000 K.

5.11.3.2 Equally space four vertically mounted 1,2 m fluorescent tubes on a white background measuring 2 m × 2 m.

5.11.3.3 Orientate the lights towards the specimen.

5.11.3.4 Conduct the following procedure:

a) lights on for 10 s;

b) lights off for 10 s;

c) number of cycles: 20.

5.11.4 Metal halide light

5.11.4.1 Use a metal halide light with a light output of 25 000 lx and a colour temperature of 3 600 K.

5.11.4.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.4.3 Orientate the light towards the specimen.

5.11.4.4 Conduct the following procedure:

a) light on for 15 min;

b) light off for 1 min;

c) number of cycles: 3.

5.11.5 Halogen light

5.11.5.1 Use a halogen light with a light output of 10 000 lx and a colour temperature of 3 000 K.

5.11.5.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.5.3 Orientate the light towards the specimen.

5.11.5.4 Conduct the following procedure:

a) lights on for 30 s;

b) lights off for 30 s;

c) number of cycles: 5.

5.11.6 LED Beacon

5.11.6.1 Use a 750 lx LED with a colour temperature of 3 000 K.

5.11.6.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.6.3 Orientate the light towards the specimen.

5.11.6.4 Conduct the following procedure.

a) lights on for 30 s;

b) lights off for 30 s;

c) number of cycles: 5.

5.11.7 Rotating beacon — Optional

5.11.7.1 Use a 1,5 J, 1 Hz red coloured rotating beacon.

5.11.7.2 Mount the light on a pole at a height of 2 m.

5.11.7.3 Conduct the following procedure:

a) light on for 30 s;

b) light off for 30 s;

c) number of cycles: 5.

5.11.7.4 Repeat the test using an amber coloured beacon.

5.11.8 Xenon beacon — Optional

5.11.8.1 Use a 1,5 J, 1 Hz red coloured xenon beacon.

5.11.8.2 Mount the light on a pole at a height of 2 m.

5.11.8.3 Conduct the following procedure:

a) light on for 30 s;

b) light off for 30 s;

c) number of cycles: 5.

5.11.8.4 Repeat the test using an amber coloured beacon.

5.11.9 High pressure sodium light — Optional

5.11.9.1 Use a high pressure sodium light with an illuminance of 45 000 lx and a colour temperature of 2 100 K.

5.11.9.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.9.3 Orientate the light towards the specimen.

5.11.9.4 Conduct the following procedure:

a) light on for 15 min;

b) light off for 1 min;

c) number of cycles: 3.

5.11.10 Low pressure sodium light — Optional

5.11.10.1 Use a low pressure sodium light with a light output of 8000 lx and a colour temperature of 1 800 K.

5.11.10.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.10.3 Orientate the light towards the specimen.

5.11.10.4 Conduct the following procedure:

a) light on for 15 min;

b) light off for 1 min;

c) number of cycles: 3.

5.11.11 Incandescent light — Optional

5.11.11.1 Use a 100 W pear-shaped incandescent light with a clear glass envelope conforming to IEC 60064.

5.11.11.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.11.3 Orientate the light towards the specimen.

5.11.11.4 Conduct the following procedure:

a) lights on for 30 s;

b) lights off for 30 s;

c) number of cycles: 5.

5.11.12 HID xenon light — Optional

5.11.12.1 Use a HID xenon light with a light output of 32 000 lx and a colour temperature of 6 000 K.

5.11.12.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.12.3 Orientate the light towards the specimen.

5.11.12.4 Conduct the following procedure:

a) lights on for 30 s;

b) lights off for 30 s;

c) number of cycles: 5.

5.11.13 Laser light — Optional

5.11.13.1 Use a laser light with a light output of 5 mW at 600 nm to 700 nm wavelength.

5.11.13.2 Mount the light on a white background measuring 2 m × 2 m.

5.11.13.3 Orientate the light towards the specimen.

5.11.13.4 Conduct the following procedure:

a) lights on for 30 s;

b) lights off for 30 s;

c) number of cycles: 5.

5.11.13.5 Requirements

No alarm or fault signals shall be given.

5.12 Arc welding — Optional

5.12.1 Object of test

To demonstrate the immunity of the detector to arc welding.

5.12.2 Test apparatus

Use the following test apparatus:

a) arc welder set to an output of 200 A;

b) welding rods 5,0 mm diameter, Type 7014, 7013 or 6012, in accordance with ISO 2560.

5.12.3 Test procedure

5.12.3.1 Adjust the specimen to the maximum sensitivity.

5.12.3.2 Mount the specimen in accordance with 5.1.3 and connect it to its supply and monitoring equipment, as specified in 5.1.4.

5.12.3.3 Allow the specimen to stabilize in its quiescent condition.

5.12.3.4 Ensure the ambient illumination shall not exceed 250 lx.

5.12.3.5 Ensure that the person conducting the test does not block the FOV.

5.12.3.6 Conduct the welding within the FOV of the VFD at a minimum distance specified by the manufacturer, and in any event, no further than the maximum detection distance.

5.12.3.7 Continue welding for the lesser of 30 s or until a single rod is consumed.

5.12.3.8 Monitor the specimen to detect any fault or alarm signals.

5.12.4 Requirements

No alarm or fault signals shall be given.

5.13 Variation in supply parameters

5.13.1 Object of test

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

5.13.2 Test procedure

Measure the response threshold value as specified in 5.1.7 at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

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

5.13.3 Final measurements

Designate the maximum response threshold value as t_{max}, the minimum value as t_{min}.

5.13.4 Requirements

5.13.4.1 No fault signals shall be given during the conditioning period.

5.13.4.2 The ratio of the response threshold values $t_{max} : t_{min}$ shall not be greater than 1,6.

5.14 Dry heat (operational)

5.14.1 Object of test

To demonstrate the ability of the detector to function correctly at high ambient temperatures which can occur for short periods in indoor service environments.

5.14.2 Test procedure

5.14.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Bb, and in 5.14.2.2 to 5.14.2.5.

5.14.2.2 State of specimen during conditioning

Mount the specimen to be tested as specified in 5.1.2 in an environmental chamber and connect it to its supply and monitoring equipment as specified in 5.1.3. A window in the environmental chamber will be required to enable the specimen to sense the fire.

5.14.2.3 Conditioning

Apply the following conditioning.

Temperature: Starting at an initial air temperature of (23 ± 5) °C, increase the air temperature to (55 ± 3) °C.

Duration: Maintain this temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of < 1 K/min for the transitions to and from the conditioning temperature.

5.14.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.14.2.5 Final measurements

5.14.2.5.1 Measure the response threshold value as specified in 5.1.7, but at a temperature of (55 ± 3) °C.

5.14.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.14.3 Requirements

5.14.3.1 No alarm or fault signals shall be given during the period that the temperature is increasing to the conditioning temperature or during the conditioning period until the response threshold value is measured, at which time the alarm signal shall be released.

5.14.3.2 The ratio of the response threshold values $t_{max} : t_{min}$ shall not be greater than 1,6.

5.15 Dry heat (operational) — Optional

5.15.1 Object of test

To demonstrate the ability of the detector with a declared maximum operating temperature of 70 °C to function correctly at high ambient temperatures which can occur for short periods in outdoor service environments.

5.15.2 Test procedure

5.15.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Bb, and in 5.15.2.2 to 5.15.2.5.

5.15.2.2 State of specimen during conditioning

Mount the specimen to be tested as specified in 5.1.2 in an environmental chamber and connect it to its supply and monitoring equipment as specified in 5.1.3. A window in the environmental chamber will be required to enable the specimen to sense the fire.

5.15.2.3 Conditioning

Apply the following conditioning.

Temperature outdoor 1:	Starting at an initial air temperature of (23 ± 5) °C, increase the air temperature to (70 ± 3) °C.
Temperature outdoor 2:	Starting at an initial air temperature of (23 ± 5) °C, increase the air temperature to (55 ± 3) °C.
Duration:	Maintain this temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of < 1 K/min for the transitions to and from the conditioning temperature.

5.15.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.15.2.5 Final measurements

5.15.2.5.1 Measure the response threshold value as specified in 5.1.6, but at a temperature of (70 ± 3) °C.

5.15.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.15.3 Requirements

5.15.3.1 No alarm or fault signals shall be given during the period that the temperature is increasing to the conditioning temperature or during the conditioning period until the response threshold value is measured, at which time the alarm signal shall be released.

5.15.3.2 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.16 Cold (operational)

5.16.1 Object of test

To demonstrate the ability of the detector to function correctly at low ambient temperatures which can occur for short periods in indoor service environments.

5.16.2 Test procedure

5.16.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1, Test Ab, and in 5.16.2.2 to 5.16.2.5.

5.16.2.2 State of specimen during conditioning

Mount the specimen in an environmental chamber as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.4. A window in the environmental chamber will be required to enable the specimen to sense the fire.

5.16.2.3 Conditioning

Apply the following conditioning.

Temperature: (−10 ± 3) °C

Duration: 16 h

NOTE Test Ab specifies rates of change of temperature of < 1 K/min for the transitions to and from the conditioning temperature.

5.16.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.16.2.5 Final measurements

5.16.2.5.1 Measure the response threshold value as specified in 5.1.7, but at a temperature of (−10 ± 3) °C.

5.16.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max}, and the lesser as t_{min}.

5.16.3 Requirements

5.16.3.1 No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

5.16.3.2 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.17 Cold (operational) — Optional

5.17.1 Object of test

To demonstrate the ability of the detector with a declared minimum operating temperature of −40 °C to function correctly at low ambient temperatures which can occur for short periods in outdoor service environments.

5.17.2 Test procedure

5.17.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1, Test Ab, and in 5.17.2.2 to 5.17.2.5.

5.17.2.2 State of specimen during conditioning

Mount the specimen in an environmental chamber as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.4. A window in the environmental chamber will be required to enable the specimen to sense the fire.

5.17.2.3 Conditioning

Apply the following conditioning.

Temperature indoor and outdoor 1:	(–10 ± 3) °C
Temperature outdoor 2:	(–40 ± 3) °C
Duration:	16 h

NOTE Test Ab specifies rates of change of temperature of < 1 K/min for the transitions to and from the conditioning temperature.

5.17.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.17.2.5 Final measurements

5.17.2.5.1 Measure the response threshold value as specified in 5.1.7, but at a temperature of (–40 ± 3) °C.

5.17.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max}, and the lesser as t_{min}.

5.17.3 Requirements

5.17.3.1 No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

5.17.3.2 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.18 Damp heat, steady-state (operational)

5.18.1 Object of test

To demonstrate the ability of the detector to function correctly at high relative humidity (without condensation), which can occur for short periods in the anticipated service environment.

