
**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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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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 second edition cancels and replaces the first edition (ISO/TS 7240-9:2012), which has been technically revised.

The main changes are as follows:

- The content has been reworded to include reproductions of clauses from other Parts of the ISO 7240 series so that this document can be considered a catalogue of information.

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

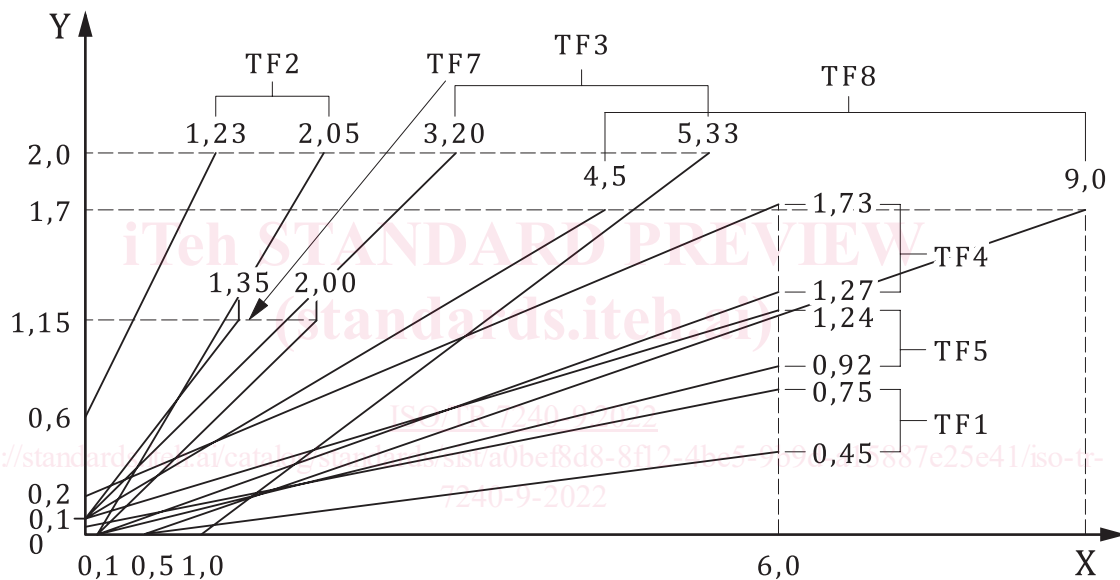
Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides a summary of the standard test fires defined in other Parts of the ISO 7240 series and where they are used. It has been published to provide a convenient catalogue of test fires. The formal definition and description of each test fire remains within the individual Parts of the ISO 7240 series. All text which has been reproduced from other Parts of the ISO 7240 series is written in italic font.

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. This figure illustrates how the test fires are designed to represent a reasonable cross-section of fire types and ensure that the response characteristics of the detectors being assessed are broadly capable of detecting the majority of common fires that can occur in practice.



Key

X measuring ionization chamber (MIC) reading, y (dimensionless)

NOTE y is the known function of the concentration of particulates in the smoke or aerosol.

Y absorbance index, m (dB/m)

TF1 to TF5, types of test fire which are explained in this document and which have been selected to illustrate a TF7 and TF8 spectrum of large and small combustion particles.

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

The test fires described in this document are intended to be applicable for the evaluation of all automatic fire detectors (smoke, heat, flame, etc.). TF7 has completed its original purpose, but has been maintained for reference now and in the future. The test fires described are or have been 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, has been used to evaluate the response of point-type heat detectors. Test fires TF1 through TF5 have been selected to evaluate the response of system-connected smoke detectors. Test fire TF7 has been selected in lieu of test fire TF2 to evaluate the response of smoke alarms intended primarily for installation in residential-type occupancies. 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.

Table 1 shows the test fires that are employed in product standards (indicated with a tick).

