TECHNICAL SPECIFICATION

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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

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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;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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*.

ISO/TS 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 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 9: Test fires for fire detectors* [Technical Specification]

— *Part 10: Point-type flame detectors*

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— *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 19: Design, installation, commissioning and service of sound systems for emergency purposes*

— *Part 21: Routing equipment*

— *Part 22: Smoke detection equipment for ducts*

The following part is under preparation:

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

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Introduction

Many countries in different parts of the world have developed standards for the evaluation of fire detectors with the result that there are many variations in a smoke chamber, subjection to different environmental conditions, and variations in test fires.

Except for test fires TF7 and TF9, the working document from which this document evolved was EN 54-9[1], developed by Technical Committee TC 72, which had been adopted as a CEN (European Committee for Standarization) Standard in July 1982. This European Standard was withdrawn in December 2000.

Test fire TF7, *Slow smouldering (pyrolysis) wood test*, is based on development work[2] conducted in the United States. It represents the build up of combustion products in the home from the smouldering of a cigarette on a cotton mattress. This is the same test as presently appears in ANSI-UL217-1994[3], except the test parameters have been translated into the "m" and "y" parameter of this Technical Specification.

Test fire TF9, *Deep seated smouldering cotton fire*, is based on a test developed in the United Kingdom by the BFPSA and LPCB for carbon monoxide fire detectors.

The test fires included in this document are intended to represent a majority of test fires that can occur in the real world. While they are not the actual fires, they are typical of occurrence in practice. The combustibles selected represent the full spectrum of large (m) and small (y) combustion particles for both gray and black smoke. These include burning liquids, plastics and cellulosic (wood) materials, and glowing and smouldering fabrics. See Figure 1 for the acceptable test fire profiles.

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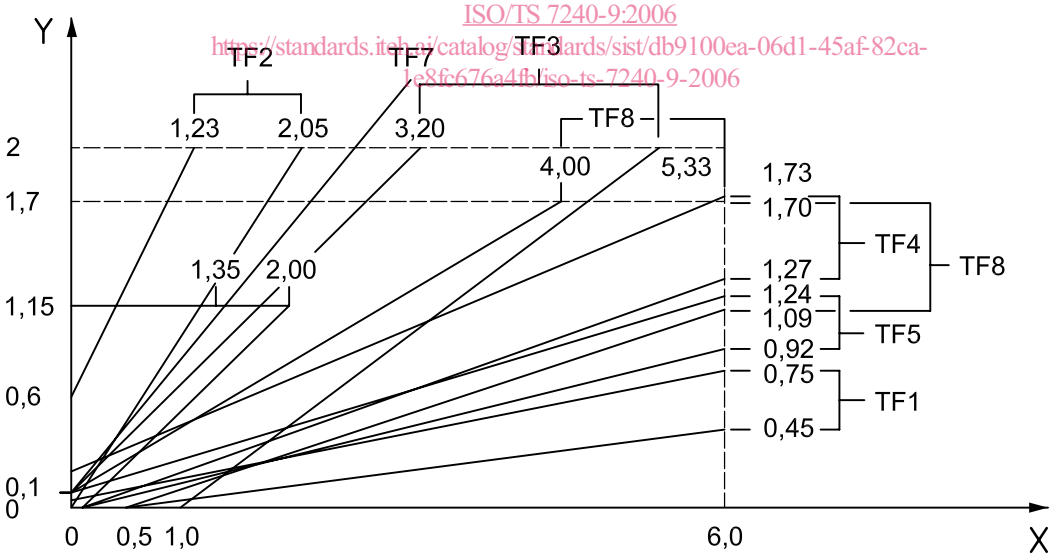

Key

Y absorption index, m, dB/m

X MIC, y (dimensionless)

Figure 1 — Composite of ISO test fires TF1 to TF8 profile curves: m versus y

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The fires included in this document represent a general test of fire detector performance. The response of the detectors subjected to test fires in this document can be evaluated in relation to three levels during a test fire. Such information is then helpful in permitting the designer of the fire alarm system to select the proper sensitivity for the anticipated application.

The test fires in this document 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 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 and flame are subjected as specified in other International Standards 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.

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

ISO/TS 7240-9:2006
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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.

3.1
sensitivity
relative degree of response of a smoke detector

NOTE 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

4.1 Description

Nine test fires are described in Clause 8 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 8. 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 fire (wood)	Strong	Strong	Yes	Predominantly invisible	Dark	—
TF2	Rapid smouldering pyrolysis fire (wood)	Can be neglected	Weak	Yes	Predominantly visible	Light, high scattering	Yes
TF3	Glowing smouldering fire (cotton)	Can be neglected	Very weak	Yes	Predominantly invisible	Light, high scattering	Strong
TF4	Open plastics fire (polyurethane)	Strong	Strong	Yes	Partially invisible	Very dark	Weak
TF5	Liquid fire (*n*-heptane)	Strong	Strong	Yes	Predominantly invisible	Very dark	Weak
TF6	Liquid fire (methylated spirits)	Strong	Strong	No	None	None	—
TF7	Slow smouldering (pyrolysis)	Can be neglected	Weak	Yes	Predominantly visible	Light high scattering	—
TF8	Low temperature black smoke	Can be neglected	Weak	Yes	Predominantly visible	Dark	Very weak
TF9	Slow smouldering	Weak	Weak	Yes	Predominantly visible	Light high scattering	Yes

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4.2 Measurement parameters

During each test the following parameters are to be recorded:

Parameter	Symbol	Unit
Temperature	T	°C
Temperature change	ΔT	°C
Time	t	seconds (s)
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.