5.18.2 Test procedure

5.18.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab, and in 5.18.2.2 to 5.18.2.5.

5.18.2.2 State of the specimen during conditioning

Mount the specimen in an environmental chamber as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.4.

5.18.2.3 Conditioning

Apply the following conditioning.

Temperature: (40 ± 2) °C

Relative humidity: (93 ± 3) %

Duration: 4 d

5.18.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.18.2.5 Final measurements

5.18.2.5.1 After a recovery period of at least 1 h at the standard laboratory conditions, measure the response threshold value as specified in 5.1.7.

5.18.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.18.3 Requirements

5.18.3.1 No alarm or fault signals shall be given during the conditioning.

5.18.3.2 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.19 Damp heat, steady-state (endurance)

5.19.1 Object of test

To demonstrate the ability of the detector to withstand the long-term effects of humidity in the service environment (e.g. changes in electrical properties of materials, chemical reactions involving moisture, galvanic corrosion).

5.19.2 Test procedure

5.19.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab, and in 5.19.2.2 to 5.19.2.5.

5.19.2.2 State of the specimen during conditioning

Mount the specimen in an environmental chamber as specified in 5.1.3. Do not supply it with power during the conditioning.

5.19.2.3 Conditioning

Apply the following conditioning.

Temperature: (40 ± 2) °C

Relative humidity: (93 ± 3) %

Duration: 21 d

5.19.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.19.2.5 Final measurements

5.19.2.5.1 After a recovery period of at least 1 h in standard laboratory conditions, measure the response threshold value as specified in 5.1.7.

5.19.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max}, and the lesser as t_{min}.

5.19.3 Requirements

5.19.3.1 No fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen.

5.19.3.2 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.20 Protection against ingress of foreign bodies

5.20.1 Object of test

To demonstrate that the degree of protection provided by the enclosure of the specimen, with regard to the ingress of solid foreign objects and the harmful effects due to the ingress of water.

5.20.2 Enclosure of the VFD

The enclosure of the specimen or relevant subassemblies of the specimen, designed to be installed in the operating environment, shall be taken as comprising any parts of the outer physical envelope of the specimen which prevents or restricts access of solid foreign objects to the sensor(s), electronic assembly(ies) and wiring terminals.

NOTE Ingress of liquid inside the enclosure is possible, but should not adversely affect the operation of the specimen.

5.20.3 Test procedure

5.20.3.1 Reference

The test apparatus and test procedure shall be as described in IEC 60529 and in 5.20.3.2 to 5.20.3.5.

5.20.3.2 State of the specimen during conditioning

5.20.3.2.1 Mount the specimen, including wiring termination boxes which form part of the VFD, as specified in 5.1.3 to a rigid fixture, and in accordance with IEC 60529.

5.20.3.2.2 For the test for protection against ingress of water, connect the specimen to its supply and monitoring equipment as specified in 5.1.4.

5.20.3.2.3 For the test for protection against ingress of solid foreign objects and the test for protection against access to hazardous parts, do not connect the specimen to its supply and monitoring equipment.

5.20.3.3 Conditioning

5.20.3.3.1 Apply the test conditions specified in IEC 60529 for the following IP Codes:

a) indoor use (IP30):

   1) protection against solid foreign objects (indicated by the first characteristic numeral);

   2) protection against water (indicated by the second characteristic numeral);

b) outdoor use (IP54):

   1) protection against solid foreign objects (indicated by the first characteristic numeral);

   2) protection against water (indicated by the second characteristic numeral);

   3) protection against access to hazardous parts (indicated by the additional letter).

5.20.3.3.2 Measure the response threshold value as specified in 5.1.7.

5.20.3.4 Measurement during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.20.3.5 Final measurements

5.20.3.5.1 Examine the specimen for ingress of water.

5.20.3.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max}, and the lesser as t_{min}.

5.20.4 Requirements

5.20.4.1 No alarm or fault signals shall be given during the conditioning period.

5.20.4.2 The specimen shall comply with rating IP30 for indoor use or IP54C for outdoor use specified in IEC 60529.

5.20.4.3 No water shall penetrate the enclosure or, if water has penetrated the enclosure, the specimen shall incorporate adequate provision for drainage.

5.20.4.4 The ratio of the response threshold values $t_{max} : t_{min}$ shall not be greater than 1,6.

5.21 Sulfur dioxide (SO_2) corrosion (endurance)

5.21.1 Object of test

To demonstrate the ability of the detector to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

This test does not apply to the controller where the controller is separate and remote from the camera

5.21.2 Test procedure

5.21.2.1 Reference

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-42, Test Kc, but carry out the conditioning as specified in 5.21.2.3.

5.21.2.2 State of specimen during conditioning

Mount the specimen as specified in 5.1.3. Do not supply it with power during the conditioning, but equip it with untinned copper wires of the appropriate diameter, connected to a sufficient number of terminals to allow the final measurement to be made without making further connections to the specimen.

5.21.2.3 Conditioning

Apply the following conditioning.

Temperature:	(25 ± 2) °C
Relative humidity:	(93 ± 3) %
SO_2 concentration:	(25 ± 5) µl/l
Duration:	21 d

5.21.2.4 Final measurements

5.21.2.4.1 Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, < 50 % RH, followed by a recovery period of at least 1 h at the standard laboratory conditions. After this, measure the response threshold value as specified in 5.1.7.

5.21.2.4.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.21.3 Requirements

5.21.3.1 No fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen.

5.21.3.2 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.22 Shock (operational)

5.22.1 Object of test

To demonstrate the immunity of the detector to mechanical shocks which are likely to occur, albeit infrequently, in the anticipated service environment.

5.22.2 Test procedure

5.22.2.1 Reference

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-27, Test Ea, but carry out the conditioning as specified in 5.22.2.3.

5.22.2.2 State of specimen during conditioning

Mount the specimen as specified in 5.1.3 to a rigid fixture, and connect it to its supply and monitoring equipment as specified in 5.1.4.

5.22.2.3 Conditioning

5.22.2.3.1 For specimens with a mass ≤ 4,75 kg, apply the following conditioning.

Shock pulse type:	Half sine
Pulse duration:	6 ms
Peak acceleration:	$10 \times (100 - 20M)$ m/s^2 (where M is the mass of the specimen in kilograms)
Number of directions:	6
Pulses per direction:	3

5.22.2.3.2 Do not test specimens with a mass > 4,75 kg.

5.22.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any alarm or fault signals.

5.22.2.5 Final measurements

5.22.2.5.1 Measure the response threshold value as specified in 5.1.7.

5.22.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as y_{max} or m_{max}, and the lesser as y_{min} or m_{min}.

5.22.3 Requirements

5.22.3.1 No alarm or fault signals shall be given during the conditioning period or the additional 2 min.

5.22.3.2 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.23 Impact cameras (operational)

5.23.1 Object of test

To demonstrate the immunity of the detector to mechanical impacts upon its surface, which it can sustain in the normal shipping, installation, and service environments, and which it can reasonably be expected to withstand.

5.23.2 Test procedure

5.23.2.1 Apparatus

The test apparatus (Annex Q) shall consist of a swinging hammer incorporating a rectangular-section aluminium alloy head (aluminium alloy Al CuSiMg complying with ISO 209, solution- and precipitation-treated condition) with the plane-impact face chamfered to an angle of 60° to the horizontal when in

the striking position (i.e. when the hammer shaft is vertical). The hammer head shall be (50 ± 2,5) mm high, (76 ± 3,8) mm wide and (80 ± 4) mm long at mid-height.

5.23.2.2 State of specimen during conditioning

Mount the specimen rigidly to the apparatus by its normal mounting means and position it so that it is struck by the upper half of the impact face when the hammer is in the vertical position (i.e. when the hammerhead is moving horizontally). Choose the azimuthal direction and the position of impact relative to the specimen as that most likely to impair the normal functioning of the specimen, excluding a direct impact on the lens. Connect the specimen to its supply and monitoring equipment as specified in 5.1.4. Camera lenses shall not be impacted.

5.23.2.3 Conditioning

Use the following test parameters during the conditioning.

Impact energy: (1,9 ± 0,1) J

Hammer velocity: (1,5 ± 0,13) m/s

Number of impacts: 1

5.23.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period and for a further 2 min to detect any alarm or fault signals.

5.23.2.5 Final measurements

5.23.2.5.1 Measure the response threshold value as specified in 5.1.7.

5.23.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max} and the lesser as t_{min}.

5.23.3 Requirements

5.23.3.1 No alarm signal shall be given during the conditioning period or the additional 2 min. If a fault signal is given, the fault shall reset within 2 min of the conditioning period.

5.23.3.2 The impact shall not detach the specimen from its base, or the base from the mounting.

5.23.3.3 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.24 Impact controllers (operational)

5.24.1 Object of test

The object of the test is to demonstrate the immunity of the equipment to mechanical impacts upon the surface, which it could sustain in the normal service environment and which it can reasonably be expected to withstand.

5.24.2 Test procedure

5.24.2.1 General

Use the test apparatus and perform the procedure in accordance with IEC 60068-2-75.

5.24.2.2 Initial examination

Before conditioning, subject the specimen to the functional test.

5.24.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3 and connect it to suitable power supply-, monitoring- and loading equipment (see 5.1.4).

The specimen shall be in the quiescent condition.

5.24.2.4 Conditioning

Apply impacts to all surfaces of the specimen which are accessible.

For all such surfaces, apply three blows to any point or points considered likely to cause damage to or impair the operation of the specimen.

Care should be taken to ensure that the results from a series of three blows do not influence subsequent series.

In case of doubt, disregard the defect and apply a further three blows to the same position on a new specimen.

Apply the following severity of conditioning:

Impact energy: 0,5 ± 0,04 J

Number of impacts per point: 3

5.24.2.5 Measurements during conditioning

Monitor the specimen during the conditioning periods to detect any changes in functional condition, and to ensure that the results of the three blows do not influence subsequent series.

5.24.2.6 Final measurements

After the conditioning, subject the specimen to the functional test and inspect it visually for mechanical damage both externally and internally.

5.25 Vibration, sinusoidal, (operational)

5.25.1 Object of test

To demonstrate the immunity of the detector to vibration at levels considered appropriate to the normal service environment.

5.25.2 Test procedure

5.25.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.25.2.2 to 5.25.2.5.

5.25.2.2 State of specimen during conditioning

5.25.2.2.1 Mount the specimen on a rigid fixture as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.4.

5.25.2.2.2 Maintain the test environment at an ambient light level specified by the manufacturer, with the camera not pointed at any light source.

