TECHNICAL SPECIFICATION

ISO/TS 7240-9

Second edition
2012-12-15

Fire detection and alarm systems —

Part 9: Test fires for fire detectors

Systèmes de détection et d'alarme d'incendie —

Partie 9: Essais sur foyers pour détecteurs d'incendie

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Contents

Page

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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

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

ISO/TS 7240-9 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

This second edition cancels and replaces the first edition (ISO/TS 7240-9:2006) which has been technically revised.

ISO 7240 consists of the following parts, under the general title *Fire detection and alarm systems*:

— *Part 1: General and definitions*

— *Part 2: Control and indicating equipment*

— *Part 3: Audible alarm devices*

— *Part 4: Power supply equipment*

— *Part 5: Point-type heat detectors*

— *Part 6: Carbon monoxide fire detectors using electro-chemical cells*

— *Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

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

— *Part 9: Test fires for fire detectors* [Technical Specification]

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- — *Part 10: Point-type flame detectors*
- — *Part 11: Manual call points*
- — *Part 12: Line type smoke detectors using a transmitted optical beam*
- — *Part 13: Compatibility assessment of system components*
- — *Part 14: Guidelines for drafting codes of practice for design, installation and use of fire detection and fire alarm systems in and around buildings* [Technical Report]
- — *Part 15: Point type fire detectors using scattered light, transmitted light or ionization sensors in combination with a heat sensor*
- — *Part 16: Sound system control and indicating equipment*
- — *Part 17: Short-circuit isolators*
- — *Part 18: Input/output devices*
- — *Part 19: Design, installation, commissioning and service of sound systems for emergency purposes*
- — *Part 20: Aspirating smoke detectors*
- — *Part 21: Routing equipment*
- — *Part 22: Smoke-detection equipment for ducts*
- — *Part 23: Visual alarm devices*[1)]
- — *Part 24: Sound-system loudspeakers*
- — *Part 25: Components using radio transmission paths*
- — *Part 27: Point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor*
- — *Part 28: Fire protection control equipment*

A part 29 dealing with video fire detectors is under development.

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1) To be published.

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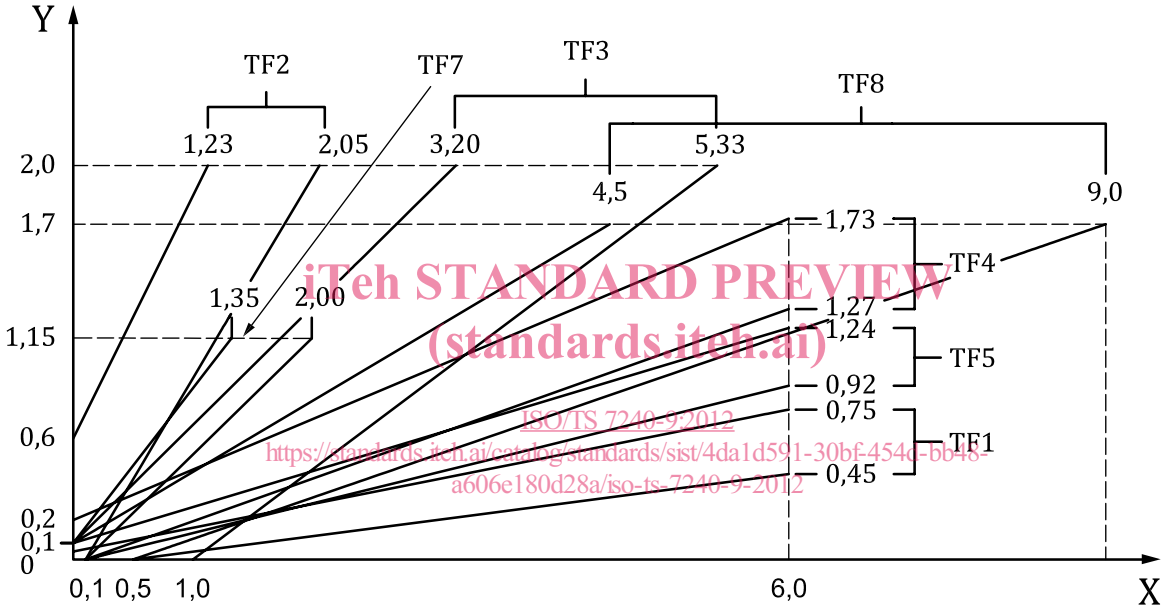
Introduction

This part of ISO 7240 is based on ISO/TR 7240-9:2006. It provides a summary of the standard test fires defined in other parts of ISO 7240 and where they are used. It has been published to provide a convenient catalogue of fire tests but the formal definition and description of each fire remains within the individual parts of ISO 7240.

