
**Protective clothing — Protection against
heat and flame — Method of test for limited
flame spread**

*Vêtements de protection — Protection contre la chaleur et les flammes —
Méthode d'essai pour la propagation de flamme limitée*



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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15025 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

Annexes A and C form a normative part of ISO 15025. Annex B is for information only.

Introduction

This International Standard was initially prepared by Technical Committee ISO/TC38/SC19 as part of the revision of ISO 6940 and ISO 6941. This specific work item was transferred to Technical Committee ISO/TC 94/SC 13 in April 1997.

This method of test is closely related to the method of test specified in ISO 6941. It uses the same basic equipment but a smaller specimen holder and template. Materials which do not burn to the upper or vertical edges of the smaller test specimen used in this test may be classified as producing limited flame spread.

This method assesses the properties of textile fabrics in response to a short contact with a small igniting flame 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.

A list of standards related to ISO 15025 is given in the Bibliography.

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Protective clothing — Protection against heat and flame — Method of test for limited flame spread

1 Scope

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

This test method is not appropriate for materials that demonstrate extensive melting or shrinkage.

2 Terms and definitions

For the purposes of this International Standard the following terms and definitions apply.

2.1

flame application time

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

2.2

afterflame time

duration of flame

length of time for which a material continues to flame, under the specified test conditions, after the ignition source has been removed

NOTE Afterflame time is measured to the nearest second and afterflame times of less than 1,0 s should be recorded as zero.

2.3

afterglow

persistence of glowing combustion of a material under specified test conditions, after cessation of flaming or, if no flaming occurs, after removal of the ignition source

NOTE Afterglow is a continuation of combustion with the evolution of heat and light but without flame. Some materials absorb heat during the flame application and continue to emit this absorbed heat after removal of the igniting flame. This glowing without combustion should not be recorded as afterglow.

2.4

afterglow time

duration of afterglow

time for which a material continues to afterglow, under specified test conditions after cessation of flaming or after removal of the ignition source

NOTE Afterglow time is measured to the nearest second and afterglow times of less than 1,0 s should be recorded as zero.

2.5

char

formation of a brittle residue when material is exposed to thermal energy

2.6

debris

material separating from the specimen during the test procedure and falling from the specimen without flaming

2.7

flaming debris

material separating from the specimen during the test procedure and igniting the filter paper

2.8

hole

〈surface ignition of procedure A〉 break in the test specimen of at least 5 mm in any dimension and having a continuous perimeter caused by melting, glowing or flaming

NOTE 1 If the hole is crossed by any material it is described as discontinuous.

NOTE 2 This International Standard describes the reporting of holes in any separable layer of a multilayer specimen obtained during surface ignition testing [see 8.2.1.3 g) and 10 i)].

3 Principle

A defined flame from a specified burner is applied for 10 s to the surface or the bottom edge of textile specimens which are vertically oriented.

Information is recorded on the spread of flame and afterglow, and on the formation of debris, flaming debris, or a hole. Afterflame time and afterglow time are recorded.

NOTE 1 Surface exposure tests may be performed on both sides of multilayer fabric assemblies.

NOTE 2 The bottom-edge ignition test may not offer acceptable reproducibility for testing some materials.

4 Health and safety of test operators

Burning of materials may produce smoke and toxic gases which can affect the health of operators. Between tests, the atmosphere of the test location, which should be of adequate dimensions to avoid endangering the health of operators, should be cleared of smoke and fumes by an extractor fan or other means of ventilation (see 6.1).

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

5 Reagents

5.1 Gas, of commercial grade, either propane or butane or butane/propane mixtures.

NOTE Commercial grade propane is preferred but other gases may be used and this fact recorded in the test report (see item b) in clause 10.

6 Apparatus

6.1 Test apparatus — General requirements

— Construction: consisting of material which shall not be adversely affected by the fumes and that is resistant to heat and flame.

