
**Textile fabrics — Burning behaviour —
Measurement of flame spread properties
of vertically oriented specimens**

*Textiles — Comportement au feu — Détermination des propriétés de
propagation de flamme d'éprouvettes orientées verticalement*



Reference number
ISO 6941:2003(E)

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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.

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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.

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 6941 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 19, *Burning behaviour of textiles and textile products*.

This second edition cancels and replaces the first edition (ISO 6941:1984), which has been technically revised.

Introduction

This method is one of two closely related methods of test for the inflammability of textile fabrics. This method determines the “flame spread time” — vocabulary in relation to the term defined in ISO 4880 — the other method observes and measures “ease of ignition” (see ISO 6940).

This method assesses the properties of textile fabrics in response to flame contact under controlled conditions. Results may not apply to situations where there is restricted air supply or exposure to large sources of intense heat.

The influence of seams on the behaviour of fabrics can be determined by this method, the seam being positioned within the test specimen so as to be subjected to the test flame. Whenever practicable, trimmings should be tested as part of the fabric assembly on which they are or will be used.

Textile fabrics — Burning behaviour — Measurement of flame spread properties of vertically oriented specimens

1 Scope

This International Standard specifies a method for the measurement of flame spread times of vertically oriented textile fabrics and industrial products in the form of single or multi-component fabrics (coated, quilted, multilayered, sandwich combinations, and similar combinations) when subjected to a small, defined flame.

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 4880:1997, *Burning behaviour of textiles and textile products — Vocabulary*

ISO 6940, *Textile fabrics — Burning behaviour — Determination of ease of ignition of vertically oriented specimens*

3 Terms and definitions

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

3.1

flame application time

time for which the ignition flame is applied to the test specimen

3.2

flame spread time

time taken by a flame on a burning material to travel a specified distance under specified test conditions

4 Principle

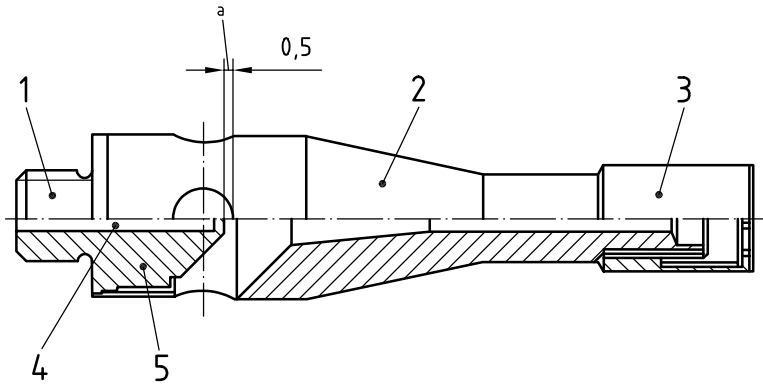
A defined flame from a specified burner is applied for 10 s to the surface or the bottom edge of textile specimens that are vertically oriented. The flame spread times in seconds for the flame front to travel between marker threads positioned adjacent to the surface of the test specimen and located at three distances from the igniting flame, are recorded.

5 Apparatus

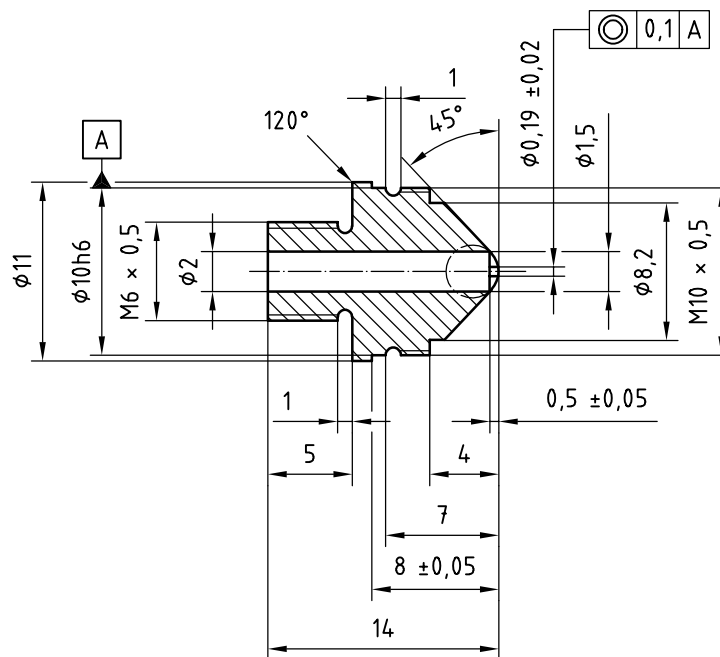
5.1 **Mounting frame**, constructed to a design capable of holding the gas burner (5.2), see Figure 1, and the test specimen holder (5.3), see Figure 2, in the specified relative orientation, see Figure 3.