Note that the test fires are adjusted to meet the characteristics of each detector. Therefore, even if they have the same name, their end-of-test conditions and test validity criteria can differ depending on the applicable product standards. When test fires are applied, they use the conditions and criteria described in the latest relevant product standard.

Based on original test fires (TF1 to TF9), modified test fires have been developed to evaluate new principles of fire detectors such as TF2A and TF2B, etc. The new modified test fires are expected to be added to the series of test fires within a few years.

Table 1 — Test fires employed in product standards

| Product standards | TF1 | TF2 | TF2A | TF2B | TF3 | TF3A | TF3B | TF4 | TF5 | TF5A | TF5B | TF6 | TF7 | TF8 | TF9 |
|-------------------|-----|-----|------|------|-----|------|------|-----|-----|------|------|-----|-----|-----|-----|
| ISO 7240-5:2018 | | | | | | | | | | | | | | | |
| ISO 7240-6:2011 | | ✓ | | | ✓ | | | | | | | | | | ✓ |
| ISO 7240-7:2018 | | ✓ | | | ✓ | | | ✓ | ✓ | | | | | | |
| ISO 7240-8:2014 | | ✓ | | | ✓ | | | ✓ | ✓ | | | | | | |
| ISO 7240-10:2012 | | | | | | | | | ✓ | | | ✓ | | | |
| ISO 7240-12:2014 | | ✓ | | | ✓ | | | ✓ | ✓ | | | | | | |
| ISO 7240-15:2014 | ✓ | ✓ | | | ✓ | | | ✓ | ✓ | | | | | ✓ | |
| ISO 7240-20:2010 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ISO 7240-22:2017 | | ✓ | | | | | | ✓ | | | | | | | |
| ISO 7240-27:2018 | | ✓ | | | ✓ | | | ✓ | ✓ | | | | | ✓ | |
| ISO 12239:2010 | | ✓ | | | ✓ | | | ✓ | ✓ | | | | | | |

Fire detection and alarm systems —

Part 9: Test fires for fire detectors

1 Scope

This document provides a catalogue of test fires and is intended to enhance comprehensive understanding of fire detection test methods. It describes a series of test fires to which fire detectors, such as smoke, heat and flame detectors, are subjected, as specified in other Parts of the ISO 7240 series.

This document does not specify normative requirements regarding the test methods for the test fires.

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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.

3.2 Abbreviated terms

For the purposes of this document, the following abbreviations apply.

a.s.d. aspirating smoke detector

MIC measuring ionization chamber

TF test fire

4 Characteristics of test fires

[Clause 7](#) describes fifteen test fires which are designated TF1 through TF9. With the exception of TF7, all of these test fires are reproduced from product standards which can be found in other Parts of the ISO 7240 series. Their characteristic features are shown in [Table 2](#).

The test fires are carried out in accordance with the descriptions of [Clause 7](#). It is acceptable for the quantities of fuel used to be slightly varied, if necessary, to produce the required values of fire parameters.

Table 2 — Characteristics of test fires

| Designation TF = Test fire | Type of fire | Develop- ment of heat | Up-current | Smoke | Aerosol spectrum | Visible portion | Carbon monoxide |
|----------------------------------|--|-----------------------------|------------|-------|---------------------------------|---------------------------|--------------------|
| TF1 | Open cellulosic (wood) | Strong | Strong | Yes | Predomi- nantly invisible | Dark | Very weak |
| TF2 | Rapid smouldering pyrolysis (wood) | Weak | Weak | Yes | Predomi- nantly visible | Light, high scattering | Yes |
| TF2A | Slow smouldering pyrolysis (wood) | Weak | Weak | Yes | Predomi- nantly visible | Light, high scattering | Yes |
| TF2B | Smouldering pyrolysis (wood) | Weak | Weak | Yes | Predomi- nantly 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 (<i>n</i> -heptane) | Strong | Strong | Yes | Predomi- nantly invisible | Very dark | Weak |
| TF5A | Liquid (<i>n</i> -heptane) small | Strong | Strong | Yes | Predomi- nantly invisible | Very dark | Weak |
| TF5B | Liquid (<i>n</i> -heptane) medium | Strong | Strong | Yes | Predomi- nantly invisible | Very dark | Weak |
| TF6 | Liquid (methylated spirit) | Strong | Strong | No | None | None | Very weak |
| TF7 | Slow smouldering (pyrolysis) wood | Weak | Weak | Yes | Predomi- nantly visible | Light, high scattering | Very weak |
| TF8 | Low temperature black smoke (decalin) liquid | Weak | Weak | Yes | Predomi- nantly visible | Dark | Very weak |