The combustibles selected represent a spectrum of large (*m*) and small (*y*) combustion particles for both grey and black smoke. These include burning liquids, plastics and cellulosic (wood) materials, and glowing and smouldering fabrics.

Figure 1 shows the limits of *m* vs *y* where they are defined for the relevant test fires. It illustrates how the test fires are designed to represent a reasonable cross–section of fire types and thus ensure that the response characteristics of the detectors being assessed are broadly capable of detecting the majority of common fires that may occur in practise.



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Key

Y absorption index, m, dB/m

X MIC, y (dimensionless)

Figure 1 — Composite of ISO test fires TF1 to TF5, TF7 and TF8 profile curves: *m* versus *y*

The test fires in this part of ISO 7240 are intended to be applicable for the evaluation of all automatic fire detectors (smoke, heat, flame, etc.). They are employed on a selective basis for use in concert with a specified International Standard covering the particular type of detector. For example, test fire TF6, methylated spirits, is used to evaluate the response of heat detectors. Test fires TF1 through TF5 are selected to evaluate the response of system-connected smoke detectors. Test fire TF7 is selected in lieu of test fire TF2 to evaluate the response of smoke alarms intended primarily for installation in residential type occupancies. In view of the residential type application, smoke alarms are evaluated for compliance with test fire TF7 using a 3 m high rather than a 4 m high ceiling. Test fires TF2, TF3 and TF9 are suitable for testing the response of a detector to carbon monoxide. Carbon monoxide output curves are also shown for TF4, TF5 and TF8.

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Fire detection and alarm systems —

Part 9: Test fires for fire detectors

1 Scope

This Technical Specification describes methods of test using test fires to which fire detectors, such as smoke, heat, flame are subjected as specified in other parts of ISO 7240 for such detectors.

2 Normative references

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

ISO 7240-1, *Fire detection and alarm systems — Part 1: General and definitions*

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3 Terms, definitions and symbols

For the purposes of this document, the terms, definitions and symbols given in ISO 7240-1 and the following apply.

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3.1
sensitivity
relative degree of response of a smoke detector

Note 1 to entry: A high sensitivity denotes response to a lower concentration of smoke particles than a low sensitivity under identical smoke build-up conditions.

4 Characteristics of test fires — Description

Fifteen test fires are described in Clause 7 and designated TF1 through TF9. Their characteristic features are shown in Table 1.

The test fires shall be carried out in accordance with the descriptions of Clause 7. It is permissible to vary slightly the quantities of fuel used, if necessary, to produce the required values of fire parameters.

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Table 1 — Characteristics of test fires

Designation TF = Test fire	Type of fire	Development of heat	Up-current	Smoke	Aerosol spectrum	Visible portion	Carbon monoxide
TF1	Open cellulosic (wood)	Strong	Strong	Yes	Predominantly invisible	Dark	Very weak
TF2	Rapid smouldering pyrolysis (wood)	Weak	Weak	Yes	Predominantly visible	Light, high scattering	Yes
TF2a	Slow smouldering pyrolysis (wood)	Weak	Weak	Yes	Predominantly visible	Light, high scattering	Yes
TF2b	Smouldering pyrolysis (wood)	Weak	Weak	Yes	Predominantly visible	Light, high scattering	Yes
TF3	Glowing (fast smouldering) (cotton)	Weak	Very weak	Yes	Partially visible	Light, high scattering	Strong
TF3a	Glowing (slow smouldering) cotton	Weak	Very weak	Yes	Partially visible	Light, high scattering	Strong
TF3b	Glowing (smouldering) cotton	Weak	Very weak	Yes	Partially visible	Light, high scattering	Strong
TF4	Open plastics (polyurethane)	Strong	Strong	Yes	Partially invisible	Very dark	Weak
TF5	Liquid (*n*-heptane)	Strong	Strong	Yes	Predominantly invisible	Very dark	Weak
TF5a	Liquid (*n*-heptane) small	Strong	Strong	Yes	Predominantly invisible	Very dark	Weak
TF5b	Liquid (*n*-heptane) medium	Strong	Strong	Yes	Predominantly invisible	Very dark	Weak
TF6	Liquid (methylated spirit)	Strong	Strong	No	None	None	Very weak
TF7	Slow smouldering (pyrolysis) wood	Weak	Weak	Yes	Predominantly visible	Light, high scattering	Very weak
TF8	Low temperature black smoke (decalin) liquid	Weak	Weak	Yes	Predominantly visible	Dark	Very weak
TF9	Deep seated smouldering cotton	Weak	Weak	Yes	Predominantly visible	Light, high scattering	Yes