5.25.2.2.3 Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

5.25.2.3 Conditioning

5.25.2.3.1 Apply the following conditioning.

Frequency range:	(10 to 150) Hz
Acceleration amplitude:	5 m/s2 (approximately 0,5 gn)
Number of axes:	3
Sweep rate:	1 octave/min
Number of sweep cycles:	1 /axis

5.25.2.3.2 The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. Only one final measurement need be made.

5.25.2.3.3 Measure the response threshold value as specified in 5.1.7.

5.25.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.25.2.5 Final measurements

5.25.2.5.1 Visually inspect the specimen for mechanical damage both internally and externally.

NOTE The final measurements are normally made after the vibration endurance test and should only need be made here if the operational test is conducted in isolation.

5.25.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max}, and the lesser as t_{min}.

5.25.3 Requirements

5.25.3.1 No alarm signal shall be given during the conditioning. If a fault signal is given, the fault shall reset within 2 min of the conditioning period.

5.25.3.2 No mechanical damage either internally or externally shall result.

5.25.3.3 The ratio of the response threshold values t_{max}: t_{min} shall not be greater than 1,6.

5.26 Vibration, sinusoidal (endurance)

5.26.1 Object of test

To demonstrate the ability of the detector to withstand the long-term effects of vibration at levels appropriate to the shipping, installation, and service environment.

5.26.2 Test procedure

5.26.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and 5.26.2.2 to 5.26.2.4.

5.26.2.2 State of specimen during conditioning

5.26.2.2.1 Mount the specimen on a rigid fixture as specified in 5.1.3, but do not supply it with power during conditioning.

5.26.2.2.2 Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting axis of the specimen.

5.26.2.3 Conditioning

5.26.2.3.1 Apply the following conditioning.

Frequency range:	(10 to 150) Hz
Acceleration amplitude:	10 m/s2 (≈1,0 gn)
Number of axes:	3
Sweep rate:	1 octave/min
Number of sweep cycles:	20/axis

5.26.2.3.2 The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. Only one final measurement need be made.

5.26.2.3.3 Measure the response threshold value as specified in 5.1.7.

5.26.2.4 Final measurements

5.26.2.4.1 Visually inspect the specimen for mechanical damage both internally and externally.

NOTE The final measurements are normally made after the vibration endurance test and should only need be made here if the operational test is conducted in isolation.

5.26.2.4.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max}, and the lesser as t_{min}.

5.26.3 Requirements

5.26.3.1 No alarm or fault signals shall be given during the conditioning.

5.26.3.2 No mechanical damage either internally or externally shall result.

5.26.3.3 The ratio of the response threshold values t_{max} : t_{min} shall not be greater than 1,6.

5.27 Electromagnetic compatibility (EMC) immunity (operational)

5.27.1 Object of test

To demonstrate the immunity of the detector to sources of electro-magnetic radiation likely to occur, albeit infrequently, in the anticipated service environment.

5.27.2 Test procedure

5.27.2.1 Reference

Use the test apparatus and the test procedures shall be as described in IEC 62599-2 and in 5.27.2.2 to 5.27.2.5.

5.27.2.2 State of specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.4.

5.27.2.3 Conditioning

Conduct the following EMC immunity tests as specified in IEC 62599-2:

a) electrostatic discharge;

b) radiated electromagnetic fields;

c) conducted disturbances induced by electromagnetic fields;

d) fast transient bursts at a repetition rate of 100 kHz;

e) slow high-energy voltage surges.

5.27.2.4 Measurements during conditioning

5.27.2.4.1 Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.27.2.4.2 The functional test called for in the initial measurements shall be the response threshold value test as specified in 5.1.7.

5.27.2.5 Final measurements

5.27.2.5.1 The functional test called for in the final measurements shall be the response threshold value test as specified in 5.1.7.

5.27.2.5.2 Designate the greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test as t_{max}, and the lesser as t_{min}.

5.27.3 Requirements

5.27.3.1 No alarm or fault signals shall be given during the conditioning period.

5.27.3.2 The ratio of the response threshold values $t_{max} : t_{min}$ shall not be greater than 1,6.

5.28 Test report

The test report shall contain as a minimum the following information:

a) identification of the VFD tested;

b) reference to this document, i.e. ISO 7240-29:2017;

c) results of the tests, including the individual response threshold values and the minimum, maximum, and arithmetic mean values where appropriate;

d) conditioning period and the conditioning atmosphere;

e) temperature and the relative humidity in the test room throughout the test;

f) details of the supply and monitoring equipment and the alarm criteria;

g) details of any deviation from this document or from the International Standards to which reference is made, and details of any operations regarded as optional.

6 Marking

6.1 Each VFD shall be clearly marked with the following information:

a) a reference to this document (i.e. ISO 7240-29:2017);

b) name or trademark of the manufacturer or supplier;

c) model designation (type or number);

d) fire phenomenon the VFD is designed to detect (see 4.2);

e) if a non-replaceable camera lens is used, the manufacturer shall specify the specific range and FOV;

f) if a replaceable camera lens can be used with the VFD, the manufacturer shall specify for each camera lens combination the specific range, FOV, lens diameter, focal length and f-number;

g) ambient light operation (see 4.14);

h) enclosure protection rating (see 4.13);

i) operating environment rating (see 4.15);

j) wiring terminal designations;

k) an indication of proper camera mounting orientation if a factor for performance;

l) 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.

NOTE Where insufficient space is available on the VFD enclosure, items e) to k) can be satisfied by referencing the installation and user documentation (see 7.4).

6.2 Where a mounting bracket is used in conjunction with the camera, the mounting bracket shall be marked with a model designation.

6.3 Where the camera is not integral with the controller, the controller shall be marked with 6.1 items a), b), c), h), i), j) and l).

6.4 Where the camera is separate from the controller, technical data should identify compatible components (e.g. cameras and controllers). This information can be marked on the components.

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

6.6 The wiring terminal designations shall be visible during installation of the detector and shall be accessible during maintenance.

6.7 The markings shall not be placed on screws or other easily removable parts.

7 Data

7.1 General

In order to assist the process of design inspection, the manufacturer shall inform, in writing, that the design has been carried out in accordance with a quality management system, that incorporates a set of rules for the design of all elements of FDCIE, and the components of FDCIE have been selected for the intended purpose, and are expected to operate within their specification when the environmental conditions outside the cabinet of FDCIE comply with Class 3k5 of IEC 60721-3-3.

7.2 Software documentation

7.2.1 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 document 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;

   6) a description of those areas of memory used for the various purposes (e.g. the program, site-specific data and running data);

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

7.2.2 The manufacturer shall prepare and maintain detailed design documentation. This shall be available for inspection in a manner that respects the manufacturers' rights for confidentiality. 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 comments for the program flow to be recognized;

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

NOTE This detailed design documentation can be reviewed at the manufacturers' premises.

7.3 Hardware documentation

The manufacturer shall prepare design documentation, which shall include drawings, parts lists, block diagrams, circuit diagrams and a functional description to such an extent that compliance with this document can be checked and that a general assessment of the mechanical and electrical design is made possible.

7.4 Installation and user documentation

The manufacturer shall prepare installation and user documentation. If these data are not supplied with each detector, reference to the appropriate data sheet shall be given on or with each detector. The data shall comprise at least the following:

a) a general description of the equipment, including a list of the optional functions with requirements of this document;

b) functions relating to other parts of ISO 7240, and ancillary functions not required by this document;

c) technical specifications of the inputs and outputs of detector sufficient to permit an assessment of the mechanical, electrical, and software compatibility with other components of the system (e.g. as described in ISO 7240-1), including, where relevant:

   1) the power requirements for recommended operation;

   2) the maximum and minimum electrical ratings for each input and output;

   3) information on the communication parameters employed on each transmission path;

   4) recommended cable parameters for each transmission path;

d) camera lens characteristics used with the VFD for nominated distances. Characteristics shall include focal length FOV and FOD.

   If a replaceable camera lens can be used with the VFD the manufacturer shall specify for each camera lens combination the specific range, FOV, FOD and focal length, rated ambient light level operating range;

e) installation information, including

   1) considerations to avoid configurations that can impede the correct processing of the signals from the detector,

   2) the suitability for use in various environments, including a specification of detection sensitivity over the rated range of ambient light,

   3) if VFD is contained in more than one cabinet, how the requirements of 4.13.2 and 4.15.2 can be met;

f) mounting instructions, and instructions for connecting the inputs and outputs;

g) configuring and commissioning instructions, including an *in situ* test method to ensure that detectors operate correctly when installed;

h) operating instructions;

i) maintenance information.

NOTE Additional information could be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this document.

Annex A
(normative)

Fire test room

A.1 The fire sensitivity tests shall be conducted in a rectangular room with a flat horizontal ceiling, and the following dimensions:

Length:> 25 m;

Width:≥ 6 m;

Height:3,8 m to 4,2 m;

Ambient light level:no less than 500 lx for type A VFD, and no greater than 15 lx for type B VFD.

A.2 The fire test room shall be equipped with the following measuring instruments:

a) measuring ionization chamber (MIC) (see Annex R);

b) obscuration meter (see Annex R);

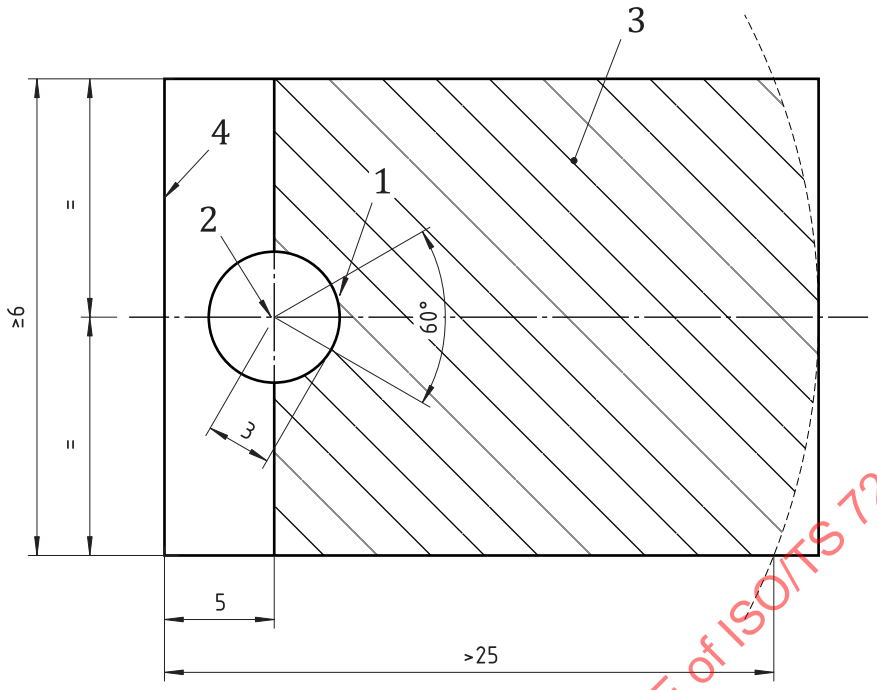
c) temperature probe.

