



**International
Standard**

ISO 7240-29

**Fire detection and alarm systems —
Part 29:
Video fire detectors**

*Systèmes de détection et d'alarme d'incendie —
Partie 29: Détecteurs de fumée vidéo*

**First edition
2024-01**

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of 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 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*.

This first edition of ISO 7240-29 cancels and replaces the first edition of ISO/TS 7240-29:2017, which has been technically revised.

The main changes are as follows:

- additional detail has been added to the requirements for the response threshold value (RTV) test for Type A and AB video smoke detectors;
- the RTV test has been eliminated for Type B detectors;
- requirements have been provided for controllers that are and are not in the same environment as the cameras;
- the dark and light background during fire tests can now be replaced with high and low illumination of the background;
- the non-uniform illumination test has been corrected to remove references to alternate background screens and related diagrams have been corrected;
- the requirement to operationally test the detector during hot and cold conditioning tests has been removed;
- the operational impact test has been modified to reference IEC 62262;
- the operational vibration test has been eliminated;
- a vibration endurance test has been added for the controller.

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

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Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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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 can 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 senses 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.

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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 (VFDs), 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 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 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

response threshold value

RTV

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

active field of view

aFOV

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](#))

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
aFOV	active field of view
FOV	field of view
MIC	measuring ionization chamber
IP	ingress protection
VFD	video fire detector

RTV response threshold value

4 Requirements

4.1 Conformity

In order to claim conformance to this document, the VFD shall meet the following requirements.

- The VFD shall conform to the requirements of [Clause 4](#). This conformance shall be verified by visual inspection or engineering assessment.
- The VFD shall be tested as specified in [Clause 5](#), and shall meet the requirements of the tests.
- The VFD shall be marked in accordance with [Clause 6](#) and shall 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 VFDs can detect flame emitted by test fire for type A VFD, and can also detect smoke from a type B test fire. Thus, a 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 VFDs can have two types (Type A and Type B) if the flame detection and smoke detection algorithms within the VFD can be separately activated/monitored.

4.3 Immunity to unwanted alarms

Detectors shall be immune to phenomena that can cause unwanted alarms.

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

VFDs may use interchangeable or variable focal length lenses.

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

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

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

4.7 Individual alarm indication

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

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

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.

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

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

- a) for all of the settings for which the manufacturer claims conformance, the detector shall conform 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 for which the manufacturer does not claim conformance 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 conform with this document.

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

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 (minimum) (see IEC 60529)
Indoor	30
Outdoor	54
Other	A rating nominated by the manufacturer exceeding the minimum for the application.

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 do not need to 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 at least over the range 15 lx to 10 000 lx.

NOTE In an installation, the light level range can need to be ensured by artificial illumination (an illuminator) or shading if necessary. The VFD can be tested over a wider range if desired.

4.15 Operating temperature

The manufacturer shall declare 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
Other	nominated by the manufacturer and is an extension of the above

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:

- the software shall have a modular structure;
- the design of the interfaces for manually and automatically generated data shall not permit invalid data to cause error in the program operation;
- 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 for conformance to 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

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

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

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

- 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 unfavourable for each test.

5.1.4 Operating conditions for tests

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.

Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range.

If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary equipment (e.g. through wiring to an end-of-line device for point detectors) to allow a fault signal to be recognized.

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

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

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 series).

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

5.1.6 Provision for tests

The following shall be provided for testing conformance 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 conforming with this document;
- d) the data specified by [Clause 7](#).

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.

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

Mount the specimen in accordance with [5.1.3](#) in the fire test room in the designated area (see [Annex A](#)) or other suitable test area in accordance with the manufacturer's instructions.

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.

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.

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 except in [5.8](#) or [5.9](#). The illumination shall be agreed between the test house and manufacturer in a range of 50 lx to 500 lx.

For type A and type AB detectors, use smouldering smoke test fire TF2 or a recording of TF2 as specified in [5.1.7.3](#).

Alternatively, another RTV may be used if the RTV test produces an increasing amount (positive slope over any 20 s interval) of smoke in the field of view that enables the discernment of different levels of sensitivity for the specific technology or algorithm employed by the manufacturer.

For type B detectors, no RTV test shall be required.

NOTE This will establish a sensitivity equivalent to the full-scale fire testing in [5.7](#).

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

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 In order to record the time, it can be necessary to allow for the test fire to become established while the sensor is masked, e.g. by a mirror facing away from the test fire. The time then starts from the moment at which 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 stimuli.

5.1.7.3 Recorded fire video

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.

The minimum specifications for the video camera are as follows.

- 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 VFDs require specific camera settings (exposure, gain control, wide dynamic range). Camera settings of recording camera should be as required by the manufacturer.

NOTE The manufacturer can 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.

Record the test specified in [5.1.7.2](#) using a high-quality video recorder.

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.

The minimum specifications for the video display are as follows.

- 1) Resolution shall be equal to or greater than the specimen under test.
- 2) Minimum 450 nit combined with minimum 4 000:1 (fixed) contrast, not dynamic contrast.
- 3) Video display shall be equipped with anti-glare layer to eliminate reflections.

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. the specimen with the lowest response threshold time is numbered 1). For cameras with a separate controller, choose one controller arbitrarily to conduct the indicated tests.

Table 4 — Test schedule

Test	Subclause	Specimen No. (s)		
		Camera with and without separate controller	Controller installed in the same location as camera	Controller installed in an indoor controlled location
Repeatability	5.2	One chosen arbitrarily	N/A	N/A
Reproducibility	5.3	All specimens	N/A	N/A
Detector lens monitoring	5.4	1	N/A	N/A
Detector lens blocking	5.5	1	N/A	N/A
Detector lens focus fault ^a	5.6	1	N/A	N/A
Fire sensitivity	5.7	All specimens	N/A	N/A
Ambient light (minimum)	5.8	1	N/A	N/A
Ambient light (maximum)	5.9	1	N/A	N/A
Non-uniform illumination	5.10	2	N/A	N/A
Light source immunity	5.11	3	N/A	N/A
Arc welding — Optional	5.12	4	N/A	N/A
Variation in supply parameters	5.13	2	N/A	N/A
Dry heat (operational)	5.14	3	1	N/A
Dry heat (operational) — Optional ^b	5.15	3	1	N/A
Cold (operational)	5.16	4	1	N/A
Cold (operational) — Optional ^c	5.17	4	1	N/A
Cold controllers (operational)	5.18	4	N/A	1
Damp heat, steady state (operational)	5.19	5	1	1
Damp heat, steady state (endurance)	5.20	1	1	1
Protection against ingress of foreign bodies	5.21	1	1	1
Sulfur dioxide (SO ₂) corrosion (endurance)	5.22	2	N/A	N/A
Shock (operational)	5.23	3	1	N/A
Impact camera (operational)	5.24	4	N/A	N/A
Impact controllers (operational)	5.25	4	1	1
Vibration, sinusoidal (endurance)	5.26	1	1	N/A
Vibration, sinusoidal controller (endurance)	5.27	1	N/A	1
Electromagnetic compatibility (EMC) immunity (operational)	5.27	5	1	1
^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 behaviour with respect to its sensitivity, even after a number of alarm conditions.

5.2.2 Test procedure

Measure the response threshold value of the specimen to be tested six times as specified in [5.1.7](#).

Designate the maximum response threshold value as $t_{\max}$ and 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

Measure the response threshold value of each specimen as specified in [5.1.7](#).

Calculate the mean of these response threshold values, which shall be designated t .

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

5.3.3 Requirements

The ratio of the response threshold values $t_{\max}:t$ shall not be greater than 1,33, and the ratio of the response threshold values $t:t_{\min}$ 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 that the detector is still able to detect before that point of going into fault signal.

5.4.2 Test procedure

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](#).

Place a variable attenuation filter as specified by [Annex R](#) in front of the camera lens such that the lens FOV is completely covered. The attenuation filter shall not distort or pixelate the image.

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

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

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

If the specimen does not 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.

Remove the density filter D_{fault} and replace it by the density filter $D_{\text{fault}} - 10$ which is the last density filter which doesn't create a fault signal. Allow the specimen to return to the quiescent condition.

Conduct the sensitivity test as specified in [5.1.7](#).

Designate the greater of the response threshold values 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

The specimen shall release a fault signal within 300 s when tested in accordance with [5.4.2](#). If the specimen does not raise a fault condition, but it does raise a fault condition in accordance with [5.5.3](#), then the filter is not sufficiently opaque 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.