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5 Test laboratory

5.1 Dimensions

The dimensions of the test room shall be within the following limits:

— length: 10 m ± 1 m;

— width: 7 m ± 1 m;

— height: 4 m ± 0,2 m for all tests except TF7 which specifies a 3 m ± 0,2 m ceiling height. This can be achieved by placing the hotplate on a 1 m high platform.

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The ceiling and walls shall be flat with no obstructions between the fire source and the detectors and instrumentation. The fire source shall be centred as much as possible with respect to the four walls to minimize reflection of smoke and/or heat. Fire curtains may be employed to reduce the room size within specified limits, if needed.

5.2 Ambient test conditions

The following ambient conditions shall be established prior to conducting each test fire:

a) temperature: (15 to 35) °C. Recommend maximum 2 °C difference between ceiling and floor temperatures for smouldering tests TF2, TF3, TF3a, TF3b and TF7;

b) relative humidity: (25 to 75) %;

c) air pressure: (86 to 106) kPa;

d) air movement: negligible;

e) MIC reading: less than y = 0,05;

f) optical beam reading: less than m = 0,05 dB/m;

g) CO concentration: less than S = 5 µl/l

NOTE For improved consistency of test fires, the temperature can be controlled to (31 to 25) °C and the relative humidity can be controlled to (45 to 55) %.

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5.3 Instruments

The measuring instruments or their specification employed during the test fires are described under the following annexes:

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— optical measuring equipment (see Annex C);

— measuring ionization chamber (see Annex D);

— spark generator (see Annex E).

6 Test method

6.1 Arrangement

The location and arrangement of the detectors under test, smoke density, temperature and carbon monoxide level measuring instrumentation, and test fire location are illustrated in Figure 2.

For those tests that require ignition inside the test room, the personnel entrusted with the performance of the test shall leave the test room immediately after igniting the fuel, taking care to prevent air movement, which may affect the development of the test. All doors, windows, or other openings shall be kept closed during the test.

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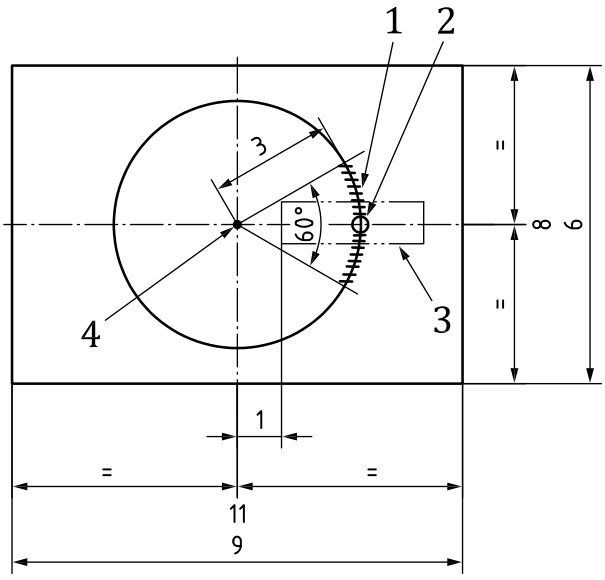
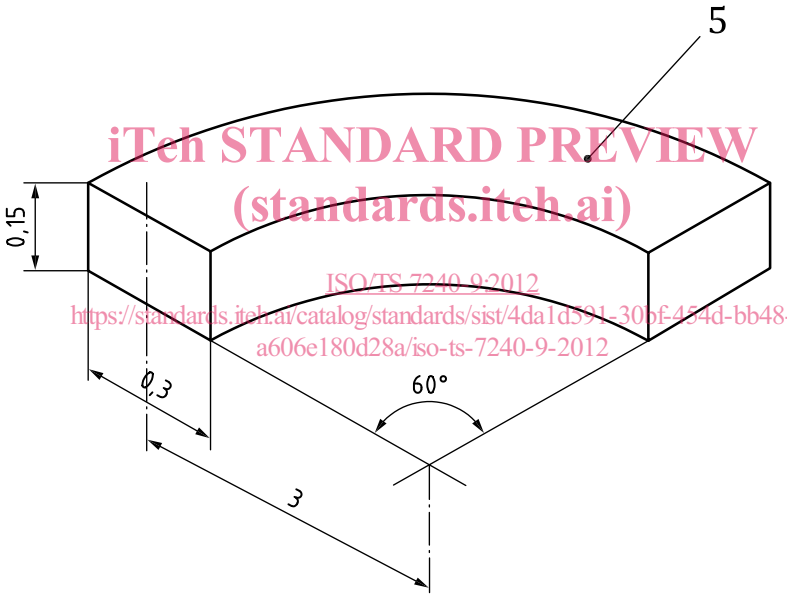