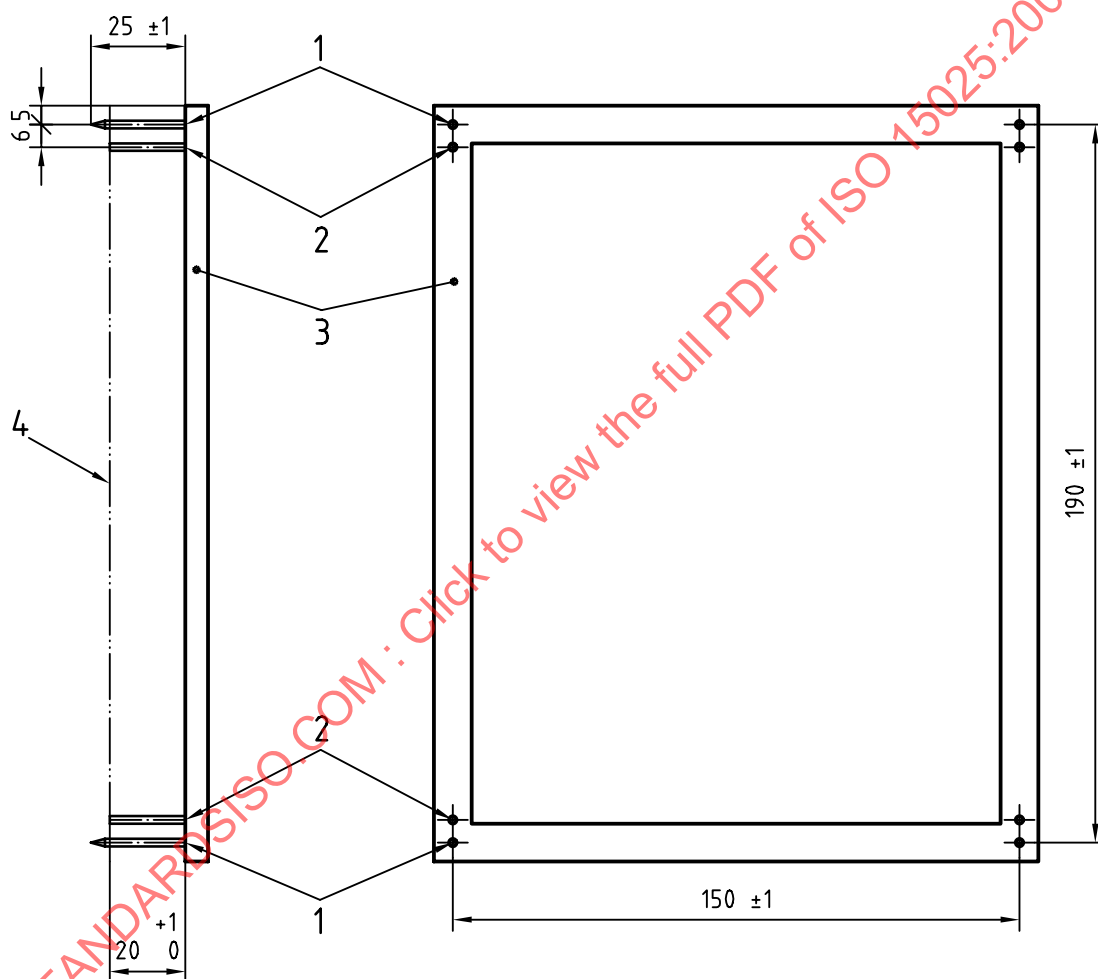
NOTE Some products of combustion are corrosive.

- Location: surrounded by a volume of air sufficient not to be 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.

6.2 Mounting frame, constructed to a design capable of holding the test specimen holder (see 6.4 and Figure 1) and the gas burner (see 6.3 and Figure 2) in the specified relative orientation (see Figure 3).

6.3 Gas burner, as described in annex A (see Figure 2), 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 a) and 3 b) respectively].