The ratio of the response threshold values $t_{\text{max}}:t_{\text{min}}$ 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

Mount the specimen as specified in [5.1.3](#) and connect to the supply and monitoring equipment specified in [5.1.4](#).

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

Monitor the specimen for alarm and fault signals.

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

Maintain the blockage for 300 s.

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

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

Maintain the blockage for 300 s.

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

5.5.3 Requirements

A fault signal shall be given during blockages.

No alarm signal shall be given.

5.6 Detector lens focus fault

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

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](#).

Defocus the camera lens until a fault signal is given. Record the setting. Where a fault signal is not given, even when the camera lens is fully defocused, RTV measurement shall be conducted at the extreme of the focus adjustment range.

The rate of change in the focus shall be agreed with the manufacturer and the test house.

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

Defocus the VFD lens to a point just prior to the setting that creates a fault signal.

Measure the response threshold value of the specimen as specified in [5.1.7](#).

Designate the greater of the response threshold values 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 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

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 can 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.

For type A VFD, where the declared range is ≤ 5 m, subject the specimens to test fires TF2, TF3, TF4, TF5, and TF8 in accordance with the specifications in [Annexes B](#) to [F](#) and in the fire test room specified in [Annex A](#).

For type A VFD, where the declared range is > 5 m, subject the specimens to test fires TF2c, TF3c, TF4a, TF5c, and TF8a in accordance with the specifications in [Annexes G](#) to [K](#) in a fire test room at least as long as the declared range.

For type B VFD, where the declared range is ≤ 5 m, subject the specimens to test fires TF1, TF4 and TF6 in accordance with the specifications in [Annexes D, L](#) and [M](#) in the fire test room specified in [Annex A](#).

For type B VFD, where the declared range is > 5 m, subject the specimens to test fires TF1a, TF4a and TF6a in accordance with the specifications in [Annexes L, N](#), and [O](#) in a fire test room at least as long as the declared range.

For type AB VFD where the declared range is ≤ 5 m, subject the specimens to test fires TF1, TF2, TF3, TF4, TF5, TF6 and TF8 in accordance with the specifications in [Annexes B](#) to [E, L](#), and [M](#) in the fire test room specified in [Annex A](#).

For type AB VFD where the declared range is > 5 m, subject the specimens to test fires TF1a, TF2c, TF3c, TF4a, TF5c, TF6a, TF8a in accordance with the specifications in [Annexes G](#) to [K, N](#), and [O](#) in a fire test room at least as long as the declared range.

For test fire TF2, TF2c, TF3 and TF3c, one of the following shall apply.

- a) The fire background shall be white.
- b) 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.
- c) For TF2 and TF2c, the white background may not be used. This deviation shall be noted in the test report. For TF3 and TF3c, the white background may be replaced by a high illumination level (10 000 lx) on at least one spot of the background behind the smoke plume (at least 1 m²). This deviation shall be noted in the test report.

For test fires TF1, TF1a, TF4, TF4a, TF5, TF5c, TF8 and TF8a, one of the following shall apply.

- a) The fire background shall be black.
- b) 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.
- c) For TF5, TF5c, TF6 and TF6a, the black background may not be used. This deviation shall be noted in the test report. For TF1, TF1a, TF4, TF4a, TF8 and TF8a, the black background may be replaced by a low illumination level (15 lx or lower level specified by manufacturer) on at least one spot of the background behind the smoke plume (at least 1 m²). This deviation shall be noted in the test report.

Acceptable contrast marks are of a size occupying not more than 5 % of the area of the background. Contrast marks are distinctively shaded areas in the FOV that are added to improve detection.

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

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

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

It is permitted to mount and test multiple specimens simultaneously for each specified test fire for all camera/lens combinations specified by the manufacturer, rather than do separate tests for each variation.

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

NOTE The minimum and maximum distance tests specified above 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.

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.

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 $< 2\text{ }^{\circ}\text{C}$, 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.

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.

For test fires conducted in the fire test room, 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): $m \leq 0,02\text{ dB/m}$

Monitor the specimen during the conditioning period to detect alarm and fault signals. During each test fire in the fire test room, 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	$^{\circ}\text{C}$
Smoke density (ionization)	y	(dimensionless)
Smoke density (optical)	m	dB/m
Time	t	seconds (s)

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. Record the time of response (alarm signal) of each specimen, and for test fires carried out in the fire test room, ΔT_a , y_a and m_a , fire parameters at the moment of response. A response of the specimen after the end of the test condition is ignored.

5.7.3 Requirements

No fault signals shall be given.

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

5.8 Ambient light (minimum)

5.8.1 Object of test

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

5.8.2 Test procedure

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 [5.1.7.2](#).

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

Measure the response threshold value of the specimen as specified in [5.1.7.2](#).

Adjust the ambient light level to the minimum absolute light level of no more than 15 lx.

Measure the response threshold value of the specimen as specified in [5.1.7.2](#).

Designate the greater of the response threshold values measured in this test as $t_{\max}$ and the lesser as $t_{\min}$.

5.8.3 Requirements

No fault signals shall be given.

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

5.9 Ambient light (maximum)

5.9.1 Object of test

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

5.9.2 Test procedure

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 shall be conducted as specified in [5.1.7.2](#).

Perform the test with an illumination level of at least 10 000 lx.

Measure the response threshold value of the specimen as specified in [5.1.7.2](#).

Compare the response threshold values measured in [5.8](#) and [5.9](#) and designate the greater of the response threshold value as $t_{\max}$ and the lesser as $t_{\min}$.

5.9.3 Requirements

No fault signals shall be given.

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

5.10 Non-uniform illumination (Type A and AB only)

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](#).

This test only applies to detectors specifying a range > 9 m.

5.10.2 Test procedure

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. It is recommended to seek the manufacturer's guidance in such cases to ensure that the state of the detectors at the start of each test is representative of their normal quiescent state.

Subject the specimens to test fire TF2c.

5.10.3 Requirements

No fault signals shall be given during the conditioning period.

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 specimen 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

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](#).

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

Adjust the specimen to the default sensitivity.

Do not manually mask the FOV.

Adjust the ambient light to 250 lx $\pm$ 20 % and colour temperature of 5 000 K.

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.

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

5.11.3 Fluorescent light

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

Equally space four vertically mounted 1,2 m fluorescent tubes on a white background measuring 2 m $\times$ 2 m.

Orientate the lights towards the specimen.

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

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

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

Orientate the light towards the specimen.

Conduct the following procedure:

- a) light on for 15 min;
- b) light off for 2 min;
- c) number of cycles: 3.

5.11.5 Halogen light

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

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

Orientate the light towards the specimen.

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

Use a 750 lm LED with a colour temperature of 3 000 K. Mount the light on a white background measuring 2 m × 2 m.

Orientate the light towards the specimen.

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

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

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

Conduct the following procedure:

- a) light on for 30 s;
- b) light off for 30 s;
- c) number of cycles: 5.

Repeat the test using an amber-coloured beacon.

5.11.8 Xenon beacon — Optional

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

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

Conduct the following procedure:

- a) light on for 30 s;
- b) light off for 30 s;
- c) number of cycles: 5.

Repeat the test using an amber-coloured beacon.

5.11.9 High-pressure sodium light — Optional

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

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

Orientate the light towards the specimen.

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

Use a low-pressure sodium light with a light output of 8 000 lm and a colour temperature of 1 800 K.

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

Orientate the light towards the specimen.

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

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

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

Orientate the light towards the specimen.

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

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

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

Orientate the light towards the specimen.

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

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

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

Orientate the light towards the specimen.

Conduct the following procedure:

- a) lights on for 30 s;
- b) lights off for 30 s;
- c) number of cycles: 5.

5.11.14 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

Adjust the specimen to the maximum sensitivity.

Mount the specimen in accordance with [5.1.3](#) and connect it to its supply and monitoring equipment, as specified in [5.1.4](#).

Allow the specimen to stabilize in its quiescent condition.

Ensure the ambient illumination shall not exceed 250 lx. Ensure that the person conducting the test does not block the FOV.

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.

Continue welding for either 30 s or until a single rod is consumed, whichever is the lesser.

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 It is possible that for some detectors, the only relevant supply parameter is the DC voltage applied to the detector. For other types of detectors (e.g. analogue addressable), it can be necessary to consider signal levels and timing. If necessary, the manufacturer can 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

No fault signals shall be given during the conditioning period.

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

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 and Outdoor 2 service environments (see [Table 3](#)).

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 [5.1.3](#) in an environmental chamber and connect the specimen to its supply and monitoring equipment as specified in [5.1.4](#).