A.3 The MIC, the temperature probe and the measuring part of the obscuration meter shall all be located as shown in Figures A.1 and A.2.

A.4 The specimens to be tested shall be located at the relevant distance from the test fire (see 4.4) and aligned on the axis to the test fire.

A.5 The specimens, the MIC and the mechanical parts of the obscuration meter shall be at least 100 mm apart, measured to the nearest edges. The centre line of the beam of the obscuration meter shall be at least 35 mm below the ceiling.

Dimensions in metres

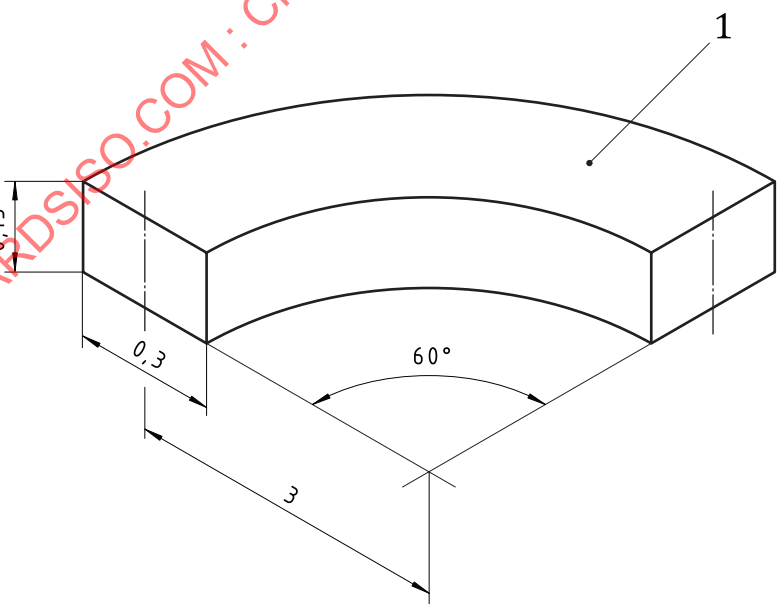


Key

1 measuring instruments
2 position of test fire
3 specimen location area (distance from test fire and height from floor)
4 position of background

Figure A.1 — Plan view of fire test room and position of specimens and monitoring instruments

Dimensions in metres



Key

1 measuring instruments

Figure A.2 — Mounting position for instruments

Annex B
(normative)

Smouldering (pyrolysis) wood fire (TF2)

B.1 Fuel

Approximately 10 dried beechwood sticks, each stick having dimensions of 75 mm × 25 mm × 20 mm.

B.2 Conditioning

Dry the sticks in a heating oven so the moisture content is approximately 5 %.

B.3 Preparation

If necessary, transport the sticks from the oven in a closed plastic bag, and open the bag just prior to laying out the sticks in the test arrangement.

B.4 Hotplate

B.4.1 The hotplate shall have a 220 mm diameter grooved surface with eight concentric grooves with a distance of 3 mm between grooves. Each groove shall be 2 mm deep and 5 mm wide, with the outer groove 4 mm from the edge. The hotplate shall have a rating of approximately 2 kW.

B.4.2 The temperature of the hot plate shall be measured by a sensor attached to the fifth groove, counted from the edge of the hotplate, and secured to provide a good thermal contact.

B.5 Arrangement

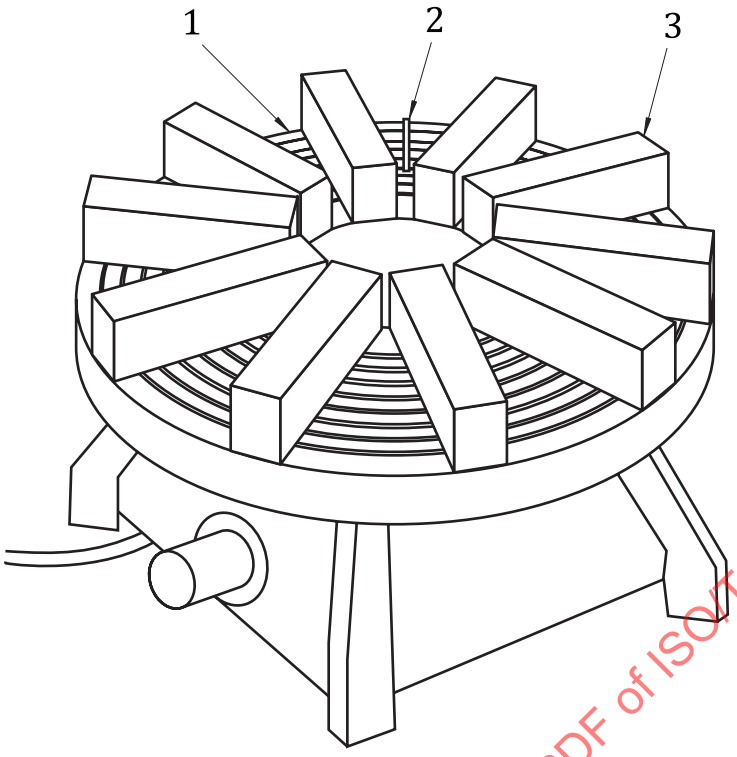
The sticks shall be arranged radially on the grooved hotplate surface, with the 20-mm side in contact with the surface such that the temperature probe lies between the sticks and is not covered, as shown in Figure B.1.

B.6 Heating rate

The hotplate shall be powered such that its temperature rises from ambient to 600 °C in approximately 11 min, and is maintained for the duration of the test.

B.7 Test validity criteria

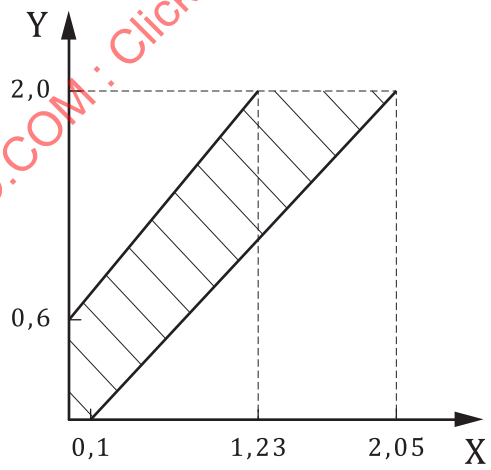
No flaming shall occur before the end-of-test condition has been reached. The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the hatched areas shown in Figures B.2 and B.3, respectively. That is, $1{,}23 \leq y \leq 2{,}05$ and $570\ \text{s} \leq t \leq 840\ \text{s}$ at the end-of-test condition $m_E = 2$ dB/m.



Key

1 grooved hotplate
2 temperature sensor
3 wooden sticks

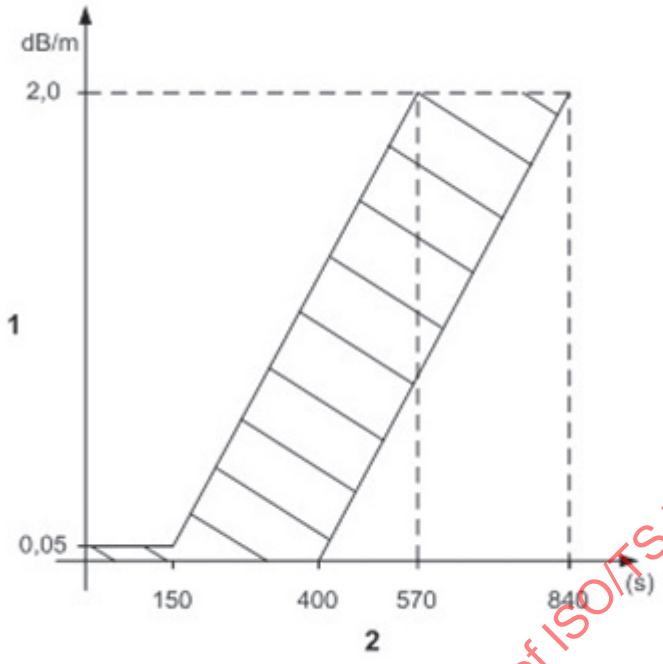
Figure B.1 — Arrangement of sticks on hotplate



Key

Y *m*-value
X *y*-value

Figure B.2 — Limits for *m* against *y*, Fire TF2



Key

1 *m*-value

2 *t*-value

Figure B.3 — Limits for *m* against time, *t*, Fire TF2

B.8 Variables

The number of sticks, the rate of temperature increase of the hotplate, and the degree of conditioning of the wood may be varied in order for the test fire to remain within the profile curve limits.

B.9 End-of-test condition

The end-of-test condition, m_E, shall be when m = 2 dB/m or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex C
(normative)

Glowing smouldering cotton fire (TF3)

C.1 Fuel

Approximately 90 pieces of braided cotton wick, each of length approximately 80 cm and weighing approximately 3 g. The wicks shall be free from any protective coating and shall be washed and dried if necessary.

C.2 Arrangement

The wicks shall be fastened to a ring approximately 10 cm in diameter and suspended approximately 1 m above a non-combustible plate as shown in Figure C.1.