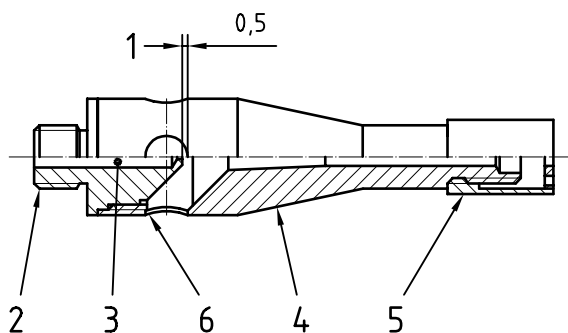
Dimensions in millimetres



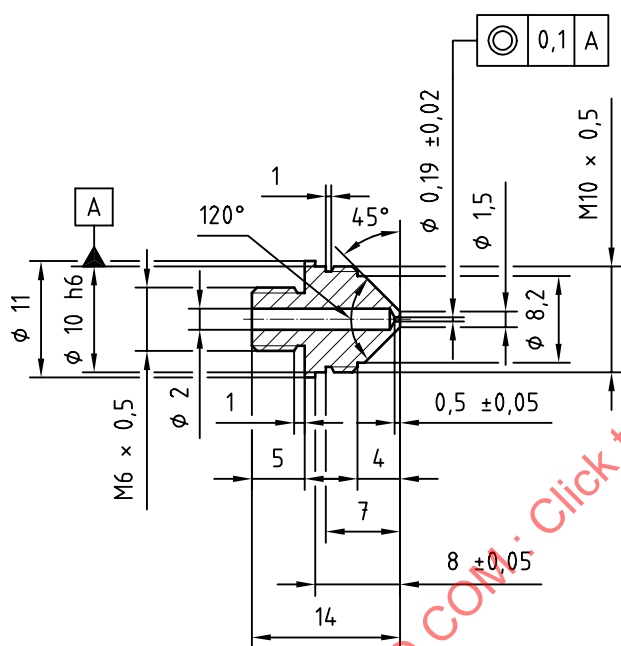
Key

- 1 Specimen support pin, $(2 \pm 0,5)$ mm diameter
- 2 Spacer stub, 2 mm diameter
- 3 Mounting frame
- 4 Specimen