5.14.2.3 Conditioning

Apply the following conditioning.

- Temperature: Starting at an initial air temperature of $(23 \pm 5) ^\circ\text{C}$, increase the air temperature to $(55 \pm 3) ^\circ\text{C}$.
- Duration: Maintain this temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of $< 1 \text{ K/min}$ 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 loss of image.

5.14.2.5 Final measurements

Measure the response threshold value as specified in [5.1.7](#).

Designate the greater of the response threshold values 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

No loss of image during the period in which the temperature is increasing to the conditioning temperature, or during the conditioning period.

For Type A and AB, the ratio of the response threshold values $t_{\text{max}}:t_{\text{min}}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

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 $70 ^\circ\text{C}$ to function correctly at high ambient temperatures which can occur for short periods in outdoor service environments.

NOTE This test applies only to products declared with temperature Outdoor 1 as per [4.15](#).

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 [5.1.3](#) in an environmental chamber and connect the specimen to its supply and monitoring equipment as specified in [5.1.4](#).

5.15.2.3 Conditioning

Apply the following conditioning.

- Temperature: Starting at an initial air temperature of $(23 \pm 5) ^\circ\text{C}$, increase the air temperature to $(70 \pm 3) ^\circ\text{C}$.
- Duration: Maintain this temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of $< 1 \text{ K/min}$ 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 loss of image.

5.15.2.5 Final measurements

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](#).

Designate the greater of the response threshold values 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

No loss of image during the period that the temperature is increasing to the conditioning temperature or during the conditioning period.

For Type A and AB, the ratio of the response threshold values $t_{\text{max}}:t_{\text{min}}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

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 the specimen to supply and monitoring equipment as specified in [5.1.4](#).

5.16.2.3 Conditioning

Apply the following conditioning.

- Temperature: $(-10 \pm 3) ^\circ\text{C}$
- Duration: 16 h

NOTE Test Ab specifies rates of change of temperature of $< 1 \text{ K/min}$ 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 loss of image.

5.16.2.5 Final measurements

Measure the response threshold value as specified in [5.1.7](#).

Designate the greater of the response threshold values 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

No loss of image during the transition to or the period at the conditioning temperature.

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

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 -25 °C and -40 °C to function correctly at low ambient temperatures which can occur for short periods in outdoor service environments.

NOTE This test applies only to products declared with temperature Outdoor 1 and Outdoor 2 as per [4.15](#).

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 the specimen to supply and monitoring equipment as specified in [5.1.4](#).

5.17.2.3 Conditioning

Apply the following conditioning.

- Temperature Outdoor 1: $(-25 \pm 3)\text{ °C}$
- Temperature Outdoor 2: $(-40 \pm 3)\text{ °C}$
- Duration: 16 h

NOTE Test Ab specifies rates of change of temperature of $< 1\text{ K/min}$ 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 loss of image.

5.17.2.5 Final measurements

Measure the response threshold value as specified in [5.1.7](#).

Designate the greater of the response threshold values 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

No loss of image during the transition to or the period at the conditioning temperature.

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.18 Cold controllers (operational)

5.18.1 Object of test

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

NOTE RTV measurement according to [5.1.7](#) can be performed before conditioning and the result can be used as the reference for comparison with the RTV after the specimen is exposed to the conditioning of this test.

5.18.2 Test procedure

5.18.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1, Test Ab, and in [5.18.2.2](#) to [5.18.2.5](#).

5.18.2.2 State of specimen during conditioning

Mount the specimen in an environmental chamber as specified in [5.1.3](#) and connect the specimen to supply and monitoring equipment as specified in [5.1.4](#).

5.18.2.3 Conditioning

Apply the following conditioning.

— Temperature: $(0 \pm 3)^\circ\text{C}$

— Duration: 16 h

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

5.18.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any loss of image.

5.18.2.5 Final measurements

Measure the response threshold value as specified in [5.1.7](#).

Designate the greater of the response threshold values 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

No loss of image during the transition to or the period at the conditioning temperature.

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

5.19 Damp heat, steady-state (operational)

5.19.1 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.

5.19.2 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](#) and connect it to supply and monitoring equipment as specified in [5.1.4](#).

5.19.2.3 Conditioning

Apply the following conditioning.

- Temperature: $(40 \pm 2) ^\circ\text{C}$
- Relative humidity: $(93 \pm 3) \%$
- Duration: 96 h

5.19.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any loss of image.

5.19.2.5 Final measurements

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](#).

Designate the greater of the response threshold values 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

No loss of image during the conditioning.

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.20 Damp heat, steady-state (endurance)

5.20.1 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).

5.20.2 Test procedure

5.20.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab, and in [5.20.2.2](#) to [5.20.2.4](#).

5.20.2.2 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.

5.20.2.3 Conditioning

Apply the following conditioning.

- Temperature: $(40 \pm 2) ^\circ\text{C}$
- Relative humidity: $(93 \pm 3) \%$
- Duration: 21 d

5.20.2.4 Final measurements

After a recovery period of at least 1 h in standard laboratory conditions, measure the response threshold value as specified in [5.1.7](#).

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

5.20.3 Requirements

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

For Type A and AB, the ratio of the response threshold values $t_{\text{max}}:t_{\text{min}}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.21 Protection against ingress of foreign bodies

5.21.1 Object of test

To demonstrate 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.

5.21.2 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.

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

5.21.3 Test procedure

5.21.3.1 Reference

The test apparatus and test procedure shall be as described in IEC 60529 and in [5.21.3.2](#) to [5.21.3.5](#).

5.21.3.2 State of the specimen during conditioning

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.

For the test for protection against ingress of water, connect the specimen to its supply and monitoring equipment as specified in [5.1.4](#).

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.

5.21.3.3 Conditioning

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

- a) indoor use (IP30 and higher);
- b) outdoor use (IP54 and higher).

Measure the response threshold values as specified in [5.1.7](#).

5.21.3.4 Measurement during conditioning

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

5.21.3.5 Final measurements

Examine the specimen for ingress of water.

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

5.21.4 Requirements

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

The specimen shall conform to the rating IP30 for indoor use or IP54 for outdoor use specified in IEC 60529.

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

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.22 Sulfur dioxide (SO₂) corrosion (endurance)

5.22.1 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

5.22.2 Test procedure

5.22.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-42, Test Kc, 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](#). 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.

5.22.2.3 Conditioning

Apply the following conditioning.

- Temperature: $(25 \pm 2) ^\circ\text{C}$
- Relative humidity: $(93 \pm 3) \%$
- SO_2 concentration: $(25 \pm 5) \mu\text{l/l}$
- Duration: 21 d

5.22.2.4 Final measurements

Immediately after the conditioning, subject the specimen to a drying period of 16 h at $(40 \pm 2) ^\circ\text{C}$, < 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](#).

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

5.22.3 Requirements

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

For Type A and AB, the ratio of the response threshold values $t_{\text{max}}:t_{\text{min}}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.23 Shock (operational)

5.23.1 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.

5.23.2 Test procedure

5.23.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-27, Test Ea, but carry out the conditioning as specified in [5.23.2.3](#).

5.23.2.2 State of specimen during conditioning

Mount the specimen as specified in [5.1.3](#) to a rigid fixture and connect the specimen to its supply and monitoring equipment as specified in [5.1.4](#).

5.23.2.3 Conditioning

For specimens with a mass $\leq 4,75$ kg, apply the following conditioning.

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

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

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

Measure the response threshold value as specified in [5.1.7](#).

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 $m_{\min}$.

5.23.3 Requirements

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

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.24 Impact (operational) for cameras

5.24.1 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.

5.24.2 Test procedure

5.24.2.1 Apparatus

The test apparatus shall consist of a spring hammer as described in IEC 62262.

5.24.2.2 State of specimen during conditioning

Mount the specimen rigidly to a fixing plate by its normal mounting means. Connect the specimen to its supply and monitoring equipment as specified in [5.1.4](#).

5.24.2.3 Conditioning

The impact shall be applied on any location where the normal functioning of the detector could be impaired, excluding a direct impact on the lens or on the window covering the lens.

Use the following test parameters during the conditioning.

- Impact energy: $(2 \pm 0,1) \text{ J}$
- Number of impacts: 1

5.24.2.4 Measurements during conditioning

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

5.24.2.5 Final measurements

Measure the response threshold value as specified in [5.1.7](#).

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

5.24.3 Requirements

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.

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

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.25 Impact (operational) for controllers

5.25.1 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.