Dimensions in metres

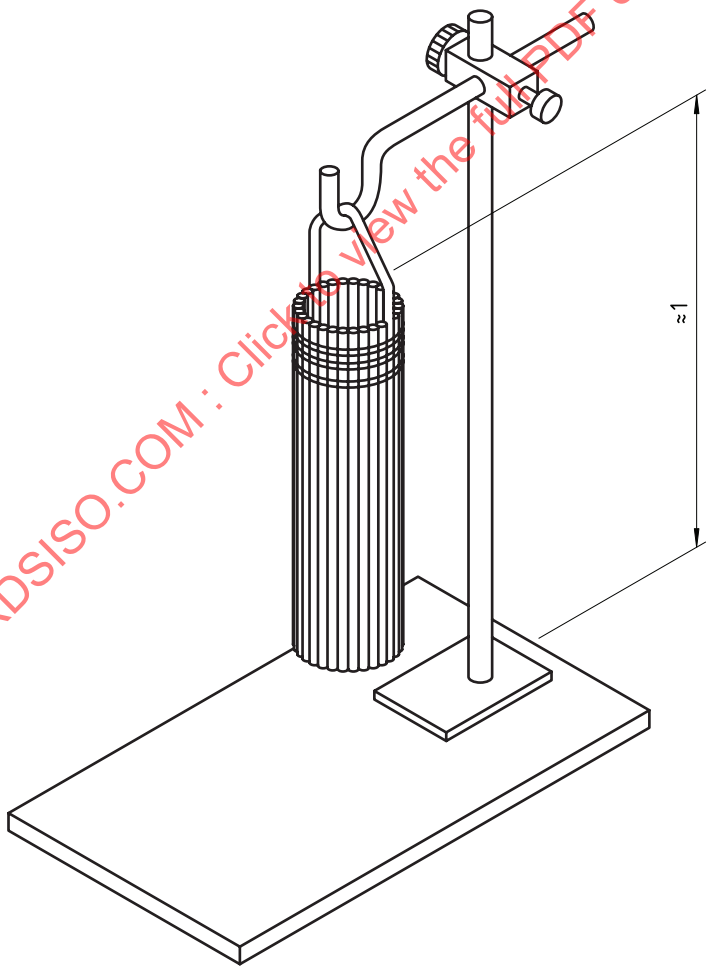


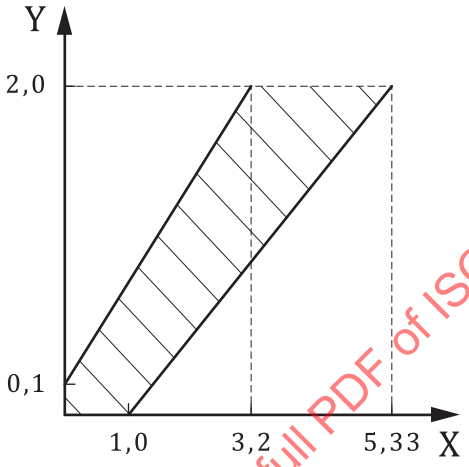
Figure C.1 — Arrangement of cotton wicks

C.3 Ignition

The lower end of each wick shall be ignited so that the wicks continue to glow. Any flaming shall be blown out immediately. The test time shall start when all wicks are glowing.

C.4 Test validity criteria

The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the hatched areas shown in Figures C.2 and C.3, respectively. That is, $3{,}2 < y < 5{,}33$ and $280 < t < 750$ at the end-of-test condition $m_E = 2$ dB/m.

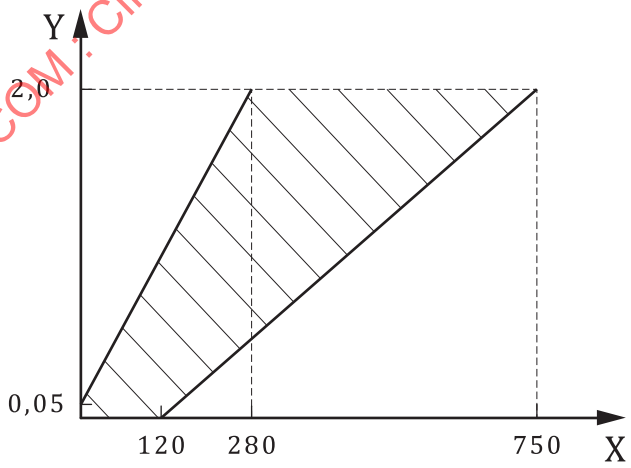


Key

Y *m*-value

X *y*-value

Figure C.2 — Limits for *m* against *y*, Fire TF3



Key

Y *m*-value

X *t*-value

Figure C.3 — Limits for *m* against time, *t*, Fire TF3

C.5 End-of-test condition

The end-of-test condition, m_E, shall be when m = 2 dB/m or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex D
(normative)

Open plastics (polyurethane) fire (TF4)

D.1 Fuel

Three mats, approximately 50 cm × 50 cm × 2 cm, of soft polyurethane foam, without flame-retardant additives and having a density of approximately 20 kg/m^3, are usually found sufficient. However, the exact quantity of fuel may be adjusted to obtain valid tests.

D.2 Conditioning

Maintain the mats in a humidity not exceeding 50 % at least 48 h prior to test.

D.3 Arrangement

Place the mats one on top of another on a base formed from aluminium foil with the edges folded up to provide a tray.

D.4 Ignition

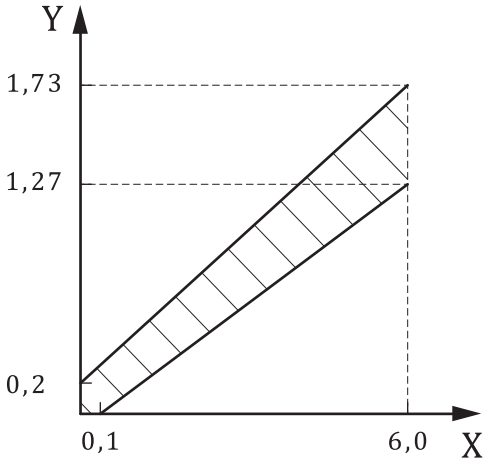
Ignite the mats at a corner of the lower mat. The exact position of ignition may be adjusted to obtain a valid test. A small quantity of a clean burning material (e.g. 5 cm^3 of methylated spirit) may be used to assist the ignition.

D.5 Method of ignition

Ignite by match or spark.

D.6 Test validity criteria

The development of the fire shall be such that the curves of m against y, m against time, t, within the limits shown in Figure D.1 and D.2 respectively. That is, 1,27 < m < 1,73 and 140 s < t < 180 s at the end-of-test conditions y_E = 6.

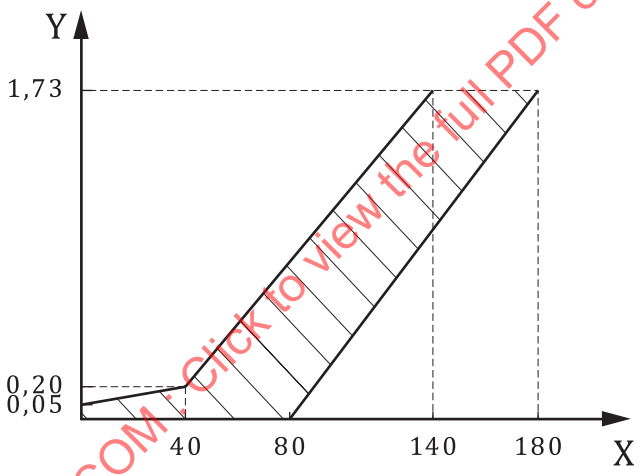


Key

Y *m*-value

X *y*-value

Figure D.1 — Limits for *m* against *y*, Fire TF4



Key

Y *m*-value

X *t*-value

Figure D.2 — Limits for *m* against time, *t*, Fire TF4

D.7 End-of-test condition

The end-of-test condition shall be when

a) $y_E = 6$, or

b) $t_E > 180$ s, or

c) all of the specimens have generated an alarm signal,

whichever is the earlier.

Annex E
(normative)

Flaming liquid (n-heptane) fire (TF5)

E.1 Fuel

Approximately 650 g of a mixture of *n*-heptane (purity > 99 %) with approximately 3 % of toluene (purity > 99 %), by volume. The precise quantities may be varied to obtain valid tests.

E.2 Arrangement

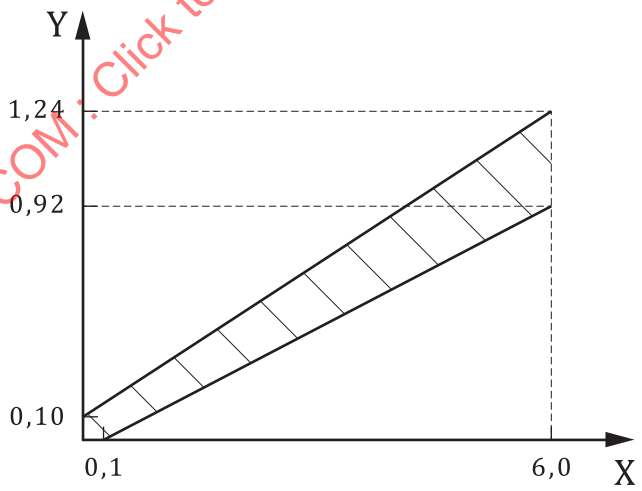
The heptane/toluene mixture shall be burnt in a square steel tray with dimensions of approximately 330 mm × 330 mm × 50 mm.

E.3 Ignition

Ignite by flame or spark.

E.4 Test validity criteria

The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the hatched areas shown in Figures E.1 and E.2, respectively. That is, the end-of-test condition y_E = 6,0 and 0,92 dB/m ≤ m ≤ 1,24 dB/m, and 120 s ≤ t ≤ 240 s.

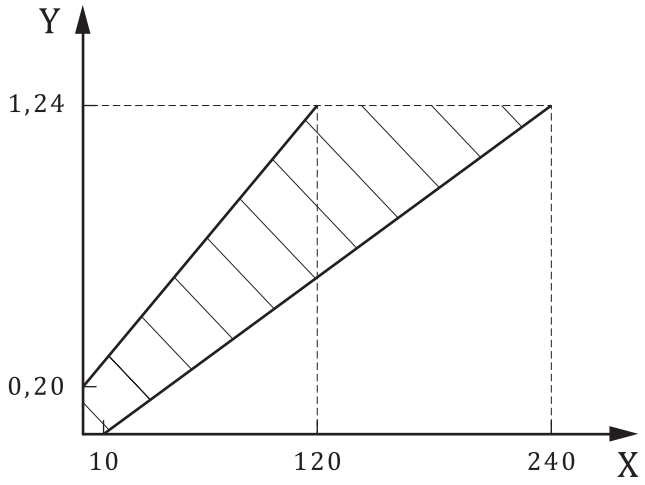


Key

Y *m*-value

X *y*-value

Figure E.1 — Limits for *m* against *y*, Fire TF5



Key

Y *m*-value

X *t*-value

Figure E.2 — Limits for *m* against time, *t*, Fire TF5

E.5 End-of-test condition

The end-of-test condition shall be when

a) $y_E = 6{,}0$, or

b) all of the specimens have generated an alarm signal,

whichever is the earlier.

Annex F
(normative)

Low temperature black smoke (decalin) liquid fire (TF8)

F.1 Fuel

Decalin (decahydronaphtaline for synthesis; a mixture of *cis* and *trans* isomers; $C_{10}H_{18}$; M = 138,25 g/mol; 1 l = 0,88 kg).

F.2 Arrangement

Burn the decalin in a square steel tray with dimensions approximately 12 cm × 12 cm and 2 cm depth.

F.3 Volume

Use approximately 170 ml of decalin.

F.4 Ignition

Ignite by flame or spark. A small quantity of a clean burning material (5 g of ethanol C_2H_5OH) may be used to assist ignition.