a) Plan view of fire test room



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b) Mounting position for instruments and specimens

Key

1 specimens and measuring instruments [see Figure 2(b)]
2 optimum position of sampling point for aspirating smoke detectors
3 ventilation system for aspirating smoke detectors [see Figure 3]
4 position of test fire
5 ceiling

Figure 2 — Location of detectors, fire and measuring instruments

6.2 Ventilation system

As a consequence of the low quantity of aerosols generated by reduced fire tests, it is necessary, for the reduced fire tests TF2a, TF2b, TF3a, TF3b, TF5a and TF5b, to introduce in the fire test room a ventilation system to increase the homogeneity of the atmosphere close to the sampling points. The following specifies those characteristics of the ventilation system which are of primary importance.

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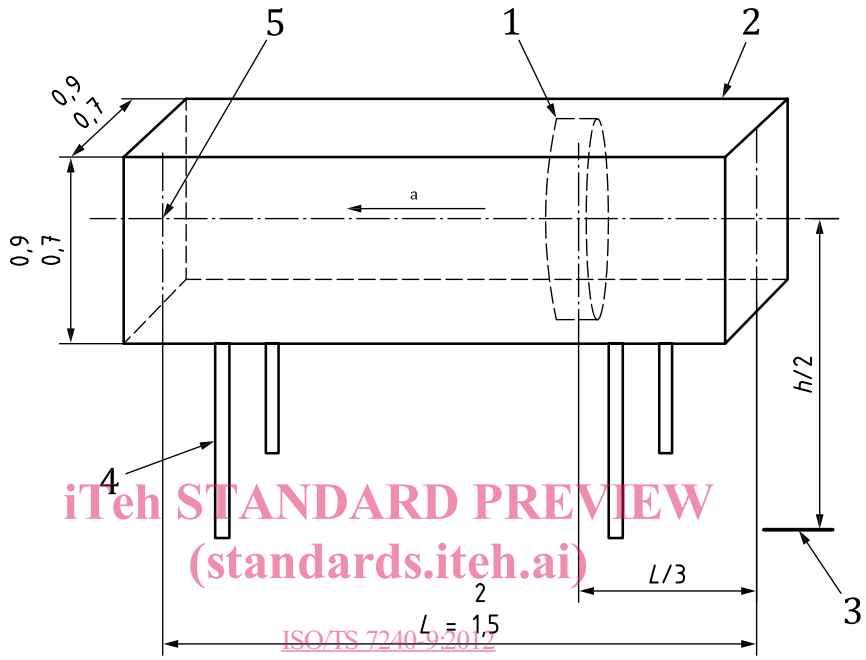
The ventilation system consists of a square duct opened in both extremities (see Figure 3).

A fan is located in the duct as described in Figure 3. The diameter of the fan shall be as close as possible to the dimensions of the sides of the square section of the duct. At the location of the fan, the section of the duct not occupied by the fan shall be closed. The axis of the fan shall be the same as the axis of the square duct.

The ventilation system shall create an airflow at (1,0 ± 0,2) m/s at the output of the duct (the airflow direction is given in Figure 3). Conformity with this requirement shall be regularly verified during the fire tests by measurements at the centre of the duct output section (see key item 5 in Figure 3).



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Key

1 fan
2 square duct
3 ground
4 stand
5 location of the flow velocity measurement
L length of the duct
h height of the fire test room [see Figure 2]
a Air flow.