5.25.2 Test procedure

5.25.2.1 General

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

5.25.2.2 Initial examination

Before conditioning, subject the specimen to a functional test by connecting a camera to ensure normal operation.

5.25.2.3 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.

5.25.2.4 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: $(0,5 \pm 0,04) \text{ J}$
- Number of impacts per point: 3

5.25.2.5 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.

5.25.2.6 Final measurements

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

5.26 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 the 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

Mount the specimen on a rigid fixture as specified in [5.1.3](#), but do not supply it with power during conditioning.

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

Apply the following conditioning.

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

Measure the response threshold value as specified in [5.1.7](#).

5.26.2.4 Final measurements

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

Designate the greater of the response threshold values 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

No mechanical damage either internally or externally shall result.

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

5.27 Vibration, sinusoidal controller (endurance)

5.27.1 Object of test

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

5.27.2 Test procedure

5.27.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and [5.27.2.2](#) to [5.27.2.4](#).

5.27.2.2 State of specimen during conditioning

Mount the specimen on a rigid fixture as specified in [5.1.3](#), but do not supply it with power during conditioning.

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.

5.27.2.3 Conditioning

Apply the following conditioning.

- Frequency range: (10 to 150) Hz
- Acceleration amplitude: $4,905 \text{ m/s}^2$ ($\approx 0,5 g_n$)
- Number of axes: 3
- Sweep rate: 1 octave/min
- Number of sweep cycles: 20/axis

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 needs to be made.

5.27.2.4 Final measurements

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

Measure the response threshold value as specified in [5.1.7](#).

Designate the greater of the response threshold values 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

No mechanical damage either internally or externally shall result.

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

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

5.28 Electromagnetic compatibility (EMC) immunity (operational)

5.28.1 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.

5.28.2 Test procedure

5.28.2.1 Reference

Use the test apparatus and the test procedures as described in IEC 62599-2 and in [5.28.2.2](#) to [5.28.2.5](#).

5.28.2.2 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](#).

5.28.2.3 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.

5.28.2.4 Measurements during conditioning

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

The functional test called for in the initial measurements shall be the response threshold value test as specified in [5.1.7](#).

5.28.2.5 Final measurements

The functional test called for in the final measurements shall be the response threshold value test as specified in [5.1.7](#).

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 $t_{\min}$.

5.28.3 Requirements

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

For Type A and AB, the ratio of the response threshold values $t_{\max}:t_{\min}$ shall not be greater than 1,6. For Type B, the detector shall respond to flame.

6 Marking

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

- a) a reference to this document;
- 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) 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 abbreviated terms 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 VFD, and the components of VFD have been selected for the intended purpose, and are expected to operate within their specification.

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 conformance 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 comment 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 conformance 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 the ISO 7240 series, and ancillary functions not required by this document;
- c) technical specifications of the inputs and outputs of a 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 aFOV.

If a replaceable camera lens can be used with the VFD the manufacturer shall specify for each camera lens combination the specific range, FOV, aFOV 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](#) and [4.15](#) can be met,

- 4) information that backgrounds shall include sufficient contrast features in the field of view to ensure correct operation, if this deviation is noted in the test report or test procedures request to include this requirement in the instruction;
- 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 can be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this document.

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Annex A (normative)

Fire test room

A.1 Fire room size

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

- Length: > 9 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.
Ambient light is measured at the fire location with the sensor towards the ceiling.

A.2 Measuring instruments

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 Instrument locations

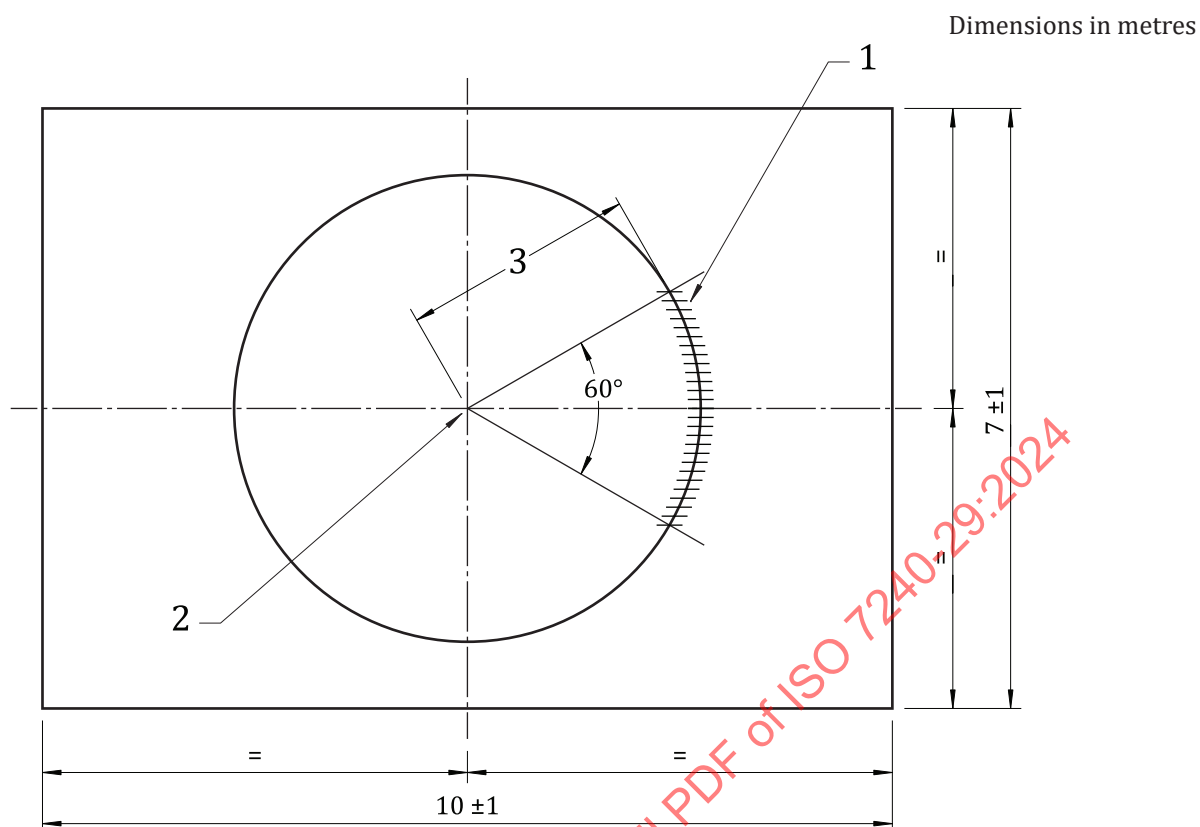
The MIC, the temperature probe and the measuring part of the obscuration meter shall all be located as shown in [Figures A.1](#) and [A.2](#).

A.4 Specimen location

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 Specimen and instrument locations

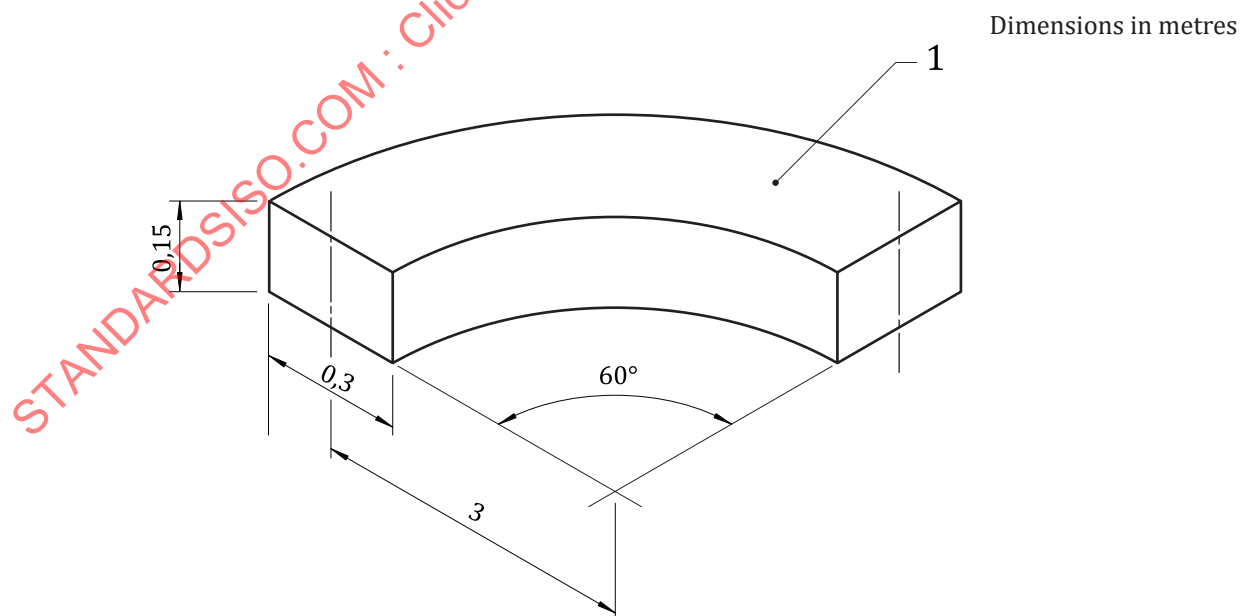
The specimens, the MIC and the mechanical parts of the obscuration meter shall be at least 100 mm apart, measured to the nearest edges. The centre line of the beam of the obscuration meter shall be at least 35 mm below the ceiling.