The design shall also permit three marker threads (see 5.7) to be attached in the positions shown in Figure 2. At each location the marker thread is mounted as a loop so that the two segments are spaced 1 mm and 5 mm from the plane of the front of the specimen. Each loop is attached to a different timing device (5.6.2).

Dimensions in millimetres



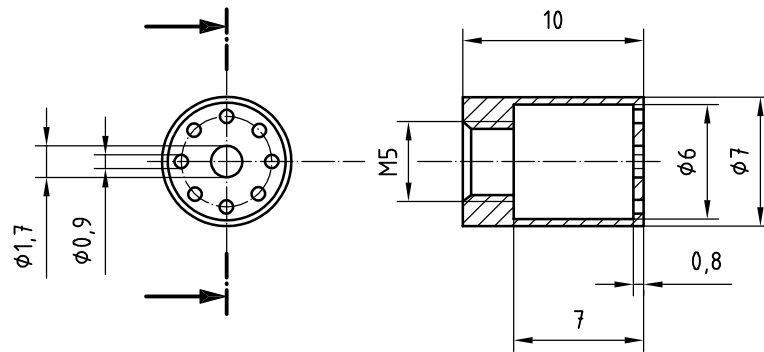
a) Gas burner arrangement



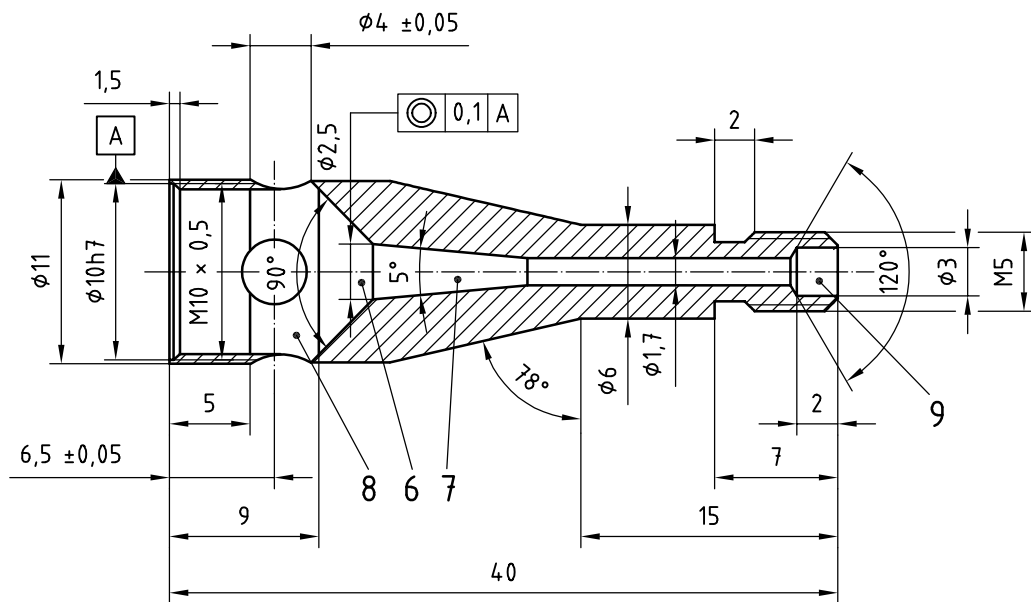
b) Gas jet

Figure 1 — Gas burner

Dimensions in millimetres



c) Flame stabilizer



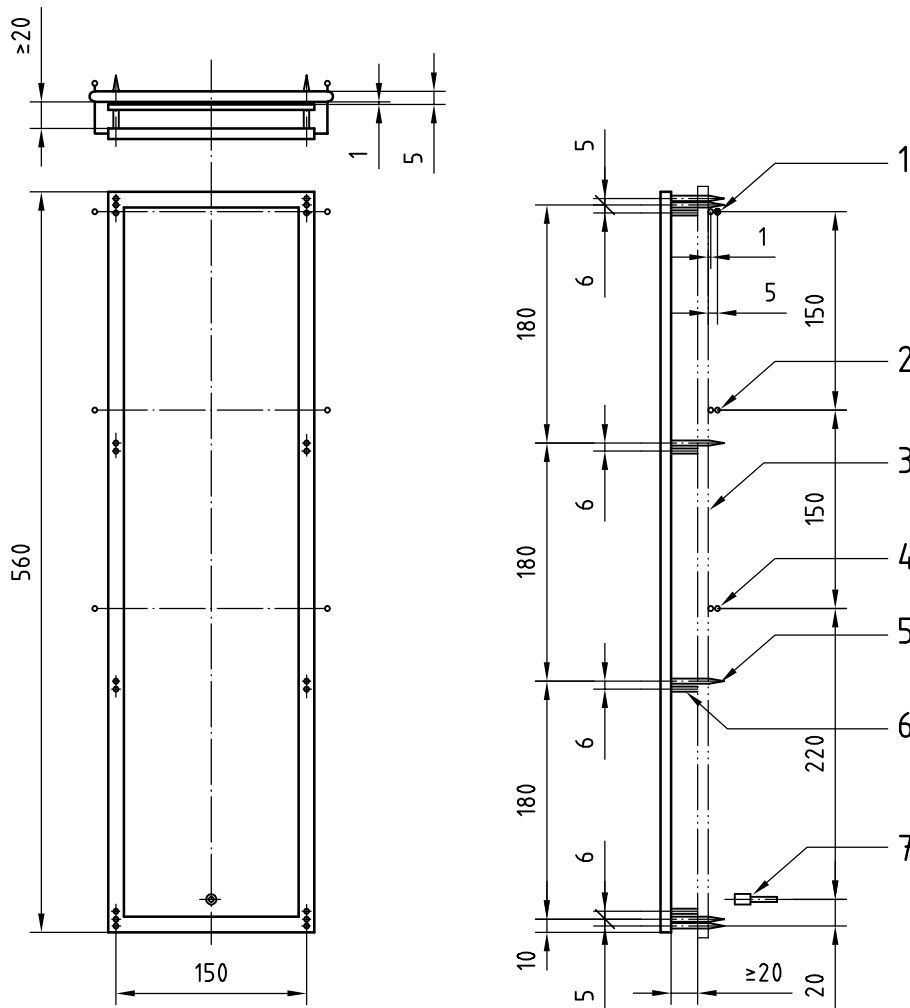
d) Burner tube

Key

- 1 gas jet
- 2 burner tube
- 3 flame stabilizer
- 4 choke tube
- 5 notch
- 6 gas mixing zone
- 7 diffusion zone
- 8 air chamber
- 9 outlet

a Fitted during assembly.

Figure 1 — Gas burner (continued)



Key

- 1 third marker thread
- 2 second marker thread
- 3 fabric specimen
- 4 first marker thread
- 5 mounting pins
- 6 spacer stubs (optional)
- 7 burner (oriented for surface ignition)

Figure 2 — Specimen holder

5.2 Gas burner, as shown in Figure 1 and described in Annex A, capable of being moved from a standby position, where the tip of the burner is at least 75 mm from the test specimen to either the horizontal or inclined operating position, see Figure 3.