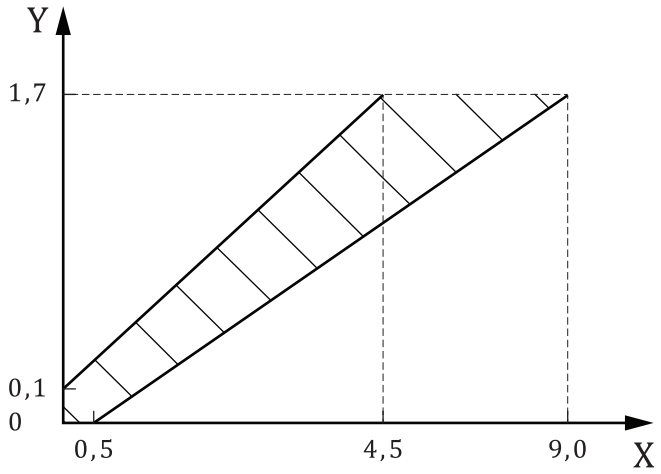
F.5 Test validity criteria

F.5.1 The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the limits shown in Figures F.1 and F.2 respectively. That is, 4,5 < y < 9,0 and 550 s < t < 1 000 s at the end-of-test condition m_E = 1,7 dB/m.

F.5.2 The temperature rise ΔT, during the test shall be less than 10 K.

F.5.3 The test condition can be changed to get the specified profile of test fire if it was not produced. For example, the height of room or the position of fire may be altered to ensure the smoke reaches the

ceiling and the tray may be kept cool (e.g. by using heavier grade steel or by placing the tray in an outer bath of cooling water) to ensure ΔT does not rise above 10 K.

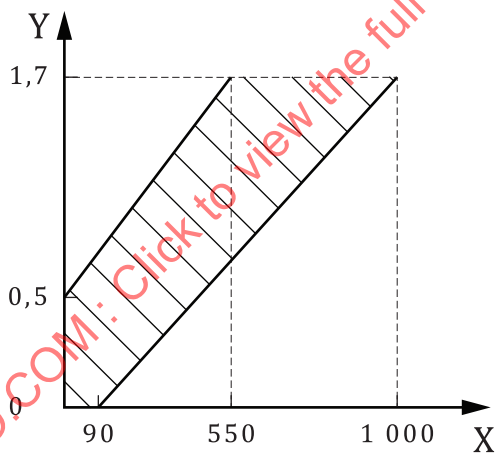


Key

Y *m*-value

X *y*-value

Figure F.1 — Limits for *m* against *y*, Fire TF8



Key

Y *m*-value

X *t*-value

Figure F.2 — Limits for *m* against time, *t*, Fire TF8

F.6 End-of-test condition

The end-of-test condition shall be when

a) m_E = 1,7 dB/m, or

b) t_E > 1 000 s, or

c) all of the specimens have generated an alarm signal,

whichever is the earlier.

Annex G
(normative)

Long range smouldering (pyrolysis) wood fire (TF2c)

G.1 Fuel

10 dried beechwood sticks, each stick having dimensions of 75 mm × 25 mm × 20 mm.

G.2 Conditioning

Dry the sticks in a heating oven so the moisture content is approximately 5 %.

G.3 Preparation

If necessary, transport the sticks from the oven in a closed plastic bag, and open the bag just prior to laying out the sticks in the test arrangement.

G.4 Hotplate

G.4.1 The hotplate shall have a 220 mm diameter grooved surface with eight concentric grooves with a distance of 3 mm between grooves. Each groove shall be 2 mm deep and 5 mm wide, with the outer groove 4 mm from the edge. The hotplate shall have a rating of 2 kW.

G.4.2 The temperature of the hot plate shall be measured by a sensor attached to the fifth groove, counted from the edge of the hotplate, and secured to provide a good thermal contact.

G.5 Arrangement

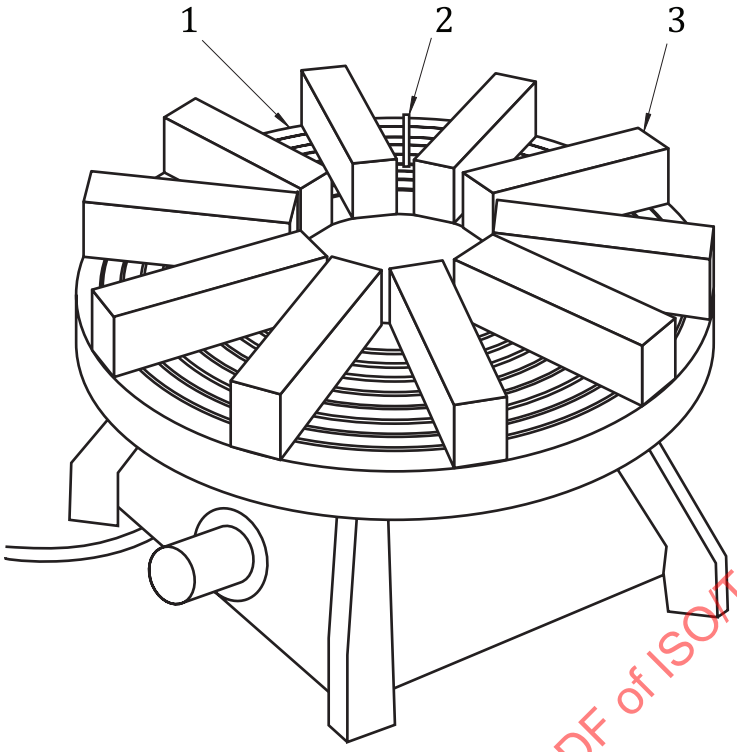
The sticks shall be arranged radially on the grooved hotplate surface, with the 20-mm side in contact with the surface such that the temperature probe lies between the sticks and is not covered, as shown in Figure G.1.

G.6 Heating rate

The hotplate shall be powered such that its temperature rises from ambient to 600 °C in 11 min, and is maintained for the duration of the test.

G.7 Test validity criteria

No flaming shall occur before the end-of-test condition has been reached.



Key

1 grooved hotplate
2 temperature sensor
3 wooden sticks

Figure G.1 — Arrangement of sticks on hotplate

G.8 End-of-test condition

The end-of-test condition shall be t = 840 s or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex H
(normative)

Long range glowing smouldering cotton fire (TF3c)

H.1 Fuel

90 pieces of braided cotton wick, each of length 80 cm and weighing 3 g. The wicks shall be free from any protective coating and shall be washed and dried if necessary.

H.2 Arrangement

The wicks shall be fastened to a ring approximately 10 cm in diameter and suspended approximately 1 m above a non-combustible plate as shown in Figure H.1.

Dimensions in metres

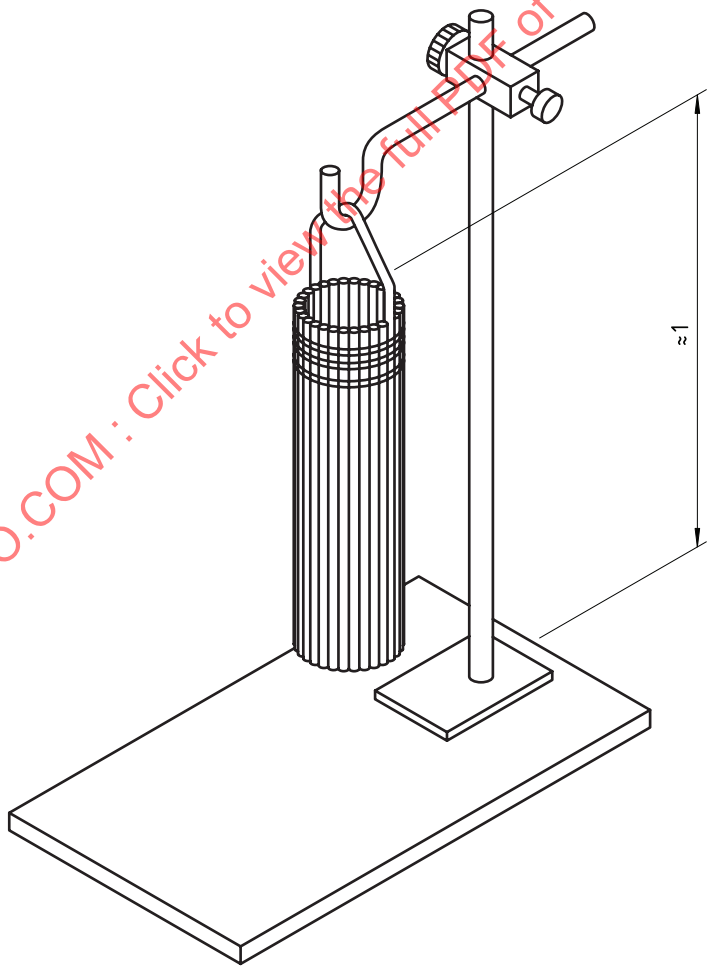


Figure H.1 — Arrangement of cotton wicks

H.3 Ignition

The lower end of each wick shall be ignited so that the wicks continue to glow. Any flaming shall be blown out immediately. The test time shall start when all wicks are glowing.

H.4 End-of-test condition

The end-of-test condition shall be t = 750 s or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex I
(normative)

Long range open plastics (polyurethane) fire (TF4a)

I.1 Fuel

Three mats, 50 cm × 50 cm × 2 cm, of soft polyurethane foam, without flame-retardant additives and having a density of 20 kg/m^3.

I.2 Conditioning

Maintain the mats in a humidity not exceeding 50 % at least 48 h prior to test.

I.3 Arrangement

Place the mats one on top of another on a base formed from aluminium foil with the edges folded up to provide a tray.

I.4 Ignition

Ignite the mats at a corner of the lower mat. A small quantity of a clean burning material (e.g. 5 cm^3 of methylated spirit) may be used to assist the ignition.

I.5 Method of ignition

Ignite by match or spark.

I.6 End-of-test condition

The end-of-test condition shall be t = 180 s or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex J
(normative)

Long range flaming liquid (n-heptane) fire (TF5c)

J.1 Fuel

650 g of a mixture of *n*-heptane (purity > 99 %) with 3 % of toluene (purity > 99 %), by volume.

J.2 Arrangement

The heptane/toluene mixture shall be burnt in a square steel tray with dimensions of approximately 330 mm × 330 mm × 50 mm.

J.3 Ignition

Ignite by flame or spark.

J.4 End-of-test condition

The end-of-test condition shall be t = 240 s or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex K
(normative)

Long range low temperature black smoke (decalin) liquid fire (TF8a)

K.1 Fuel

Decalin (decahydronaphtaline for synthesis; a mixture of *cis* and *trans* isomers; $C_{10}H_{18}$; M = 138,25 g/mol; 1 l = 0,88 kg).