Key

- 1 measuring instruments
- 2 position of test fire

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



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

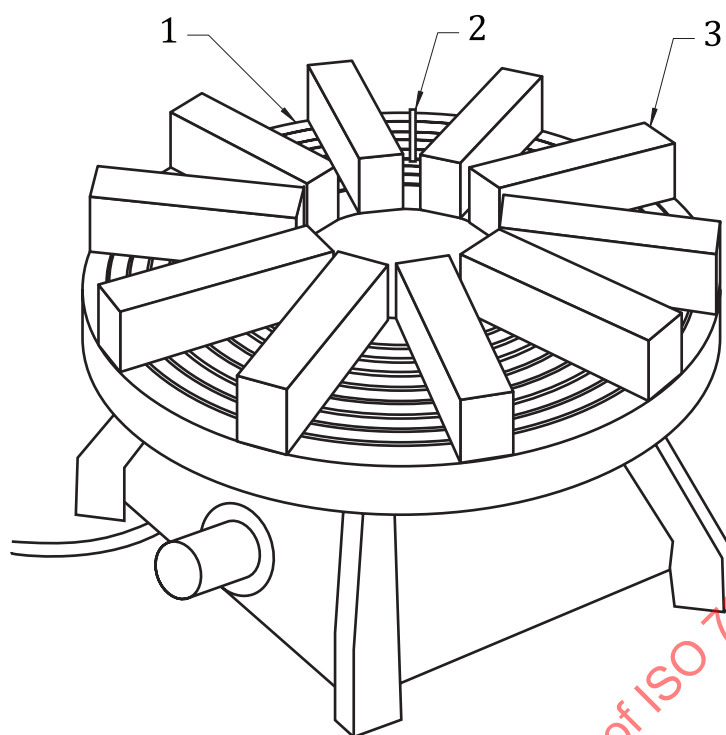
The sticks shall be arranged radially on the grooved hotplate surface, with the 20-mm side in contact with the surface such that the temperature probe lies between the sticks and is not covered, as shown in [Figure B.1](#).

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

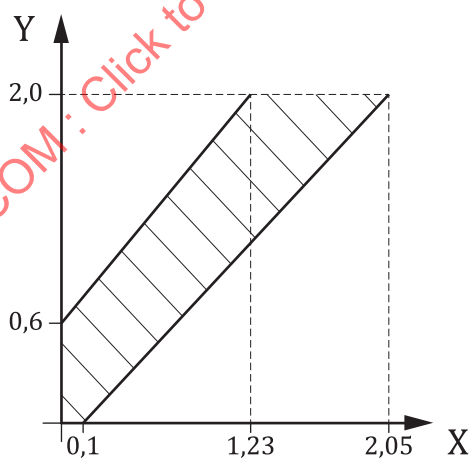
No flaming shall occur before the end-of-test condition has been reached. The development of the fire shall be such that the curves of m against y , and m against time, t , fall within the hatched areas shown in [Figures B.2](#) and [B.3](#), respectively. That is, $1,23 \leq y \leq 2,05$ and $570 \text{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



Key

- 1 grooved hotplate
- 2 temperature sensor
- 3 wooden sticks

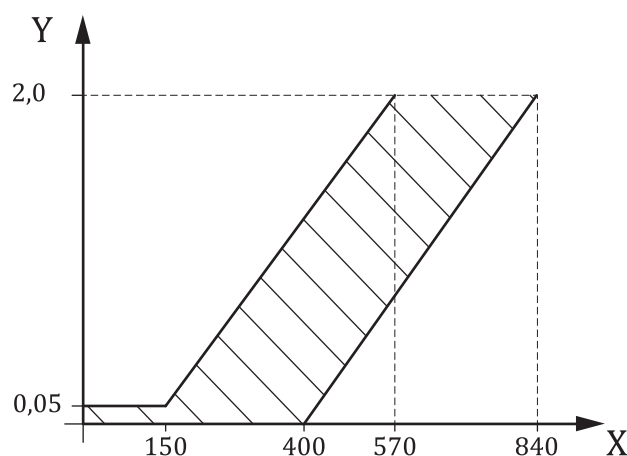
Figure B.1 — Arrangement of sticks on hotplate



Key

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

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

**Key**X t -valueY m -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 $m = 2 \text{ dB/m}$ 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

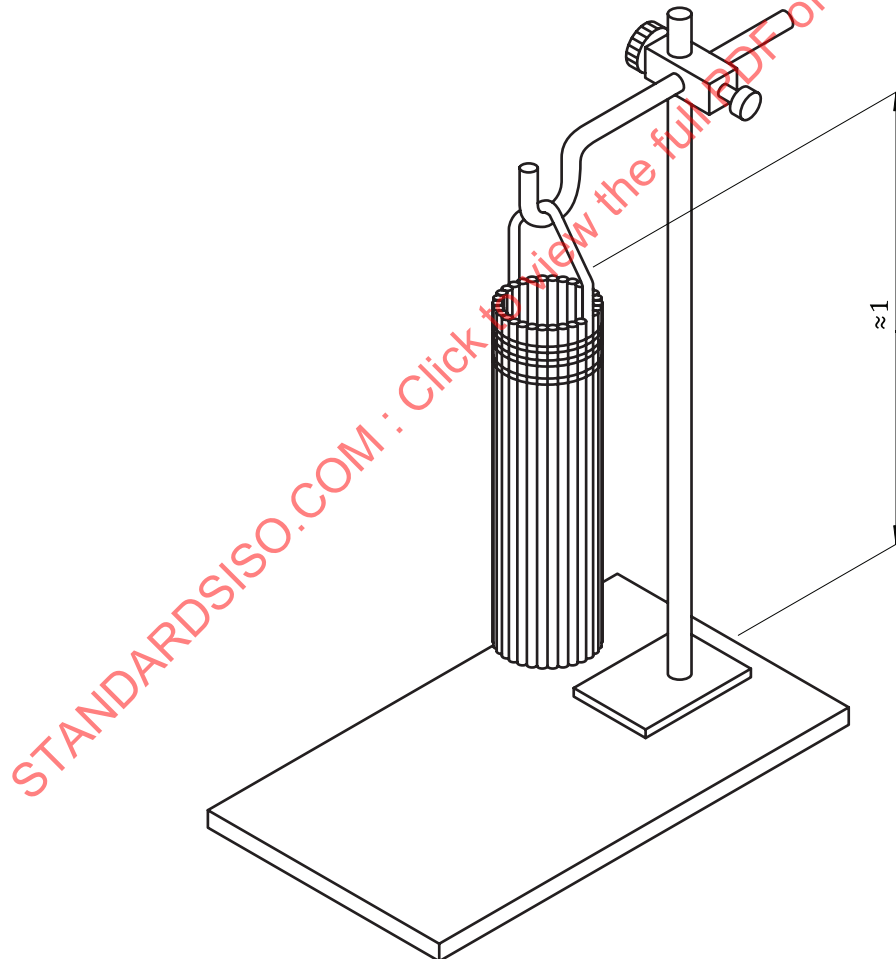


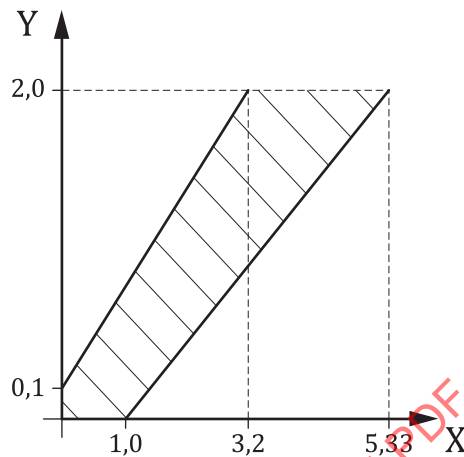
Figure C.1 — Arrangement of cotton wicks

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 $m_E = 2 \text{ dB/m}$.