Table 2 (continued)

| Designation TF = Test fire | Type of fire | Develop- ment of heat | Up-current | Smoke | Aerosol spectrum | Visible portion | Carbon monoxide |
|----------------------------------|-----------------------------------|-----------------------------|------------|-------|-------------------------------|---------------------------|--------------------|
| TF9 | Deep seated smouldering cotton | Weak | Weak | Yes | Predomi- nantly visible | Light, high scattering | Yes |

5 Test laboratory

5.1 General

The test fires are carried out in a standard fire test room.

The dimensions of the fire test room, locations of specimens being tested and measuring instruments are described in ISO 7240-7:2018, Annex F. For cataloguing purposes, these are reproduced in [subclause 5.2](#) of this document.

For aspirating smoke detectors, the relevant dimensions and locations are described in ISO 7240-20:2010, Annex I. For cataloguing purposes, these are reproduced in [subclause 5.3](#) of this document.

In addition to the details described in [5.2](#) and [5.3](#), the following points are also widely accepted as being required by manufacturers and test authorities for fire test rooms:

- The ceiling and walls are flat with no obstructions between the fire source and the detectors and instrumentation.
- The fire source is positioned as centrally as possible with respect to the four walls in order to minimize reflection of smoke and/or heat.
- It is permitted to employ fire curtains in order to reduce the room size within specified limits, if necessary.

5.2 Fire test room (for all detectors except aspirating smoke detectors)

NOTE The following text is reproduced for informational purposes from ISO 7240-7:2018, Annex F. The figure numbers have been adapted to ensure continuity of numbering within this document.

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

Length: 9 m to 11 m;

Width: 6 m to 8 m;

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

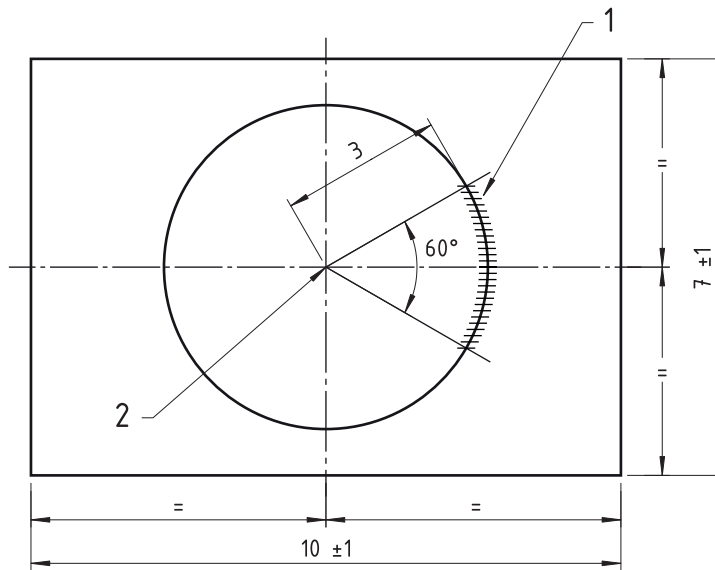
The fire test room shall be equipped with the following measuring instruments:

- *Measuring ionization chamber (MIC);*
- *Obscuration meter;*
- *Temperature probe.*

The specimens to be tested, the measuring ionization chamber (MIC), the temperature probe and the measuring part of the obscuration meter shall all be located as shown in [Figures 2](#) and [3](#).