5.3 Specimen holder, consisting of a rectangular metal frame having 12 specimen support pins mounted along the longer edge of the rectangle of length 560 mm by width 150 mm, see Figure 2. The pins for supporting the specimen are 5 mm, 10 mm, 190 mm, 370 mm, 550 mm and 555 mm above the bottom edge of the frame and have a minimum length of 26 mm.

NOTE Longer pins may be needed for mounting thick or multilayer specimens.

For the purpose of locating the specimen in a plane at least 20 mm away from the frame (see 9.1.1 and 9.2.1), a spacer stub of 2 mm diameter and a length of at least 20 mm shall be positioned adjacent to each of the pins, except for the upper and lower pins on each side.

5.4 Template, flat rigid, made of a suitable material and of a size corresponding to the size of the specimen (560 mm × 170 mm) shall be used. Twelve holes, approximately 4 mm in diameter, are drilled along the edges of the template and positioned so that the distances between the centres of the holes correspond to the distance between the pins on the specimen holder (see Figure 2). The holes should be located equidistant about the vertical centreline of the template.

5.5 Gas, commercial grade propane or butane or butane/propane mixtures.

NOTE Commercial grade propane is preferred but other gases may be used.

5.6 Timing device

5.6.1 A timing device to control and measure the flame application time and which can be set at 1 s and adjusted at 1 s intervals with an accuracy of 0,2 s or better.

5.6.2 Three timing devices reading to 0,2 s or better are required to measure the flame spread times. These devices are started simultaneously when the igniting flame is applied and are stopped automatically when the individual marker threads are severed.

5.7 Marker threads, white mercerized cotton thread having a linear density of 45 tex to 50 tex.

6 Precautions

6.1 Construction of testing equipment.

Some products of combustion are corrosive. The equipment shall be constructed of material that will not be adversely affected by the fumes.

6.2 Location of test apparatus

The volume of air surrounding the test location shall be such that the test is not affected by any reduction of oxygen concentration. Where an open fronted cabinet is used for the test, provision shall be made to permit the specimen to be mounted at least 300 mm from any wall.

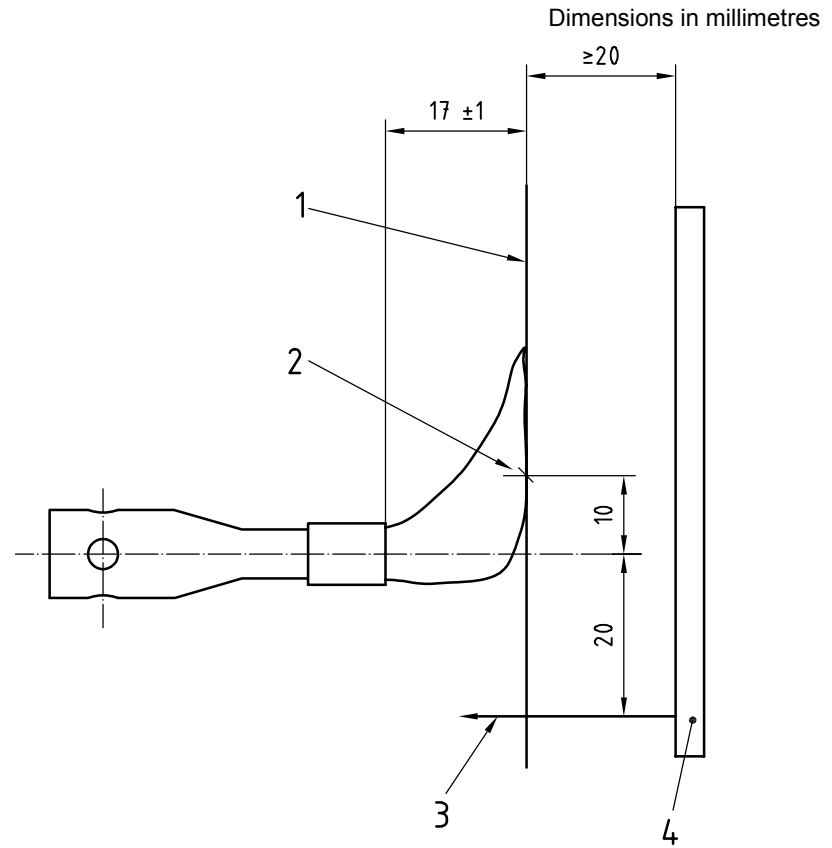
6.3 Health and safety of operators

Burning of materials may produce smoke and toxic gases that can affect the health of operators. Between tests, the atmosphere of the testing location, which shall be of adequate dimensions to avoid endangering the health of operators, shall be cleared of smoke and fumes by an extractor fan or other means of ventilation (see 6.2).