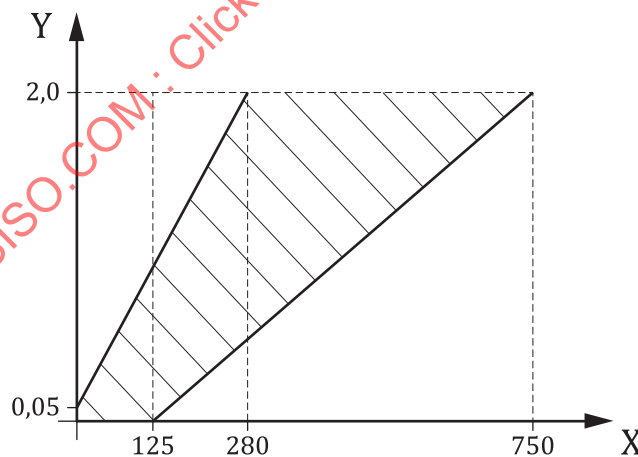


Key

X y -value

Y m -value

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



Key

X t -value

Y m -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.

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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/m³, 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

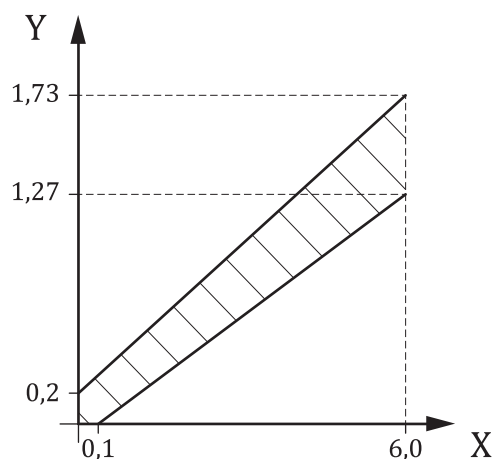
Ignite the mats at a corner of the lower mat. The exact position of ignition may be adjusted to obtain a valid test. A small quantity of a clean burning material (e.g. 5 cm³ of methylated spirit) may be used to assist the ignition.

D.5 Method of ignition

Ignite by match or spark.

D.6 Test validity criteria

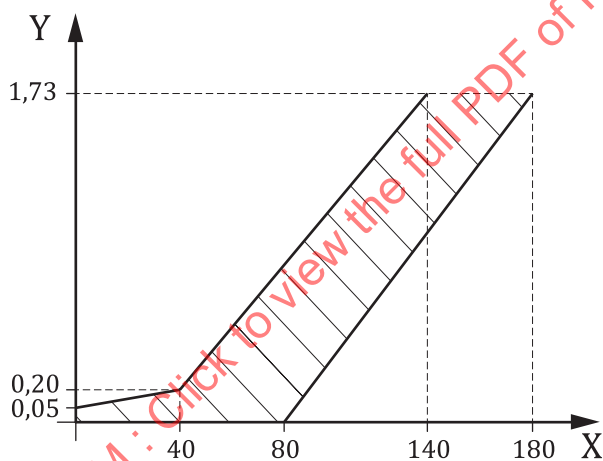
The development of the fire shall be such that the curves of m against y , m against time, t , fall within the limits shown in [Figure D.1](#) and [D.2](#) respectively. That is, $1,27 < m < 1,73$ and $140 \text{ s} < t < 180 \text{ s}$ at the end-of-test conditions $y_E = 6$.



Key

X y -value
Y m -value

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



Key

X t -value
Y m -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 $0,92 \text{ dB/m} \leq m \leq 1,24 \text{ dB/m}$, and $120 \text{ s} \leq t \leq 240 \text{ s}$.

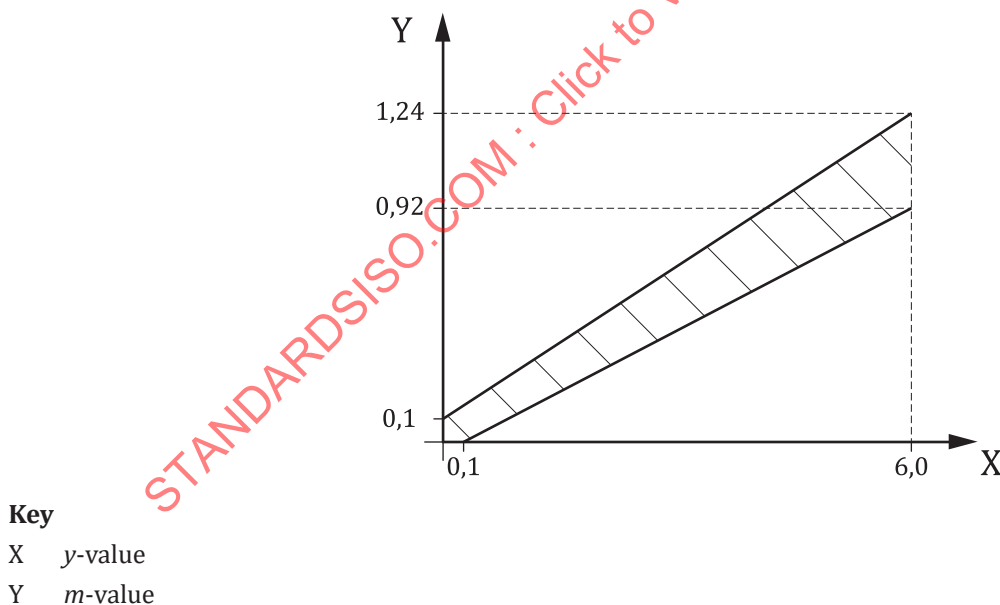
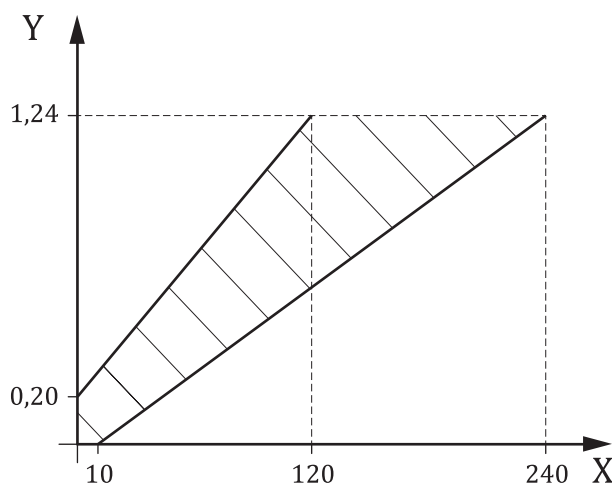


Figure E.1 — Limits for m against y , Fire TF5

**Key**

X t -value
Y m -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; $1\text{ l} = 0,88$ kg).

F.2 Arrangement

Burn the decalin in a square steel tray with dimensions approximately $12\text{ cm} \times 12\text{ cm}$ 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.

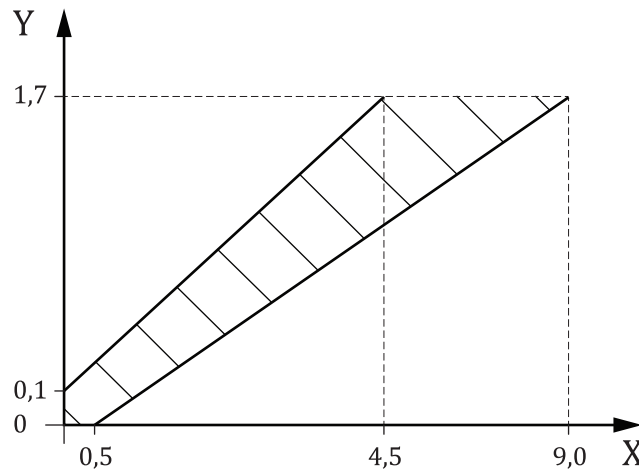
F.5 Test validity criteria

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 $550\text{ s} < t < 1\,000\text{ s}$ at the end-of-test condition $m_E = 1,7\text{ dB/m}$.

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.