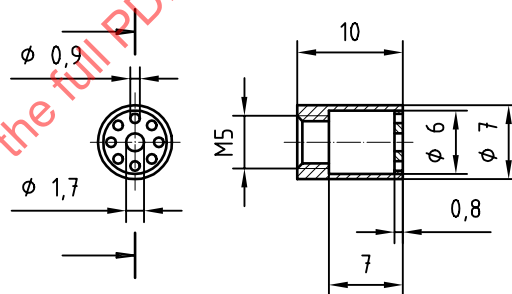
Figure 1 — Test specimen holder



a) Gas burner arrangement



b) Gas jet



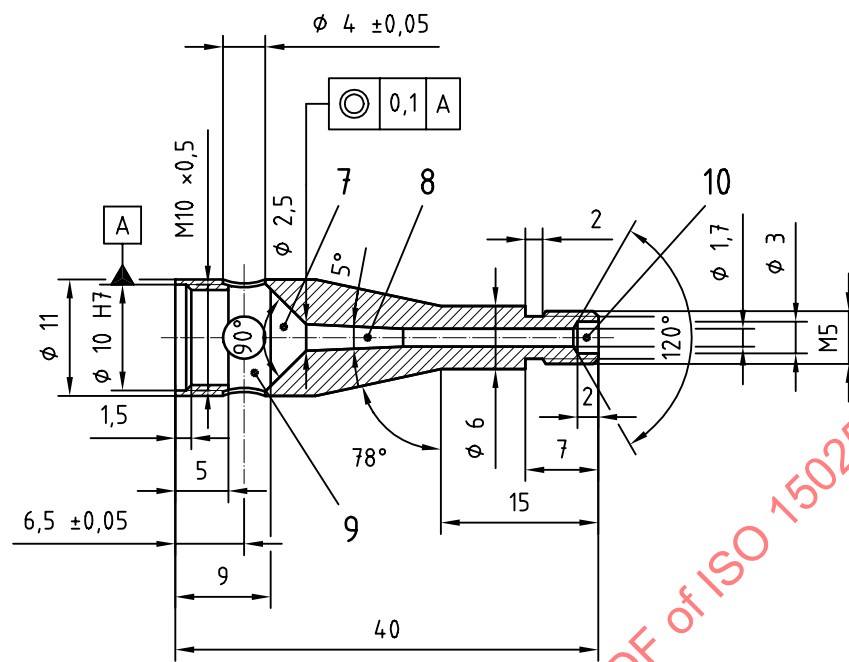
c) Flame stabilizer

Key

- 1 Fitted in during assembly
- 2 Gas jet
- 3 Choke tube
- 4 Burner tube
- 5 Flame stabilizer
- 6 Notch

Figure 2 — Gas burner

Dimensions in millimetres



d) Burner tube

Key

- 7 Gas-mixing zone
8 Diffusion zone
9 Air chamber
10 Outlet

Figure 2 — Gas burner (continued)