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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.

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 are to prevail 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 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.

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5.3 Instruments

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

— 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, instrumentation and fire test 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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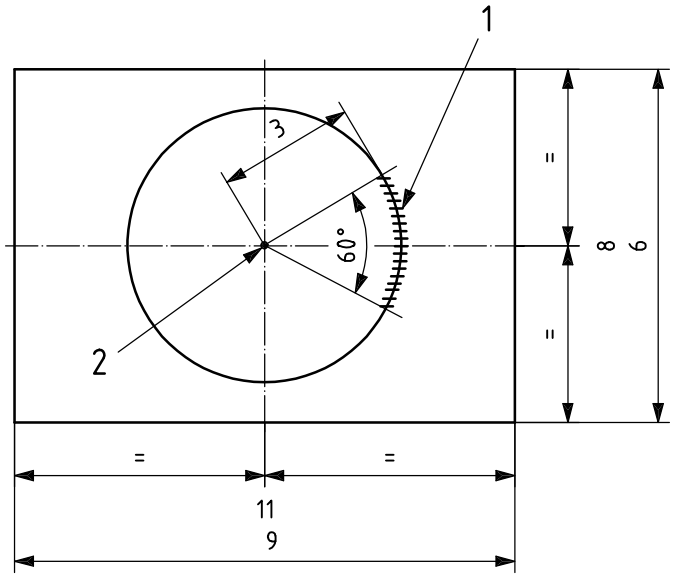
Dimensions in metres



Key

1 specimens and measuring instruments [see Figure 2 b)]

2 position of test fire

a) Plan view of fire test room

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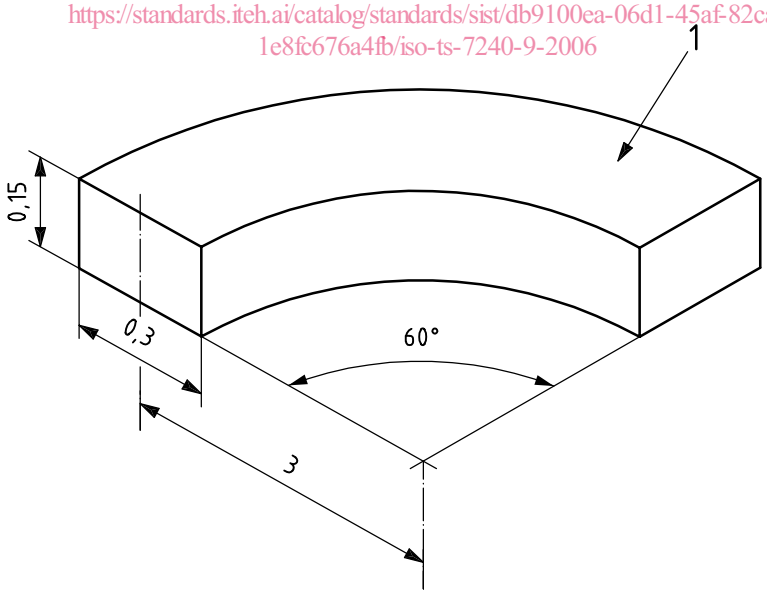
Dimensions in metres



Key

1 ceiling

b) Mounting positions for instruments and specimens

Figure 2 — Location of detectors, fire and measuring instruments

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6.2 Samples

The following samples and conditions shall be employed during each test fire, except as otherwise required in the product standard.

a) Four detectors of the same model, calibrated to the lowest sensitivity setting to be produced by the manufacturer shall be supplied.

b) Detectors shall be mounted in accordance with the manufacturer's instructions and be oriented so that the least favourable position (most difficult to detect) for smoke entry, response to heat or to flame, faces the fire source.

c) Detectors shall be energized from the maximum rated source of supply voltage and frequency. If a voltage range is specified, then the detectors are to be energized from the voltage least likely to obtain an alarm response.

d) Prior to each fire test, the detectors shall be energized in the quiescent (normal standby) condition for a least 15 min or as recommended by the manufacturer.

6.3 Profile curves

6.3.1 MIC versus beam

The MIC (y) versus infrared beam (m) curve build-up during the course of test fires TF1, TF2, TF3, TF4, TF5, TF7 and TF8 shall be within the limits of Figures 5, 8, 12, 15, 18, 23 and 25, respectively.

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6.3.2 Beam versus time

The optical density (m) versus time (t) build-up during the course of test fires TF1, TF2, TF3, TF4, TF5, TF7 and TF8 shall be within the limits of Figures 6, 9, 13, 16, 19, 24 and 26, respectively.

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6.3.3 Temperature versus time

The temperature (T) curve build-up during the course of test fire TF6 shall be within the limits of Figure 21.