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

Dimensions in metres



Key

- 1 specimens and measuring instruments (see Figure 3)
- 2 position of test fire

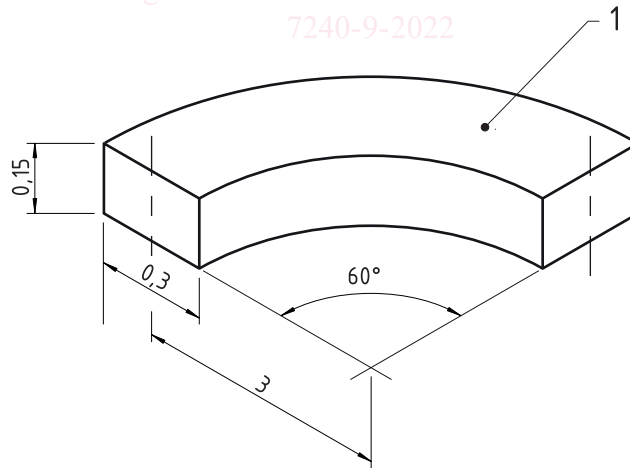
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Figure 2 — Plan view of fire test room and position of specimens and monitoring instruments

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<https://standards.iteh.ai/catalog/standards/sist/a0bef8d8-8f12-4be5-9b9d-a1587240-9-2022> Dimensions in metres

7240-9-2022



Key

- 1 ceiling

Figure 3 — Mounting position for instruments and specimens

5.3 Fire test room and ventilation system (for aspirating smoke detectors)

NOTE The following text is reproduced for informational purposes from ISO 7240-20:2010, Annex I. The figure numbers and cross references have been adapted to ensure continuity of numbering and cross-referencing within this document.

5.3.1 Fire test room

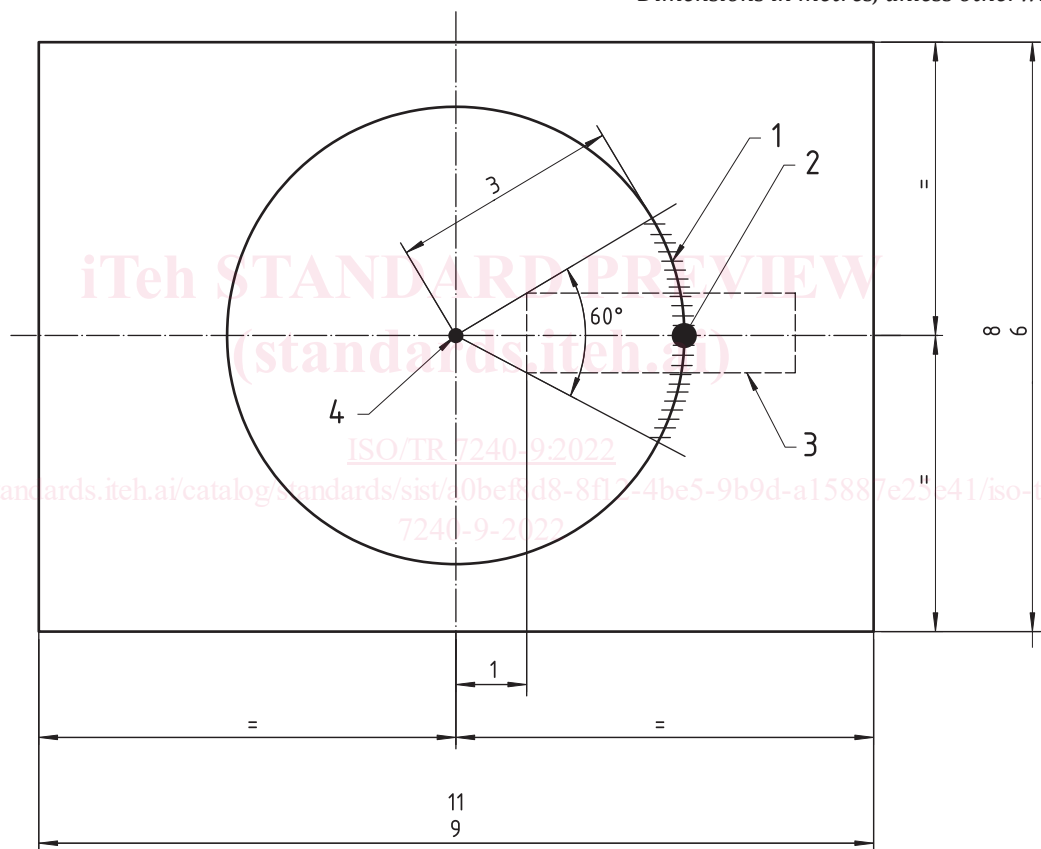
The sampling point, the MIC, the temperature probe and the measuring part of the obscuration meter shall all be located within the volume shown in [Figures 4](#) and [5](#).