Dimensions in millimetres

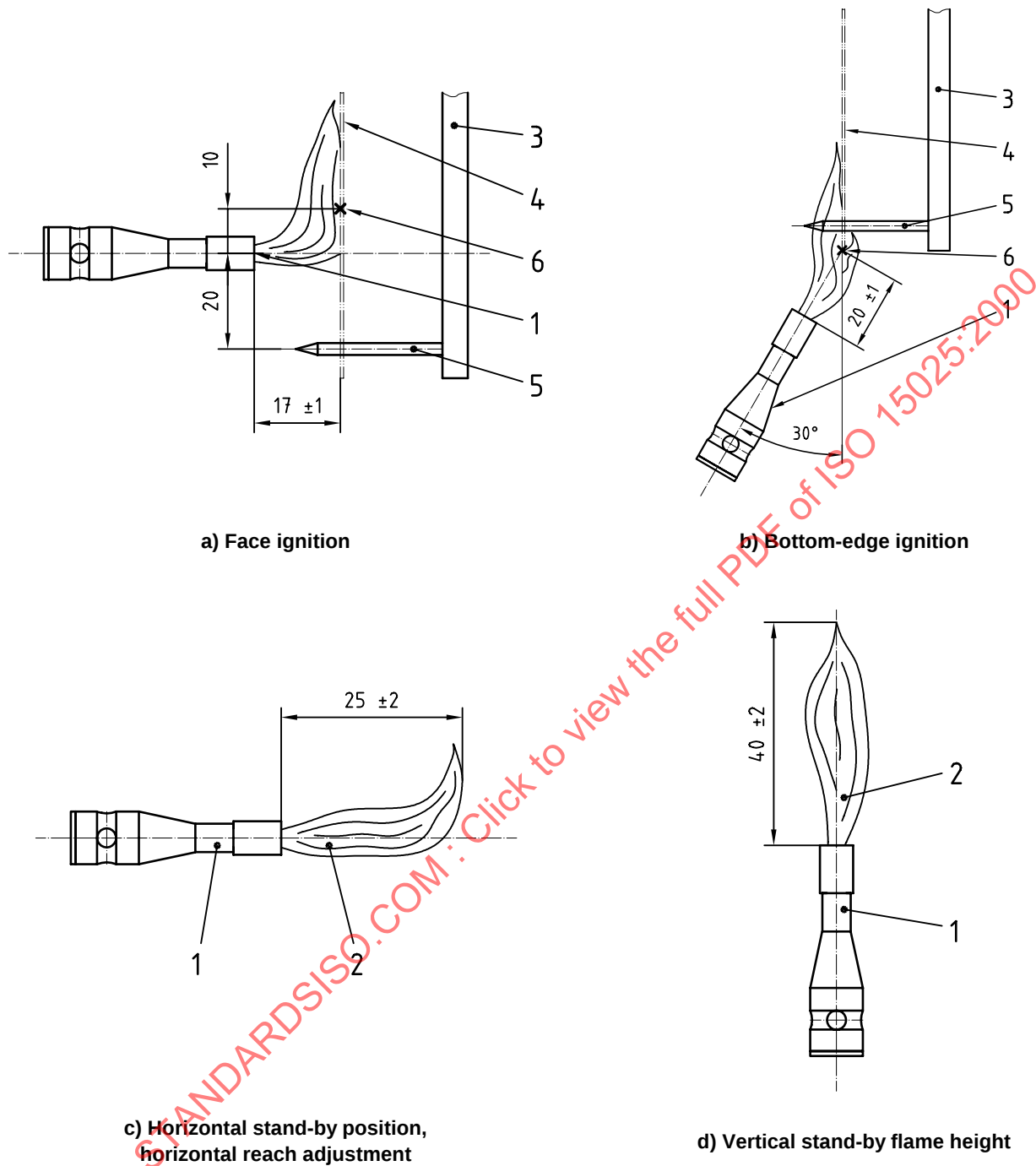


Figure 3 — Flame position and adjustment

6.4 Specimen holder, consisting of a rectangular metal frame having a specimen support pin at each corner of a rectangle of 190 mm length by 150 mm width (see Figure 1).

6.4.1 Supporting pins, for the specimen having a $(2 \pm 0,5)$ mm diameter and a length of (25 ± 1) mm.

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

6.4.2 Spacer stub, for the purpose of locating the specimen in a plane at least 20 mm away from the frame (see 8.1.2.1 and 8.1.3.1), of 2 mm diameter and a length of at least 20 mm and positioned adjacent to each of the four pins.

6.5 Template, flat and rigid, made of a suitable material and of a size corresponding to the size of the specimen (200 mm $\times$ 160 mm).

Holes approximately 4 mm in diameter shall be drilled in each corner of the template and positioned so that the distances between the centres of the holes correspond to the distances between the pins on the specimen holder (see Figure 1). The holes shall be located equidistant about the vertical centreline of the template.

6.6 Timing devices:

- One timing device to control and measure the flame application time, which can be set at 1 s intervals with an accuracy of 0,2 s or better.
- Two timing devices reading to 0,2 s or better are required to measure the afterflame time and/or afterglow time. These devices are started, preferably automatically, at the instant of test flame termination or removal, and are stopped manually.

NOTE Alternatively, a video recording of the test can be made, provided that an on-screen timer is provided with the specified precision.

6.7 Filter paper, with the following characteristics:

- area specific mass: 60 g/m² to 100 g/m²
- size: $\geq (150 \text{ mm} \times 100 \text{ mm})$
- thickness: 0,15 mm to 0,25 mm
- alpha cellulose content: $\geq 95 \%$.

7 Sampling and sample preparation

7.1 Sampling

7.1.1 Number of specimens

Using the template (6.5), mark two sets of three test specimens. Mark one set perpendicular to the other. For woven/knitted or similar materials, orient the lengthwise axis of the template in the machine and cross-machine direction.

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

An extra test specimen is required for the installation procedure (see 8.1.2 and 8.1.3).

7.1.2 Specimen-holder pin location marks

Mark the position through which the pins on the specimen holder shall pass by means of the holes in the template (6.5).

NOTE Where the fabric is of open construction (for instance scrim, gauze), small pieces of adhesive tape may be affixed to the fabric at the pin sites and the position marked on the tape.

7.1.3 Test specimen size

Cut out test specimens with dimensions of (200 ± 2) mm $\times$ (160 ± 2) mm.

7.1.4 Multilayer specimens

When specimens are composed of multiple layers or materials that are not continuous over the entire specimen, position the material of the smaller dimension along the bottom edge of the specimen, in a manner consistent with its use in the protective clothing, including the manner of attachment and orientation.