NOTE Smoke and fume emission may be subject to national regulations concerning atmospheric pollution control.

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a) Surface ignition



b) Bottom edge ignition

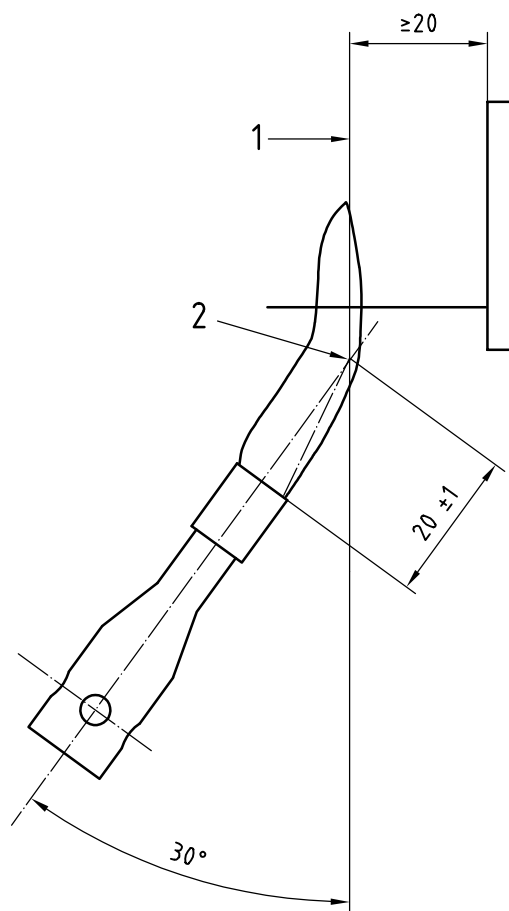
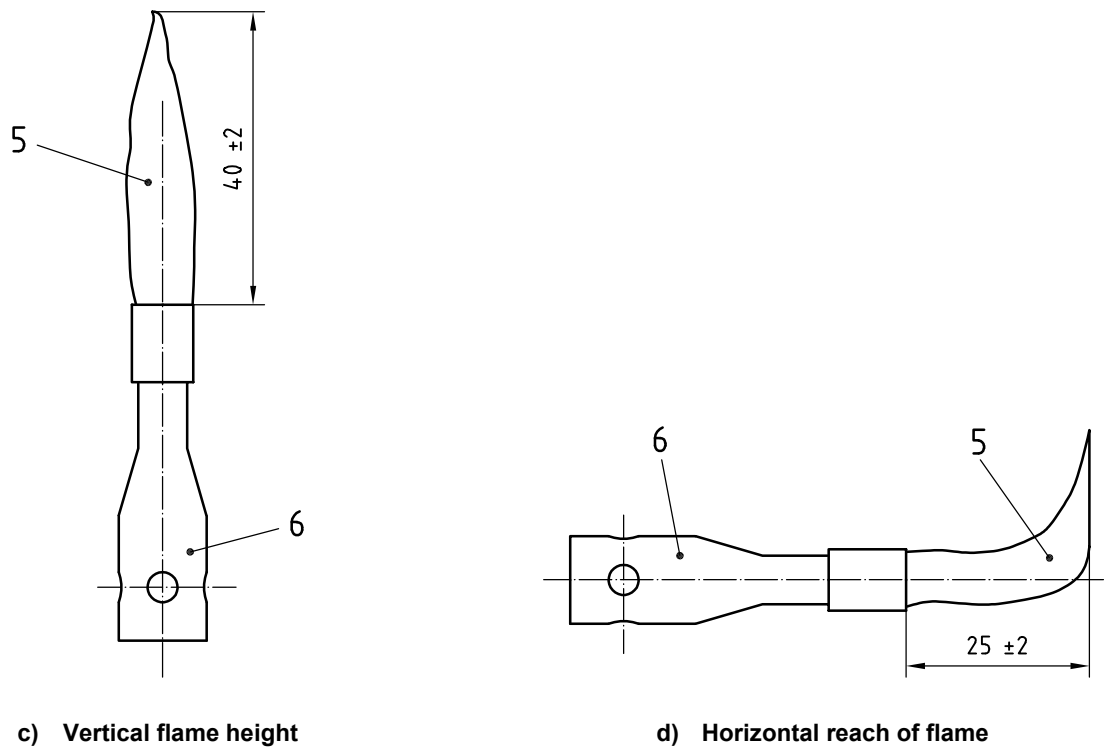