The sampling point shall be located on the 3 m arc (see [Figure 4](#), key item 1). The optimum position is marked as key item 2.

The ventilation system shall be located in the position marked as key item 3 in [Figure 4](#). The direction of the airflow produced by this system shall be toward the test fire (located at the position marked as key item 4 in [Figure 4](#)). The description of the ventilation system is given in [5.3.2](#).

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

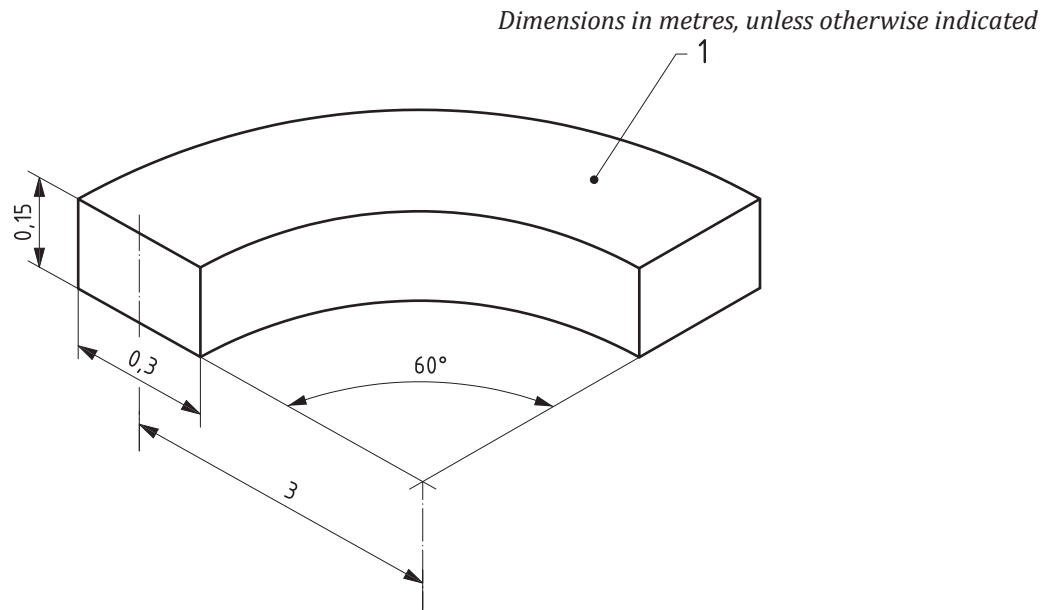
Dimensions in metres, unless otherwise indicated



Key

- | | | | |
|---|--|---|--|
| 1 | sampling point and measuring instruments (see Figure 5) | 3 | ventilation system (see Figure 6) |
| 2 | optimum position of the sampling point | 4 | position of test fire |