6.3.4 Carbon monoxide versus beam

The carbon monoxide (S) curve build-up during the course of test fire TF9 shall be within the limits of Figure 29.

6.3.5 Carbon monoxide versus time

The carbon monoxide (S) curve build-up during the course of test fires TF2, TF3, TF4, TF5, TF8 and TF9 shall be within the limits of Figures 10, 14, 17, 20, 27 and 30, respectively.

6.4 Recording of data

During the test, the fire parameters T, m, y, t and S shall be measured and recorded. The alarm signal given at the control and indicating equipment shall be taken as the indication that a detector has responded. At the moment of the alarm signal from a detector, the response values, T_A, m_A, y_A, t_A, S_A shall be recorded. If the requirements set out in the relevant test are not fulfilled the fire test shall be repeated.

During the test, at least one of the parameter values at ΔT_3, m_3, y_3, or S_3 shall be exceeded (see Clause 7).

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6.5 Fire tests response

To make it easier to assess and classify the detectors according to their response behaviour, the relevant response values T_A, m_A, y_A, t_A, S_A are inserted in the appropriate location of Table 2.

Table 2 — Fire sensitivity table

Test fire	Detector number	T_A °C	m_A dB/m	y_A	t_A s	S_A µl/l	Remarks
TF1	1 2 3 4						
TF2	1 2 3 4						
TF3	1 2 3 4						
TF4	1 2 3 4						
TF5	1 2 3 4						
TF6	1 2 3 4						
TF7	1 2 3 4						
TF8	1 2 3 4						
TF9	1 2 3 4						

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6.6 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 included in Clause 8 are used as the control of the validity and reproducibility of the test fires. The test shall be considered finished when the maximum value 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 and this shall be recorded under “Remarks” in Table 2. The specific limits for each test are included in Clause 8.

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7 Fire sensitivity classification

The purpose of the fire sensitivity classification is to give the user an indication of the suitability of a detector type in a particular potential fire situation by providing a suitability table (see example in Table 3). This classification applies only to applications for which the test conditions can be regarded as representative.

The ranges of the fire parameters are divided into three sections, thus defining a total of nine limiting values.

$$\begin{array}{ccc} \Delta T_1 & \Delta T_2 & \Delta T_3 \\ y_1 & y_2 & y_3 \\ m_1 & m_2 & m_3 \end{array}$$

In a three-dimensional system of coordinates with the axes ΔT, m and y, these values define three rectangular boxes (see Figure 3). The response values T_A, m_A, y_A, also termed alarm coordinates, constitute points in this system.

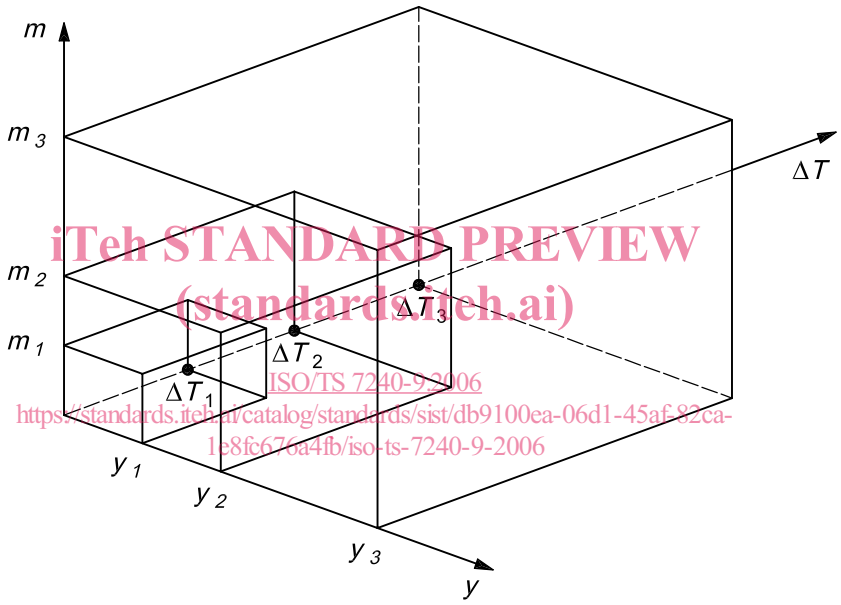

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Figure 3 — Coordinates of the rectangular boxes that define Classes A, B and C of the suitability table (see example in Table 3)

If the alarm points of all four detectors are within the smallest rectangular box, the detector for this type of fire shall be classified under Class A of the suitability table (see the example in Table 3), i.e., the following necessary conditions shall be fulfilled:

— $\Delta t_A \leqslant \Delta T_1$ and

— $m_A \leqslant m_1$ and

— $y_A \leqslant y_2$.

If the alarm points of all four detectors are inside the middle rectangular box, but not all inside the smallest one, the detector shall be classified under Class B of the suitability table (see example in Table 3) for this type of fire, i.e., the following necessary conditions shall be fulfilled:

— $\Delta T_A \leqslant T_2$ and

— $m_A \leqslant m_2$ and

— $y_A \leqslant y_2$.

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