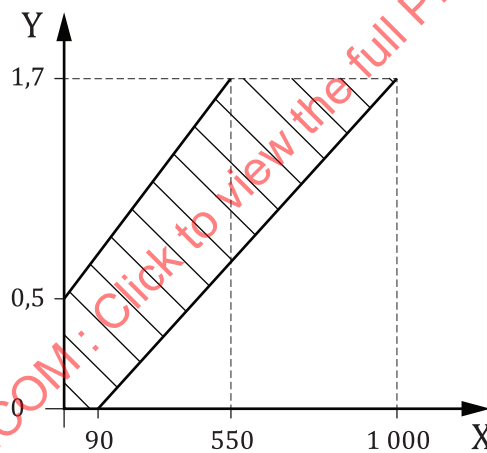


Key

X y -value

Y m -value

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



Key

X t -value

Y m -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

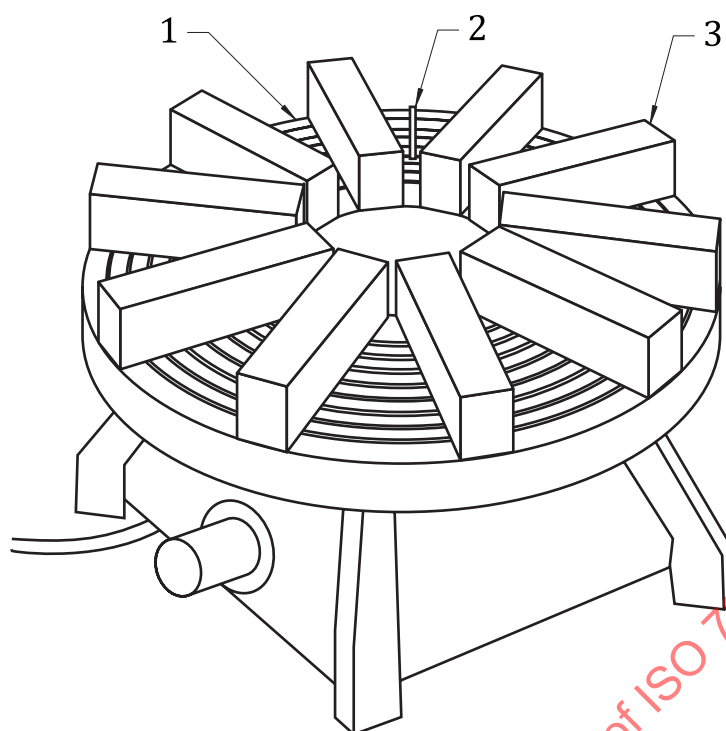
The sticks shall be arranged radially on the grooved hotplate surface, with the 20-mm side in contact with the surface such that the temperature probe lies between the sticks and is not covered, as shown in [Figure G.1](#).

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

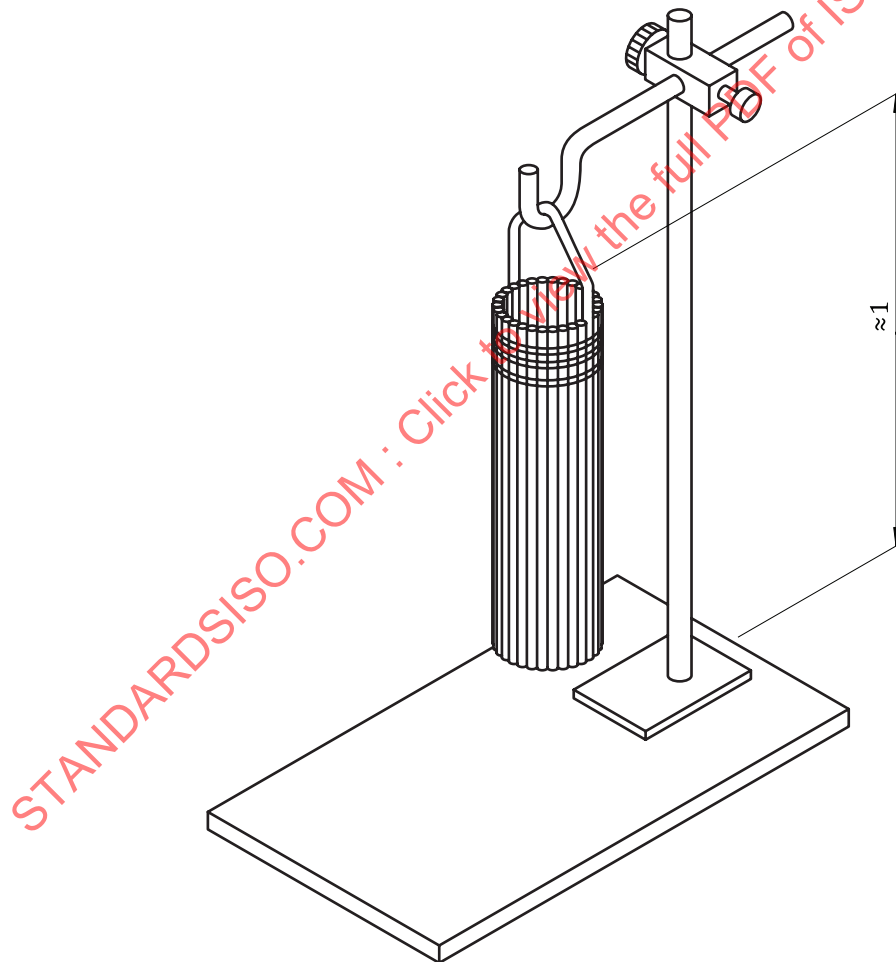


Figure H.1 — Arrangement of cotton wicks

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.

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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/m³.

I.2 Conditioning

Maintain the mats in a humidity not exceeding 50 % at least 48 h prior to the 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 cm³ 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.

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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 (e.g. 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 × 250 mm.

L.2 Conditioning

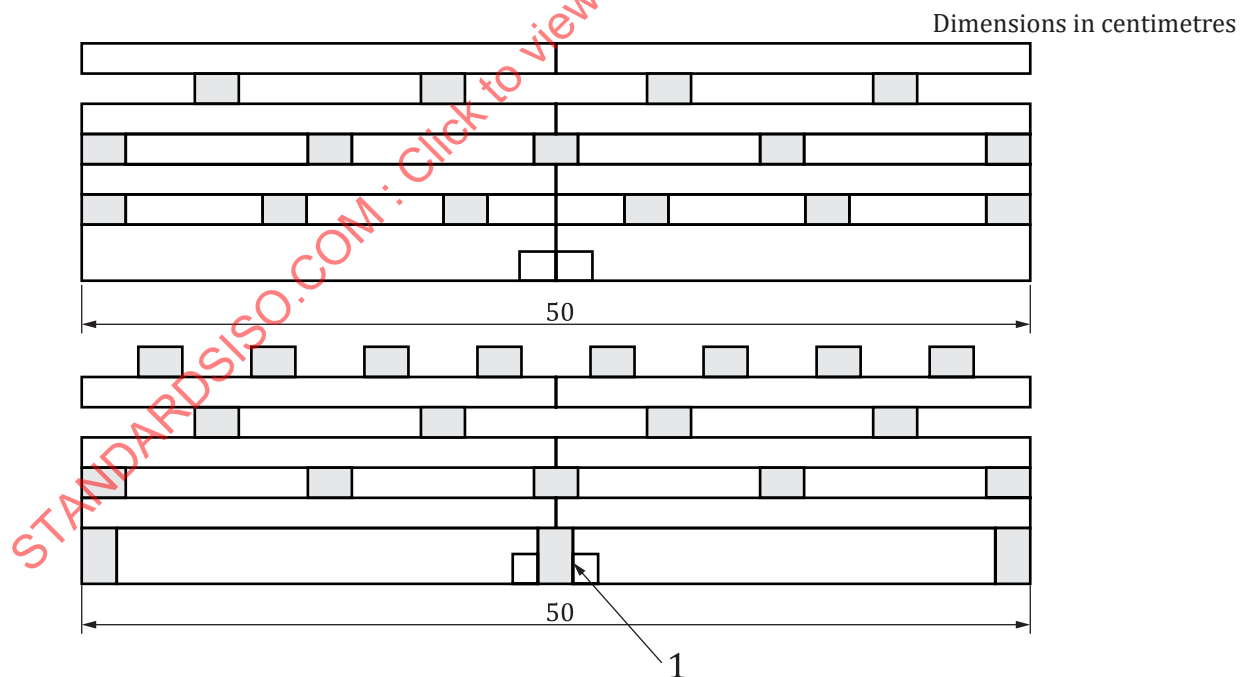
Dry the sticks in a heating oven so the moisture content is less than 3 %.

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](#)).



