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Cellular plastics — Determination of horizontal burning characteristics of small specimens subjected to a small flame

Plastiques alvéolaires — Détermination des caractéristiques de combustion de petites éprouvettes en position horizontale, soumises à une petite flamme

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Contents

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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.

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.

International Standard ISO 9772 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

Annex A of this International Standard is for information only.

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Cellular plastics — Determination of horizontal burning characteristics of small specimens subjected to a small flame

1 Scope

1.1 This International Standard specifies a small-scale laboratory screening procedure for comparing the relative burning characteristics of horizontally oriented, small cellular-plastic specimens having a density less than 250 kg/m^3 determined in accordance with ISO 845, when exposed to a low-energy source of ignition.

NOTE 1 Another standard exists covering flexible cellular plastic and cellular rubber — ISO 3582:1978, *Cellular plastic and cellular rubber materials — Laboratory assessment of horizontal burning characteristics of small specimens subjected to a small flame.*

1.2 This method of test is intended for quality assurance and limited product evaluation of component cellular materials under controlled laboratory conditions, and is not intended to assess the fire behaviour of e.g. building materials or furnishings under actual fire conditions.

1.3 The optional classification system described in annex A is intended for the preselection of component materials for products.

1.4 The burning behaviour of cellular plastics is influenced by test specimen orientation (vertical or horizontal). This method of test evaluates specimens which are oriented horizontally.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 291:1977, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 845:1988, *Cellular plastics and rubbers — Determination of apparent (bulk) density.*

ISO 1043-1:1987, *Plastics — Symbols — Part 1: Basic polymers and their special characteristics.*

ISO 1923:1981, *Cellular plastics and rubbers — Determination of linear dimensions.*

ISO 10093:—[1], *Plastics — Fire tests — Standard ignition sources.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

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

3.2 afterglow time: The length of time for which a material continues to glow, under specifed test conditions, after the ignition source has been removed and/or cessation of flaming.

1) To be published.

4 Significance of test

4.1 Tests conducted on a material under the conditions specified can be of considerable value when comparing the horizontal-burning characteristics of different materials, controlling manufacturing processes or assessing any changes in formulation or treatment prior to use.

4.2 Assessment of fire hazard requires consideration of such factors as fuel contribution, intensity of burning (rate of heat release), products of combustion and environmental factors such as intensity of source, orientation of exposed material and ventilation conditions.

4.3 Horizontal-burning characteristics, as measured by this test procedure, may be affected by such factors as density, any anisotropy of the cellular material, its melting characteristics, colour and the thickness.

4.4 Certain materials may shrink from the applied flame without igniting. In this event, test results are not valid and additional test specimens will be required to obtain 10 valid test results. If this proves impossible due to non-ignition of all the specimens, then this test is not suitable for these materials.

4.5 The horizontal-burning characteristics of some cellular-plastic materials may change with time and tests are therefore conducted before and after heat-ageing.

5 Apparatus

5.1 Laboratory fume hood (cupboard), having an inside volume of at least 0,5 m^3. It shall permit observation and shall be draught-free while permitting normal thermal circulation of air past the specimen during burning. For safety and convenience, it is desirable to fit the enclosure with a device, such as an exhaust fan, to remove products of combustion that may be toxic. However, it is important to turn the device off during the actual test and start it again immediately after the test to remove the products of combustion.

NOTE 2 The amount of oxygen available to support combustion is naturally important for the conduct of these flame tests. For tests conducted by this method when burning times are protracted, chamber sizes less than 1 m^3 may not provide accurate results.

5.2 Laboratory burner, as specified in ISO 10093, designated P/PF2 and having a barrel length of 100 mm ± 10 mm and an internal diameter of 9,5 mm ± 0,3 mm. The barrel shall not be equipped with an end attachment, such as a stabilizer.

5.3 Burner wing top, having an opening of internal length 48 mm ± 1 mm and internal width 1,3 mm ± 0,05 mm (see figure 1).

5.4 Support gauze, approximately 215 mm long by 75 mm wide, having 13 mm of its length bent to form a right angle at one end as shown in figure 2. It shall consist of 6,4 mm mesh gauze constructed of 0,90 mm ± 0,05 mm diameter stainless-steel or low-carbon-steel wire. A different support gauze is necessary for each specimen unless means are provided to burn off any residue from a prior test.