Figure 3 — Flame position and adjustment

Dimensions in millimetres

**Key**

- 1 fabric specimen
- 2 nominal flame ignition point
- 3 pin
- 4 mounting frame
- 5 flame
- 6 burner

Figure 3 — Flame position and adjustment (*continued*)**7 Sampling****7.1 Number of specimens**

Mark out a set of six test specimens, three with the longer dimension in the length direction and three with the longer dimension in the width direction, using the template (5.4).

For surface ignition, where the two surfaces of the sample are visually dissimilar and preliminary testing indicates dissimilar inflammability characteristics, each surface shall be tested by the use of a set of six specimens.

NOTE An extra test specimen is required for the setting up procedure (9.1 and 9.2).

7.2 Specimen holder pin location marks

Mark the position through which the pins on the specimen holder must pass by means of the holes in the template (5.4).

NOTE Where the fabric is of open construction (e.g., scrim, gauze), small pieces of adhesive tape may be affixed to the fabric at the pin sites and the position marked on the tape. Fabrics that sag should be straightened without stretching unduly.

7.3 Test specimen size

Cut out specimens (560 × 170) mm ± 2 mm.

8 Conditioning and testing atmosphere

8.1 Conditioning

Unless otherwise specified, test specimens shall be conditioned in an atmosphere having a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) % for at least 24 h. If testing is not carried out immediately after conditioning, place the conditioned test specimens in a sealed container. Testing of each specimen shall begin within 2 min of removing it from either the conditioning atmosphere or the sealed container.

NOTE Care should be taken to avoid injury when mounting the specimens on the pins in the time specified. If necessary, the specimen may be mounted on the specimen holder (5.3) before removal from the conditioning atmosphere.

8.2 Testing atmosphere

The tests shall be performed in an atmosphere having a temperature between 10 °C and 30 °C, a relative humidity of between 35 % and 65 %, and air movement less than 0,2 m/s at the commencement of the test of each specimen. Air movement shall not be influenced by mechanical devices operating during the test.

NOTE Draught shields may be required to maintain stability of the test flame.

9 Setting up the apparatus

9.1 Procedures A (surface ignition)

9.1.1 Mounting of the test specimen

Place the test specimen (see 7.1, Note) on the pins of the test specimen holder, making certain that the pins pass through the points marked off from the template and that the back of the specimen is at least 20 mm away from the rectangular metal frame of the test specimen holder. Fit the test specimen holder to the mounting frame with the specimen vertical.

9.1.2 Operating position of the burner

Position the burner perpendicular to the surface of the test specimen such that the axis of the burner stabilizer is 20 mm above the line of the lower pins and is aligned with the vertical centreline of the face of the test specimen. Ensure that the tip of the burner is (17 ± 1) mm from the surface of the test specimen [see Figure 3 a)].

9.1.3 Flame adjustment — horizontal reach

Set the burner in the vertical standby position (see 5.2). Light the burner and preheat it for at least 2 min. Move the burner into the horizontal standby position and adjust the horizontal reach of the flame to (25 ± 2) mm measured as the distance from the tip of the burner stabilizer to the extreme end of the yellow part of the flame when viewed against a dark background [(see Figure 3 d)].