K.2 Arrangement

Burn the decalin in a square steel tray with dimensions approximately 12 cm × 12 cm and 2 cm depth.

K.3 Volume

Use 170 ml of decalin.

K.4 Ignition

Ignite by flame or spark. A small quantity of a clean burning material (5 g of ethanol C_2H_5OH) may be used to assist ignition.

K.5 End-of-test condition

The end-of-test condition shall be t = 1 000 s or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex L
(normative)

Open cellulosic (wood) fire (TF1)

L.1 Fuel

Approximately 70 dried beechwood sticks, each stick having dimensions of 10 mm × 20 mm by 250 mm.

L.2 Conditioning

Dry the sticks in a heating oven so the moisture content is less than 3 %.

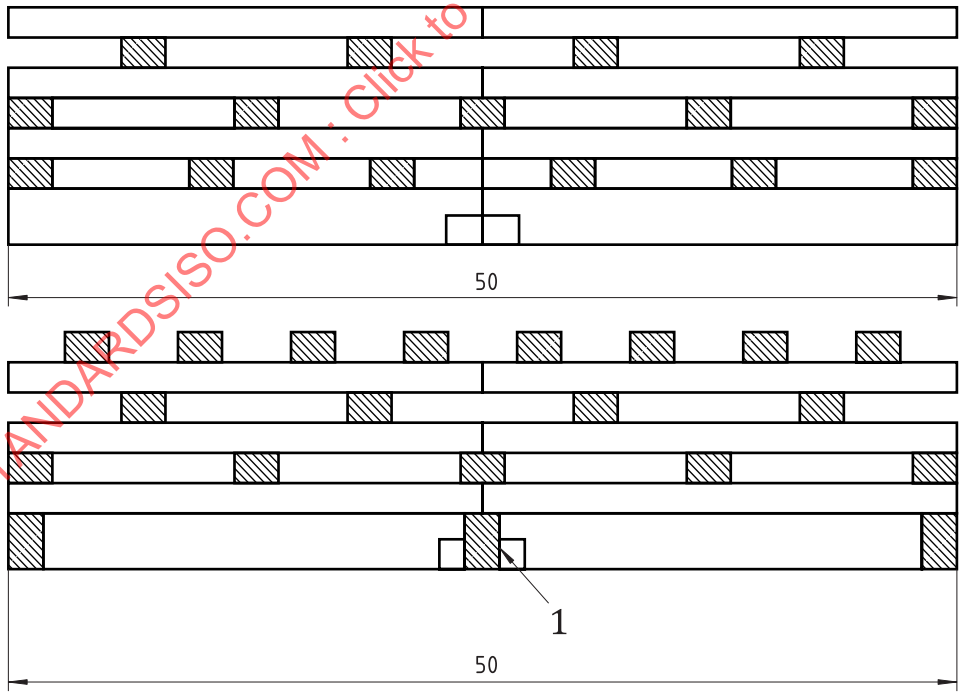
L.3 Preparation

If necessary, transport the sticks from the oven in a closed plastic bag and open the bag just prior to laying out the sticks in the test arrangement.

L.4 Arrangement

Superimpose seven layers on a base surface measuring approx. 50 cm wide × 50 cm long × 8 cm high (see Figure L.1).

Dimensions in centimetres



Key

1 container for methylated spirits

Figure L.1 — Wood arrangement for test fire TF1

L.5 Ignition

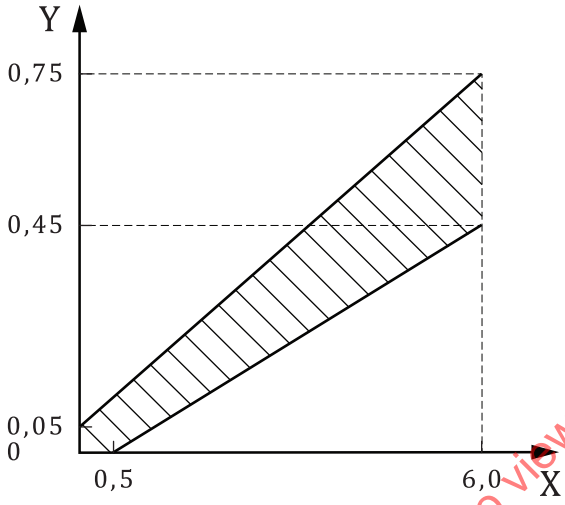
5 cm^3 methylated spirits in a bowl 5 cm in diameter. Locate the bowl in the center of base surface.

L.6 Method of ignition

Ignite by flame or spark in the methylated spirits.

L.7 Test validity criteria

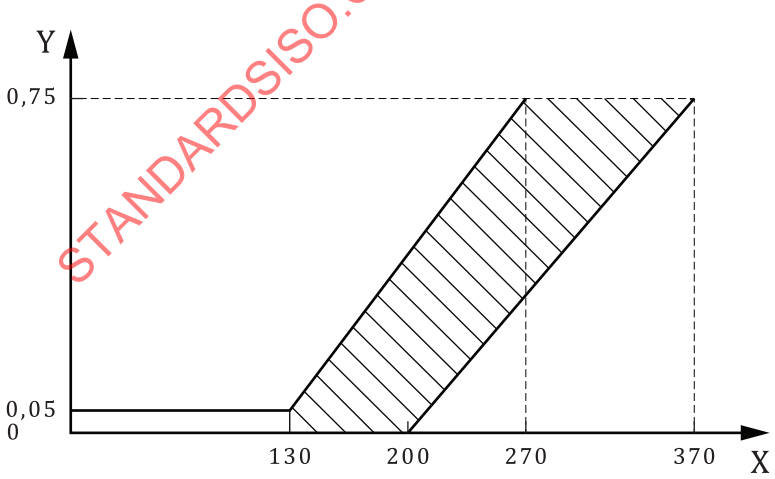
The development of the fire shall be such that the curves of m against y, and m against time, t, fall within the hatched areas shown in Figures L.2 and L.3, respectively. That is, 0,45 dB/m < m < 0,75 dB/m and 270 s < t < 370 s at the end-of-test condition y_E = 6,0.



Key

Y m-value X y-value

Figure L.2 — Limits for m against y, Fire TF1



Key

Y m-value X t-value

Figure L.3 — Limits for m against time, t, Fire TF1

L.8 Variables

The number of sticks may be varied in order for the test fire to remain within the profile curve limits.

L.9 End-of-test condition

The end of test condition shall be when either

a) $y_E = 6$, or

b) $t_E > 370$ s, or

c) all the specimens have generated an alarm signal,

whichever is the earlier.

Annex M
(normative)

Liquid (methylated spirit) fire (TF6)

M.1 Fuel

Methylated spirits at least 90 % ethanol C_2H_5OH to which has been added 10 % denaturant impurity (methanol).

M.2 Arrangement

Burn the methylated spirit in a container made from 2 mm thick sheet steel, base surface, 1 900 cm^2 area, dimensions approximately 435 mm × 435 mm × 50 mm high.

M.3 Volume

Use approximately 1,5 l of methylated spirit.

M.4 Ignition

Ignite by flame or spark.

M.5 Test validity criteria

The development of the fire shall be such that the curve of temperature, T, against time, t, falls within the hatched areas shown in Figure M.1. That is, at the end-of-test condition 80 °C < ΔT < 100 °C and t < 450 s.

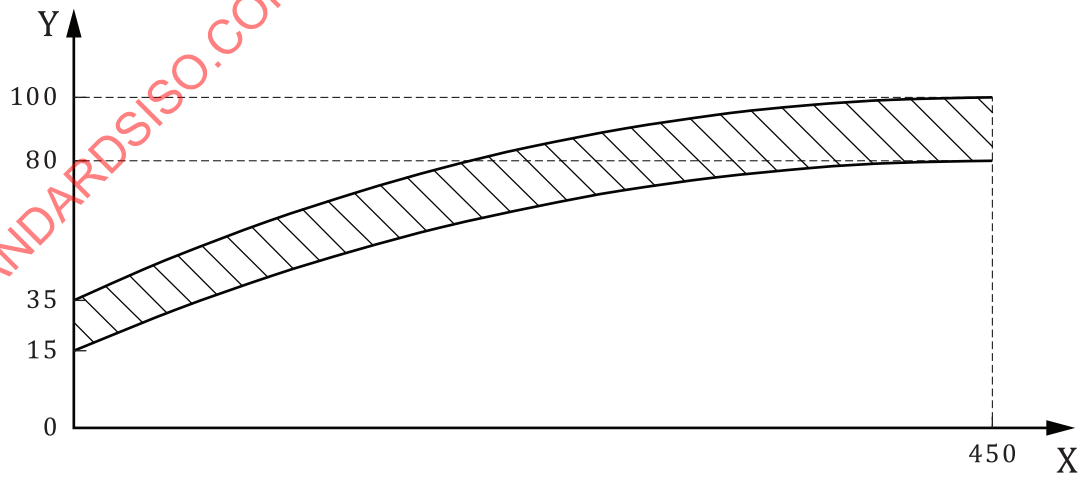


Figure M.1 — Limits for *T* against *t*, Fire TF6

M.6 End-of-test condition

The end-of-test condition shall be when

a) $\Delta T = 60$ °C, or

b) $t_E > 450$ s, or

c) all of the specimens have generated an alarm signal,

whichever is the earlier.

Annex N
(normative)

Long range open cellulosic (wood) fire (TF1a)

N.1 Fuel

70 dried beechwood sticks, each stick having dimensions of 10 mm × 20 mm by 250 mm.

N.2 Conditioning

Dry the sticks in a heating oven so the moisture content is less than 3 %.