Figure 3 — Ventilation system

6.3 Measurement parameters

During each test record the relevant test fire parameters listed in Table 2.

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Table 2 — Test fire parameters

Parameter	Symbol	Unit
Temperature	T	°C
Temperature change	ΔT	°C
Time	t	seconds (s) or minutes (min) as required
Smoke density (optical)	m	dB/m
Smoke density (ionization)	y	dimensionless
Carbon monoxide concentration	S	µl/l

See Annexes A and B for tables of m values and y values.

6.4 End-of-test parameters

The values of the fire parameters at the end of the test (T_E, m_E, y_E, t_E, S_E) together with the profile curves are used as the control of the validity and reproducibility of the test fires. The test shall be considered finished when the specific limits for each test specified in Clause 7 is reached. If a detector responds after the specified end of test fire parameters have been reached, the detector shall be considered as having failed the test.

7 Test fires

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7.1 General

This Clause contains a description of the 15 test fires, including type and amount of combustible material, illustration of 10 test setups, method of ignition, pre-conditioning of combustible material (if needed) and end-of-test parameters.

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To permit more flexibility in conducting the tests and interpreting the results, the following guidelines may be followed. This should also result in a higher success rate for a valid test.

a) Because of variation in smoke build-up that frequently occurs, the build-up curve occasionally may drift out of the limits for a short interval or near the end of the test. The test is to be considered valid if the detectors being evaluated respond during the time interval when the build-up is within the limits.

b) The following exceptions would apply to the guidelines in a):

If the build-up curve drifted to the left of the m vs y limit, the test could be considered valid if ionization type detectors actuated during that interval since they respond worse to large particles.

c) The fuels specified are the preferred test materials. Alternate fuels may be used as substitutes because of the availability of national natural resources. The alternate fuel source shall exhibit the same characteristics as the preferred fuels, i.e. colour of smoke and particle size distribution (within the profile).

d) Where the detector under test does not contain a carbon monoxide sensor, the profile curves for CO concentration need not apply to the test fire.

7.2 Test fire TF1 — Open cellulosic (wood) fire

7.2.1 Fuel

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

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7.2.2 Conditioning

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

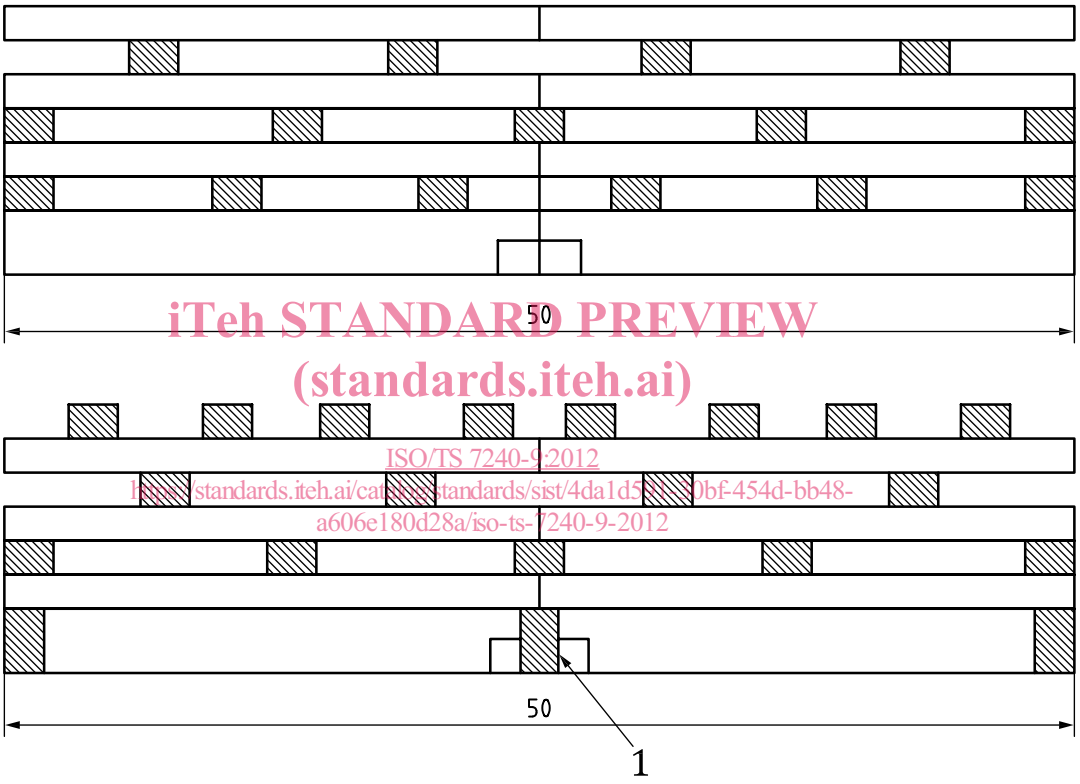
7.2.3 Preparation

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.