The flame reach shall be checked before testing each set of six specimens.

NOTE If the apparatus does not have a horizontal standby position it will be necessary to remove the test specimen before carrying out the flame adjustment.

9.1.4 Flame position

Move the burner from the standby position to the horizontal operating position (see 9.1.2). Confirm that the flame impinges on the test specimen in the correct location [see Figure 3 a)].

9.2 Procedure B (bottom edge ignition)

9.2.1 Mounting of the test specimen

Place the test specimen (see 7.1, Note) on the pins of the test specimen holder, making certain that the pins pass through the points marked off from the template and that the back of the specimen is at least 20 mm away from the rectangular metal frame of the test specimen holder. Fit the test specimen holder to the mounting frame with the specimen vertical.

9.2.2 Operating position of the burner

Position the burner in front of, but below, the test specimen such that it lies in a plane through the vertical centreline of the test specimen and perpendicular to its surface with the longitudinal axis inclined upwards at 30° to the vertical bottom edge of the test specimen. Ensure that the distance between the tip of the burner stabilizer and the bottom edge of the test specimen is (20 ± 1) mm measured as shown in Figure 3 b).

NOTE It may not be possible to obtain consistent results with fabrics that exhibit drape or sag. Surface ignition may be more appropriate for such fabrics.

9.2.3 Flame adjustment — vertical flame height

Set the burner in the vertical standby position (see 5.2). Light the burner and preheat it for at least 2 min. Adjust the flame height to (40 ± 2) mm, measured as the distance from the tip of the burner stabilizer to the extreme end of the yellow part of the flame when viewed against a dark background [see Figure 3 c)].

The flame height shall be checked before testing each set of six specimens.

9.2.4 Flame position

Move the burner from the standby position to the inclined operating position (see 9.2.2). Check that the bottom edge of the test specimen bisects the flame [see Figure 3 b)].

10 Test procedure

10.1 Surface ignition

10.1.1 Set up the apparatus as described in 9.1.

10.1.2 Position the first of a set of six fresh test specimens on the specimen holder (see 9.1.1). Attach the marker threads at the locations shown in Figure 2 (see 5.1), imposing sufficient tension to the thread to maintain its position relative to the specimen. Record whether the length or width direction is vertical and which surface of the test specimen is exposed towards the test flame.

10.1.3 Apply the test flame for 10 s or the ignition time determined as the critical ignition time in ISO 6940 testing and observe and record:

- a) the time in seconds from the start of the application of the test flame until the severance of the lower (first) marker thread;
- b) the time in seconds from the start of the application of the test flame until the severance of the middle (second) marker thread;

- c) the time in seconds from the start of the application of the test flame until the severance of the upper (third) marker thread;

10.1.4 Repeat 10.1.2 and 10.1.3 on the remaining five test specimens, with the same surface of all specimens exposed towards the flame.

10.2 Bottom edge ignition

10.2.1 Set up the apparatus as described in 9.2.

10.2.2 Position the first of a set of six fresh test specimens on the specimen holder (see 9.2.1). Attach the marker threads at the locations shown in Figure 2 (see 5.1), imposing sufficient tension to the thread to maintain its position relative to the specimen. Record whether the length or width direction is vertical and which surface of the test specimen is exposed towards the test flame.

10.2.3 Apply the test flame for 10 s or the ignition time determined as the critical ignition time in ISO 6940 testing and observe and record behaviour as listed in 10.1.3.

10.2.4 Repeat 10.2.2 and 10.2.3 on the remaining five test specimens, with the same surface of all specimens exposed towards the flame.

11 Precision

This method is used to compare the flame spread times of different inflammable materials. The precision of the method is highly dependent on the type of material to be tested.

Flame spread rates are not constant. There is no flame spread during the minimum ignition time of the specimen. After ignition there is a period of increasing intensity and acceleration of the flame. If the flame spreads to the full width of the specimen the flame spread rate becomes fairly constant. With certain thermoplastic materials the flame front may fall away so that flame spread slows down or even stops.