EXAMPLE Specimens containing retroreflective tape or emblems and lettering are typical examples of multilayer specimens where this specimen preparation procedure should be used.

7.2 Conditioning atmosphere of the test sample

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 (6.4) before removal from the conditioning atmosphere.

8 Procedure

NOTE More practical information concerning the experimental aspects of this technique are given in annex B.

8.1 Installation of the test apparatus

8.1.1 Test conditions

The tests shall be performed in an atmosphere having a temperature between 10 °C and 30 °C, a relative humidity between 15 % and 80 %, 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.

8.1.2 Procedure A — Surface ignition

8.1.2.1 Mounting of the test specimen

Place the test specimen (see 7.1.1) 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.

8.1.2.2 Operating position of the burner

Position the burner (6.3) perpendicular to the surface of the test specimen so as to align the axis of the burner 20 mm above the line of the lower pins and with the vertical centreline of the face of the test specimen. Make sure that the tip of the burner stabilizer is (17 ± 1) mm from the surface of the test specimen [see Figure 3 a)].

8.1.2.3 Flame adjustment — Horizontal reach

Set the burner (6.3) in the vertical standby position. 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 flame when viewed against a dark background [see Figure 3 c)].

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

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

8.1.2.4 Flame position

Move the burner from the standby position to the horizontal operating position (see 8.1.2.2). Confirm that the flame impinges on the test specimen in the correct location [see Figure 3 a)]. Test all six specimens within a total of 10 min from completion of the preheat procedure and flame adjustment (8.1.2.3).

8.1.2.5 Debris

If debris is observed during the installation test, the additional procedure of 8.1.4 shall be used for subsequent testing, to determine whether the debris is to be termed flaming debris.

8.1.3 Procedure B — Bottom-edge ignition

8.1.3.1 Mounting of the test specimen

Place the test specimen (see 7.1) 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.

8.1.3.2 Operating position of the burner

Position the burner in front of, but below, the test specimen so as to lie in a plane passing through the vertical centreline of the test specimen and perpendicular to its surface with the longitudinal axis inclined upwards at a 30° angle to the vertical bottom edge of the test specimen. Make sure 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 which exhibit drape or sag. Surface ignition may be more appropriate for such fabrics.

8.1.3.3 Flame adjustment — Vertical flame height

Set the burner (6.3) in the vertical standby position. 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 flame when viewed against a dark background [see Figure 3 d)].

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

8.1.3.4 Flame position

Move the burner from the standby position to the inclined operating position (see 8.1.3.2). Check that the bottom edge of the test specimen bisects the flame [see Figure 3 b)].

8.1.3.5 Debris

If debris is observed during the installation test, the additional procedure of 8.1.4 shall be used for subsequent testing to determine whether the debris is to be termed flaming debris.

8.1.4 Detection of flaming debris

If debris is observed in the installation procedure (8.1.2.5 or 8.1.3.5) or in subsequent testing, the following additional procedure shall be employed to determine if the debris is to be classified as flaming debris.

A piece of filter paper (6.7), at least (150 × 100) mm shall be placed on a horizontal solid surface (50 ± 5) mm below the bottom edge of the specimen with the centre of the filter paper directly below the centreline of the specimen.

NOTE If the burner mechanism touches the filter paper when using bottom-edge ignition, a suitable slot should be cut in the mounting plate and in each piece of filter paper used.

8.2 Test

8.2.1 Surface ignition

8.2.1.1 Set up the apparatus as described in 8.1.2.

8.2.1.2 Position test specimen on the specimen holder (see 8.1.2.1). For woven/knitted materials, record whether the machine or cross machine direction is vertical.

8.2.1.3 Apply the test flame for 10 s and observe and record:

- a) whether any flaming reaches the upper edge or either vertical edge of the test specimen;
- b) afterflame time;
- c) whether afterglow spreads beyond the flame spread area (usually the carbonized area) into the undamaged area;
- d) afterglow time;
- e) the occurrence of debris;
- f) whether debris ignites the filter paper (flaming debris), if applicable;
- g) whether a hole develops, and in which layer(s) for a multilayer specimen.