7.2.4 Arrangement

Superimpose seven layers on a base surface measuring approx. 50 cm wide × 50 cm long × 8 cm high; see Figure 4.

Dimensions in centimetres



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Key

1 container for methylated spirits

Figure 4 — Wood arrangement for test fire TF1

7.2.5 Ignition

0,5 cm^3 methylated spirits in a bowl 5 cm in diameter. Locate the bowl in the centre of base surface.

7.2.6 Method of ignition

Ignite by flame or spark in the methylated spirits.

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7.2.7 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 5 and 6, respectively. That is, 0,45 dB/m < m < 0,75 dB/m and 270 s < t < 370 s at the end-of-test condition y_E = 6,0.

For detectors using scattered or transmitted light, if the end of test condition, y_E = 6,0 is reached before all the specimens have responded, then the test is only considered valid if $m \geq 0{,}6$ dB/m.

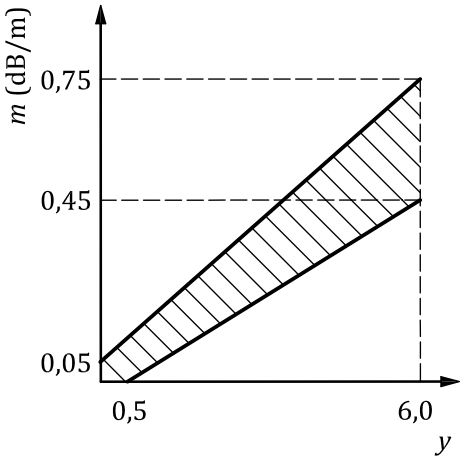

Figure 5 — Limits for m against y, Fire TF1

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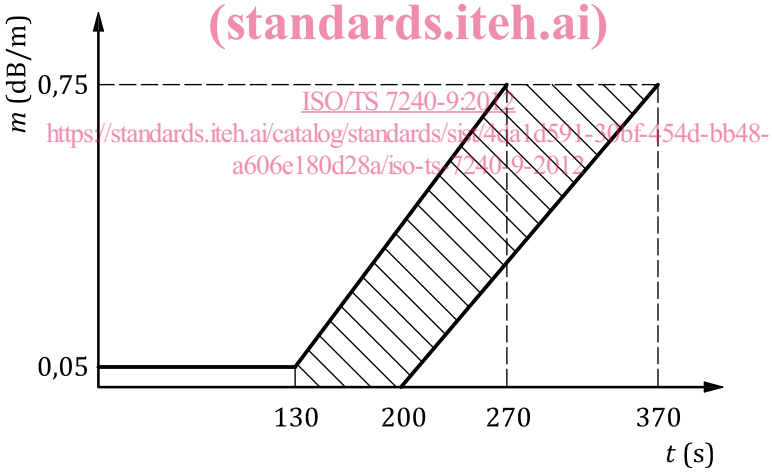

Figure 6 — Limits for m against time y, Fire TF1

7.2.8 Variables

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

7.2.9 End-of-test condition

The end-of-test condition shall be when

— y_E = 6;

— t_E > 370 s; or

— all the specimens have generated an alarm signal.

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7.3 Test fire TF2 — Rapid smouldering pyrolysis (wood) fire

7.3.1 Fuel

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

7.3.2 Conditioning

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

7.3.3 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.

7.3.4 Hotplate

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.

Measure the temperature of the hotplate by attaching a sensor to the fifth groove, counted from the edge of the hotplate, and securing the sensor to provide a good thermal contact.

7.3.5 Arrangement

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Arrange the sticks radially on the grooved hotplate surface, with the 20 mm side in contact with the surface such that the temperature sensor lies between the sticks and is not covered, as shown in Figure 7.

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