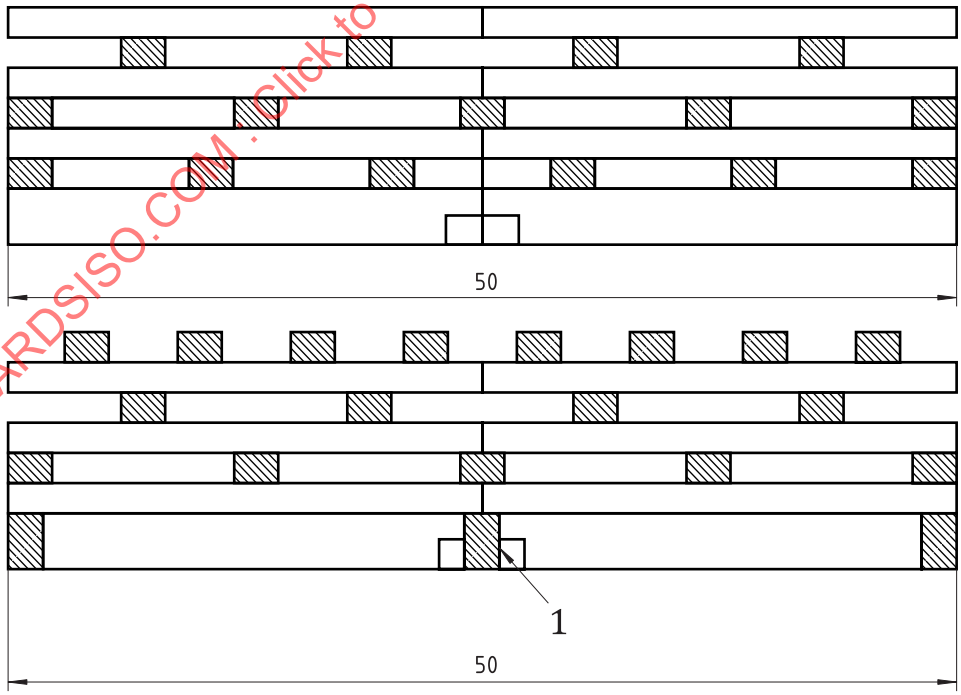
N.3 Preparation

If necessary, transport the sticks from the oven in a closed plastic bag and open the bag just prior to laying out the sticks in the test arrangement.

N.4 Arrangement

Superimpose seven layers on a base surface measuring 50 cm wide × 50 cm long × 8 cm high (see Figure N.1).

Dimensions in centimetres



Key

Y container for methylated spirits

Figure N.1 — Wood arrangement for test fire TF1

N.5 Ignition

5 cm^3 methylated spirits in a bowl 5 cm in diameter. Locate the bowl in the center of base surface.

N.6 Method of ignition

Ignite by flame or spark in the methylated spirits.

N.7 End-of-test condition

The end-of-test condition shall be t = 370 s or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex O
(normative)

Long range liquid (methylated spirit) fire (TF6a)

O.1 Fuel

Methylated spirits at least 90 % ethanol C_2H_5OH to which has been added 10 % denaturant impurity (methanol).

O.2 Arrangement

Burn the methylated spirit in a container made from 2 mm thick sheet steel, base surface, 1 900 cm^2 area, dimensions 435 mm × 435 mm × 50 mm high.

O.3 Volume

Use 1,5 l of methylated spirit.

O.4 Ignition

Ignite by flame or spark.

O.5 End-of-test condition

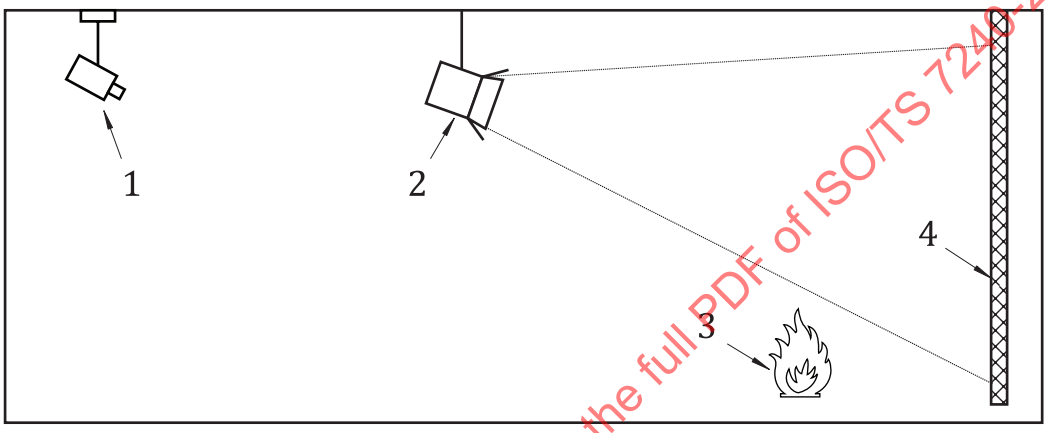
The end-of-test condition shall be t = 450 s or all of the specimens have generated an alarm signal, whichever is the earlier.

Annex P
(normative)

Non-uniform illumination test configuration

P.1 Equipment configuration

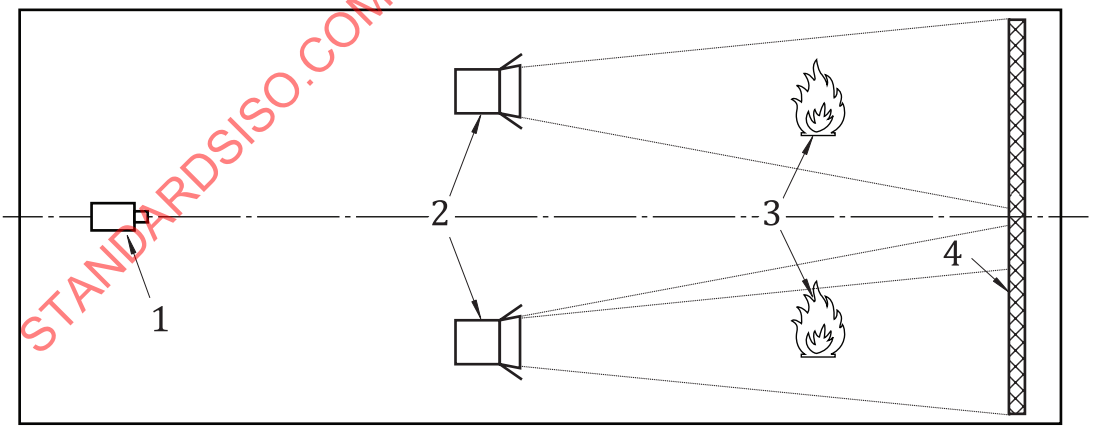
Configure the fire test room specified in Annex A with a background screen and lighting as shown in Figures P.1 and P.2.



Key

1 specimen
2 light source(s)
3 test fire
4 background screen

Figure P.1 — Side elevation



Key

1 specimen
2 light source(s)
3 test fire
4 background screen

Figure P.2 — Plan view

P.2 Background screen

The screen shall be part of the test room equipment and shall cover the specimen FOV when installed as specified in 5.1.7.

NOTE 1 The background screen might also be used as the background for the other tests.

NOTE 2 Colours are standardized by their chromaticity coordinates. However, test houses might need a guideline concerning what the respective colours look like. For this purpose, and not for colour matching, the coordinates of centroid ordinary white and black are given in Table P.1 as examples in some internationally known colour order systems.

Table P.1 — Examples of black and white colours from colour order systems

Colour	DIN 5381 DIN 6164	RAL[a]	Munsell[a]	NF X08-002 NF X08-010	NCS
Black	N : 0 : 9	RAL 9004	N 1	No. 2603	S 9000-N
White	N : 0 : 0,5	RAL 9003	N 9,5	No. 3665	S 0500-N

[a] RAL and Munsell are examples of colour order systems available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

P.3 Lighting

P.3.1 One light shall provide a high intensity light source covering floor area between test fire and one half of screen, to provide the maximum illumination rating by manufacturer. The light intensity shall be measured from a distance of 1 m in front of the screen.

P.3.2 Utilize sharp cut-off baffles to provide direct illumination only to high intensity side of room and screen.

P.3.3 A second optional light shall provide a low intensity light source if the minimum manufacturer specification is higher than that provided by stray light from high intensity lamp. If used, it shall provide illumination to bring low intensity side up to manufacturer specified minimum.

P.3.4 Where it is not possible to adequately baffle the high intensity light source from the non-illuminated area, the test can proceed. The light intensity shall be included in the test report (see 5.28).

P.4 Test fire location

The test fire shall be located at the mid-point of the illuminated area and 2 m in front of the background.

Annex Q
(normative)

Apparatus for impact test

Q.1 The apparatus (see Figure Q.1) consists essentially of a swinging hammer comprising a rectangular section head (striker) with a chamfered impact face, mounted on a tubular steel shaft. The hammer is fixed into a steel boss, which runs on ball bearings on a fixed steel shaft mounted in a rigid steel frame, so that the hammer can rotate freely about the axis of the fixed shaft. The design of the rigid frame is such as to allow complete rotation of the hammer assembly when the specimen is not present.

Q.2 The striker with overall dimensions of 76 mm (width) × 50 mm (depth) × 94 mm (length) and is manufactured from aluminium alloy (Al Cu_4SiMg as specified in ISO 209), which has been solution- and precipitation-treated. It has a plane-impact face chamfered at (60 ± 1)° to the long axis of the head. The tubular steel shaft has an outside diameter of (25 ± 0,1) mm with a wall thickness of (1,6 ± 0,1) mm.

Q.3 The striker is mounted on the shaft so that its long axis is at a radial distance of 305 mm from the axis of rotation of the assembly, the two axes being mutually perpendicular. The central boss is 102 mm in outside diameter and 200 mm long, and is mounted coaxially on the fixed steel pivot shaft, which is approximately 25 mm in diameter; however the precise diameter of the shaft will depend on the bearings used.

Q.4 Diametrically opposite the hammer shaft are two steel counter-balance arms, each 20 mm in outside diameter and 185 mm long. These arms are screwed into the boss so that the length of 150 mm protrudes. A steel counter-balance weight is mounted on the arms so that its position can be adjusted to balance the weight of the striker and arms, as in Figure Q.1. On the end of the central boss is mounted a 150 mm-diameter aluminium alloy pulley, 12 mm wide, and around this is wound an inextensible cable, with one end fixed to the pulley. The other end of the cable supports the operating weight.

Q.5 The rigid frame also supports the mounting board on which the specimen is mounted by its normal fixings. The mounting board is adjustable vertically so that the upper half of the impact face of the hammer will strike the specimen when the hammer is moving horizontally, as shown in Figure Q.1.

Q.6 To operate the apparatus, the position of the mounting board with the specimen is first adjusted as shown in Figure Q.1 and the mounting board is then secured rigidly to the frame. The hammer assembly is then balanced carefully by adjustment of the counter-balance weight with the operating weight removed. The hammer arm is then drawn back to the horizontal position ready for release and the operating weight is reinstated. On release of the assembly, the operating weight will spin the hammer and arm through an angle of $3\pi/2$ rad to strike the specimen. The mass, in kilograms, of the operating weight to produce the required impact energy of 1,9 J equals $0{,}388/(3\pi r)$ kg, where r is the effective radius of the pulley, in metres. This equals approximately 0,55 kg for a pulley radius of 75 mm.

Q.7 As this document requires a hammer velocity at impact of (1,5 ± 0,13) m/s, the mass of the hammer head will need to be reduced by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0,79 kg will be required to obtain the specified velocity, but this will have to be determined by trial and error.