NOTE When testing multilayer specimens, a hole formation should be reported in each separable layer.

8.2.1.4 Repeat 8.2.1.2 and 8.2.1.3 on the remaining five test specimens, with the same surface of all specimens exposed towards the flame.

8.2.2 Bottom-edge ignition

8.2.2.1 Set up the apparatus as described in 8.1.3.

8.2.2.2 Position the first of a set of six fresh test specimens on the specimen holder. For woven/knitted materials, record whether the machine or cross machine direction is vertical.

8.2.2.3 Apply the test flame for 10 s and observe and record behaviour as listed in 8.2.1.3, with the exception of g) which is not applicable to bottom-edge ignition. When elected, measure char length using the procedure in annex C.

NOTE The measurement of char length is optional. Some laboratories have reported that when using the bottom-edge ignition test it can be difficult to obtain consistent interlaboratory results for the measurement of the char length.

8.2.2.4 Repeat 8.2.2.2 and 8.2.2.3 on the remaining five test specimens, with the same surface of all specimens exposed towards the flame.

9 Precision

These methods are used to determine whether or not flame spread to the edge of the specimen occurs. They consistently detect two groups of fabrics:

- fabrics which give little or no afterflame and
- fabrics which burn completely.

However, there are some intermediate fabrics which can demonstrate more extensive, but not complete, flame spread under specific circumstances. These intermediate fabrics can give widely scattered results from one specimen to another and may give different results with different test procedures, for instance surface or bottom-edge ignition, and in different laboratories.

An interlaboratory trial with eleven fabrics in six laboratories was carried out in 1990. Using surface ignition, ten of the fabrics tested gave zero or very short afterflame times (< 3 s) and no afterglow. The remaining fabric consistently gave long but variable (from 8 s to 17 s) afterflame times without burning to the edge. Using bottom-edge ignition only eight of the fabrics gave consistent, low afterflame times (< 2 s). The remaining three fabrics gave longer afterflame times, which varied considerably from one specimen to another, but only in some laboratories.

On the fabrics included in this trial, the face ignition test (procedure A) gave consistent results whilst the bottom-edge ignition test (procedure B) detected inconsistent intermediate behaviour on some fabrics in some laboratories only.

10 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, i.e. ISO 15025, and details of any deviation from it;
- b) the type of gas used;
- c) the date of test;
- d) the ambient conditions of temperature and relative humidity in the area in which the test is carried out (see 8.1.1);
- e) the technique used to attach fabrics which cannot be supported on pins (see 7.1.2);
- f) an identification of the fabric tested including details of any pretreatment, for instance a cleansing procedure;

- g) the type of surface exposed towards the flame and the type of ignition used, i.e. surface or bottom-edge ignition;
- h) for each test specimen the information itemized in 8.2.1.3 as required by the appropriate performance specification;
- i) an indication of the layers developing holes during the surface ignition test as required in 8.2.1.3 for multilayer specimens.

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Annex A (normative)

Description and construction of the burner

A.1 Description

The burner¹⁾ 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 2 a). The burner consists of three parts:

A.2.1 Gas jet

The orifice diameter of the gas jet [see Figure 2 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.

A.2.2 Burner tube

The burner tube [see Figure 2 d)] consists of four zones:

- a) air chamber;
- b) gas-mixing zone;
- c) diffusion zone;
- d) gas outlet.

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

The diffusion zone is of conical shape and has the dimensions indicated in Figure 2 d). The burner has a bore of 1,7 mm internal diameter and an outlet of 3,0 mm internal diameter.

A.2.3 Flame stabilizer

The flame stabilizer is given in detail in Figure 2 c).

¹⁾ Details of the availability of the specified burner may obtained from the secretariat of ISO/TC 38/SC 19, American Textile Manufacturers Institute, 1130 Connecticut Ave., NW, Suite 1200, Washington D.C. 20036-3954, USA.