Figure 4 — Plan view of the fire test room



Key
 1 ceiling

Figure 5 — Mounting position for instruments and specimens

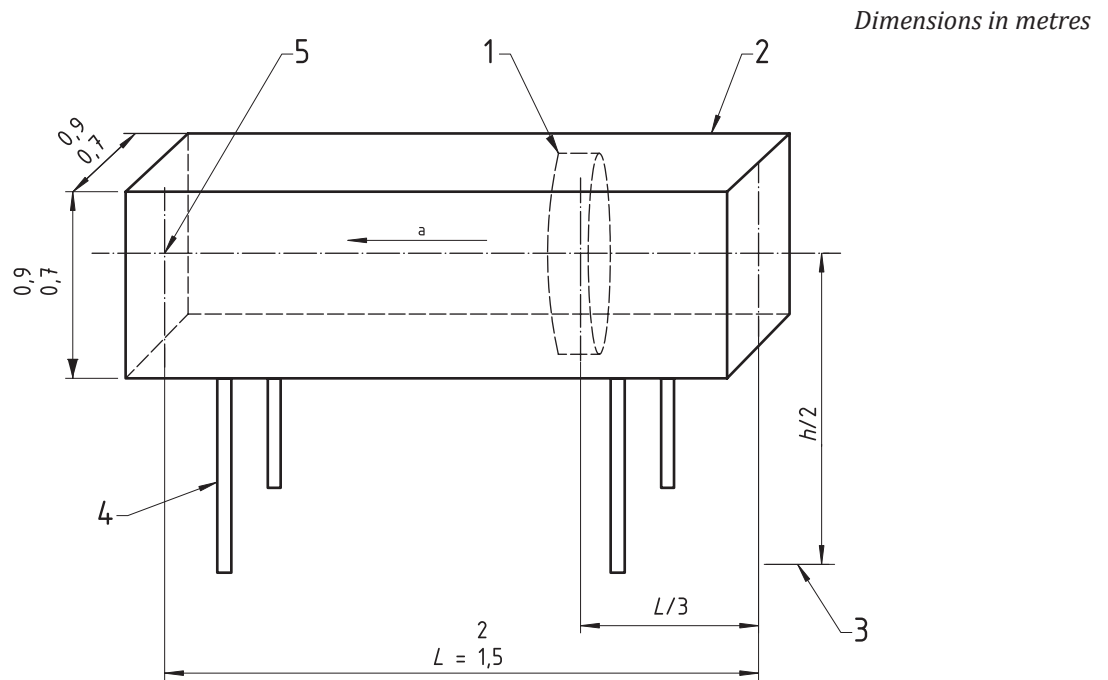
5.3.2 Ventilation system

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.

The ventilation system consists of a square duct opened in both extremities (see [Figure 6](#)).

A fan is located in the duct as described in [Figure 6](#). 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 $(1,0 \pm 0,2)$ m/s at the output of the duct (the airflow direction is given in [Figure 6](#)). 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 6](#)).

**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 (as described in ISO 7240-7:2018, 5.19.2.1)

a Air flow.

Figure 6 — Ventilation system**5.4 Ambient test condition**

The following ambient conditions are specified in the other Parts of the ISO 7240 series as indicated and applied prior to conducting each test fire:

- a) temperature: $(23 \pm 5) ^\circ\text{C}$ except ISO 7240-20, to which $(23 \begin{smallmatrix} +5 \\ -3 \end{smallmatrix}) ^\circ\text{C}$ is applied.

It is recommended to ensure less than $2 ^\circ\text{C}$ 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 or stable where the re-circulation fan is operational;
- e) MIC reading: $y \leq 0,05$ except ISO 7240-12, in which $y < 0,05$ is applied;
- f) optical beam reading: $m \leq 0,02$ dB/m except ISO 7240-12, in which $m < 0,02$ dB/m is applied;
- g) CO concentration: $S \leq 5 \mu\text{l/l}$ except ISO 7240-27, to which $S \leq 1,5 \mu\text{l/l}$ is applied.