Key

1 container for methylated spirits

Figure L.1 — Wood arrangement for test fire TF1

L.5 Ignition

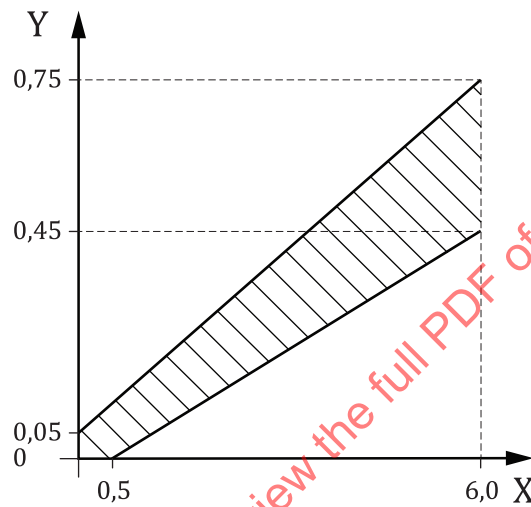
5 cm³ methylated spirits in a bowl 5 cm in diameter. Locate the bowl in the centre of the base surface.

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, $0,45 \text{ dB/m} < m < 0,75 \text{ dB/m}$ and $270 \text{ s} < t < 370 \text{ s}$ at the end-of-test condition $y_E = 6,0$.

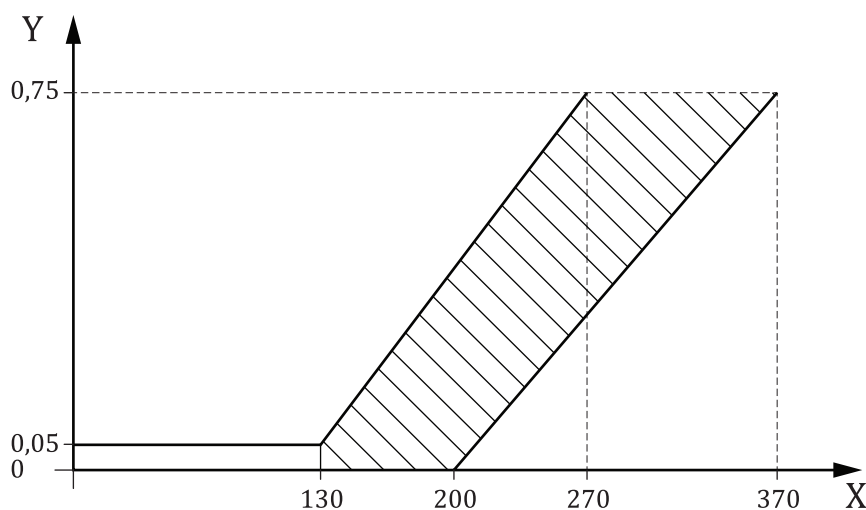


Key

X y -value

Y m -value

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

**Key**X t -valueY m -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 $\text{C}_2\text{H}_5\text{OH}$ 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 $\times$ 435 mm $\times$ 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 $80\text{ }^\circ\text{C} < \Delta T < 100\text{ }^\circ\text{C}$ and $t < 450\text{ s}$.

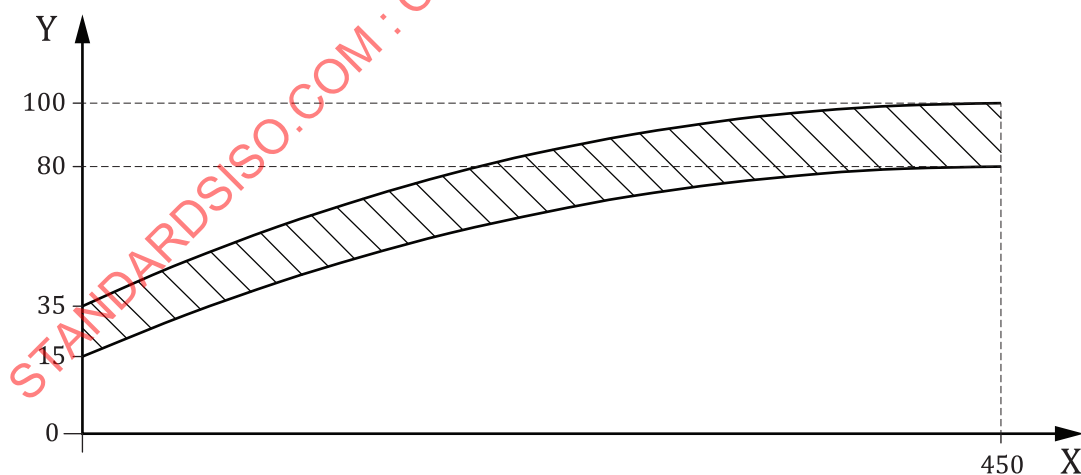


Figure M.1 — Limits for T against t , Fire TF6

M.6 End-of-test condition

The end-of-test condition shall be when:

- a) $\Delta T = 60\text{ }^\circ\text{C}$, or

- b) $t_E > 450$ s, or
- c) all of the specimens have generated an alarm signal, whichever is the earlier.

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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 × 250 mm.

N.2 Conditioning

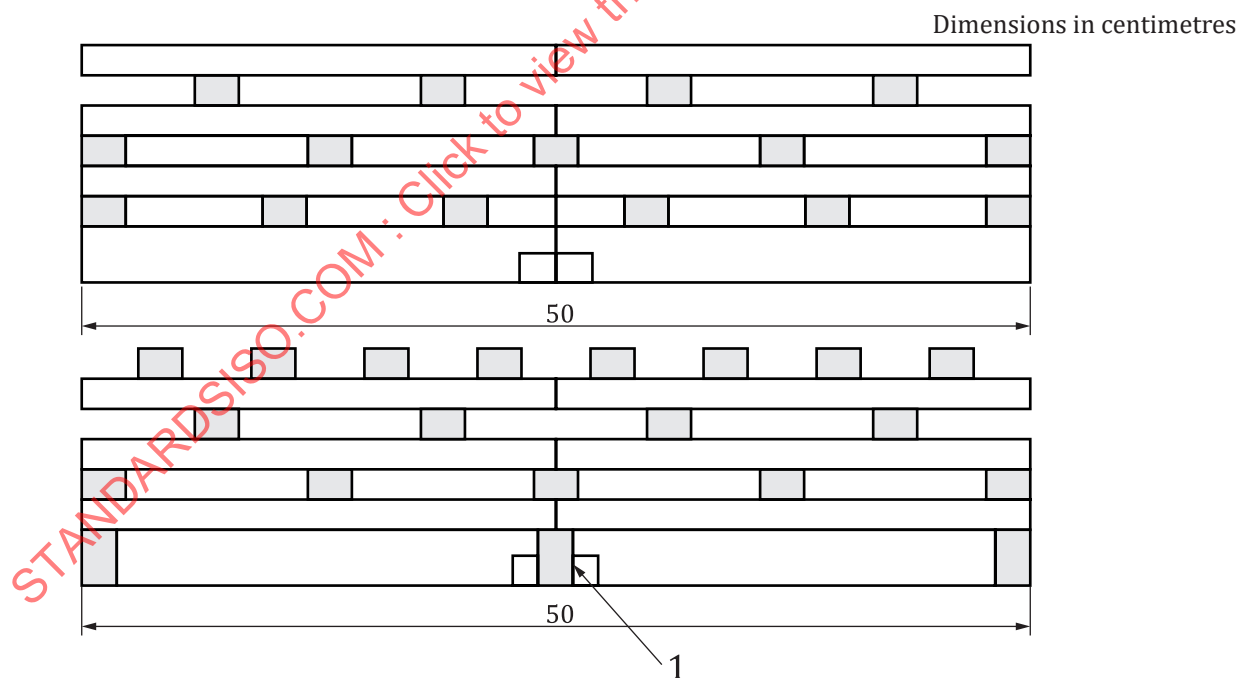
Dry the sticks in a heating oven so the moisture content is less than 3 %.

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](#)).



Key

1 container for methylated spirits

Figure N.1 — Wood arrangement for test fire TF1

N.5 Ignition

5 cm³ methylated spirits in a bowl 5 cm in diameter. Locate the bowl in the centre of the 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.

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Annex O

(normative)

Long range liquid (methylated spirit) fire (TF6a)

0.1 Fuel

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

0.2 Arrangement

Burn the methylated spirit in a container made from 2 mm thick sheet steel, base surface, 1 900 cm² area, dimensions 435 mm × 435 mm × 50 mm high.

0.3 Volume

Use 1,5 l of methylated spirit.

0.4 Ignition

Ignite by flame or spark.

0.5 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.