Calculated flame spread rates are therefore not very reproducible and the time to severance of the upper trip thread is recommended as the basis for comparison. In an inter-laboratory trial carried out by eleven laboratories in 1993, materials of normal apparel weight gave times to sever the upper trip thread of about 20 s to 24 s. Very lightweight material gave results of about half these values. The repeatability for this measurement on five woven fabrics tested was from 3 s to 4 s.

Repeatability was much worse on a knitted fabric tested. Knitted fabrics tend to sag when mounted on the specimen holder, making it difficult to control the distance from the burner to the specimen. If sagging problems are encountered they should be reported. The specimen mounting technique may have to be modified and slight tension applied to knitted specimens to hold them flat.

Materials that shrink on the application of a flame can also give repeatability problems that are affected by the method of mounting. In this case the specimens shall not be tightly mounted as this can result in shrinkage away from the igniting flame and failure to ignite.

12 Test report

The test report shall include the following information.

- a) a statement that the test was carried out in accordance with this International Standard and details of any deviation from it;
- b) gas used;
- c) date of test;

- d) ambient conditions of temperature and relative humidity in the area in which the test is carried out;
- e) technique used to attach fabrics which cannot be supported on pins (see note to 7.2);
- f) identification of fabric tested including details of any pre-treatment, e.g. a cleansing procedure;
- g) which surface was exposed towards the flame and whether surface or bottom ignition was used;
- h) the ignition time used in testing;
- i) for each test specimen the information itemized in 10.1.3 a) to c).

Annex A (normative)

Description and construction of the burner

A.1 Description

The burner provides a flame of suitable dimensions, the length of which can be adjusted from 10 mm to 60 mm.

A.2 Construction

The construction of the burner is shown in Figure 1. The burner consists of three parts:

a) Gas jet

The orifice diameter of the gas jet [see Figure 1 b)] shall be $(0,19 \pm 0,02)$ mm. The orifice shall be drilled and after drilling, all burrs shall be removed from both ends of the drilled hole without rounding the corners.

b) Burner tube

The burner tube [see Figure 1 d)] consists of four zones:

- 1) air chamber;
- 2) gas mixing zone;
- 3) diffusion zone;
- 4) gas outlet.

Within the air chamber, the burner tube has four air holes each 4mm diameter for air inlet. The forward edge of the air holes is approximately level with the tip of the jet.

The diffusion zone is a conical shape and has the dimensions indicated in Figure 1 d). The burner has a bore of 1,7 mm inside diameter and outlet of 3,0 mm inside diameter.

c) Flame stabilizer

The flame stabilizer is as detailed in Figure 1 c). Details of the availability of the specified burner may be obtained from the Secretariat of ISO/TC38/SC19.

Annex B (informative)

Experimental techniques

The quality of experimental technique required will depend to a significant extent on the design of the equipment used; e.g., the less any automatic the equipment used, the greater will be the need for a skilled operator in order to obtain high precision.

Some practical points of a general nature are as follows.

- a) For reason of safety, the test equipment should be remote from the gas cylinder, which could be located outside the building. In this case, a manually operated shut-off valve should be installed inside the room housing the apparatus where the piping enters. On each occasion the equipment is used, time should be allowed for pure gas to reach the burner jet and provide a steady flame.
- b) The equipment should be installed and used so that it is not possible for smouldering particles, which may be carried away by the hot gases or may fall from the specimen, to come to rest on combustible materials. Protective clothing, fire extinguishers and alarm signals should be available to the operator.
- c) It is important to keep the apparatus clean to maintain safety.
- d) Some unfinished fabrics, such as single knit jersey knitted fabrics, are liable to curl. This tendency may be reduced by subsequent processing. It is desirable to test this type of fabric in its finished state.
- e) Residual material adhering to the pins after testing may be removed by scraping with a wire brush. Any smouldering material should be extinguished before placing it with other waste in a non-combustible container.
- f) Preliminary tests should be undertaken to establish if one surface of the fabric under examination is likely to produce different inflammability behaviour from the other. If they are different, both surfaces should be tested.

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