5.5 Support-gauze holder, consisting of two laboratory ring stands with clamps adjustable to the desired angles and heights or a support-gauze holder constructed from aluminium or steel (see figure 3), and satisfying the following conditions:

a) the long axis of the gauze is maintained to within 1° of the horizontal;

b) the near end of the specimen is 13 mm ± 1 mm above the burner wing top (see figure 4);

c) the space both above and below the specimen is not obstructed;

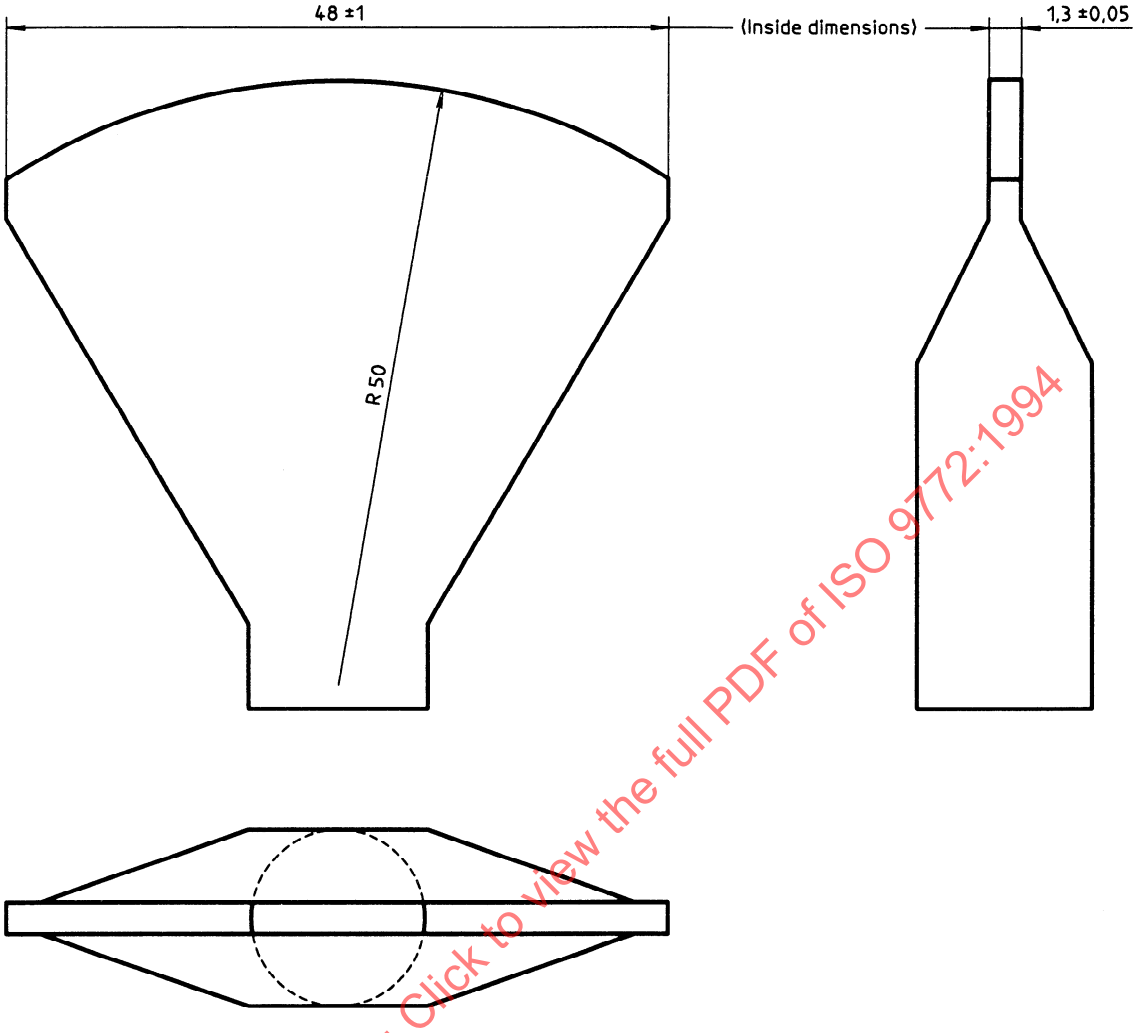
d) a means is provided for positioning the burner in the correct location relative to the specimen, preferably with a sliding mechanism and a stop to allow fast movement of the burner flame towards and away from the specimen;

e) the gauze is equidistant from the front and back, and from both sides, of the test chamber, and is 175 mm ± 10 mm above the base of the test chamber.

5.6 Two timing devices, accurate to 1 s.

5.7 Measuring scale, graduated in millimetres, to measure the length, width and thickness of the test specimen.

Dimensions in millimetres



Material: copper or stainless steel

Figure 1 — Burner wing top (5.3)

Dimensions in millimetres

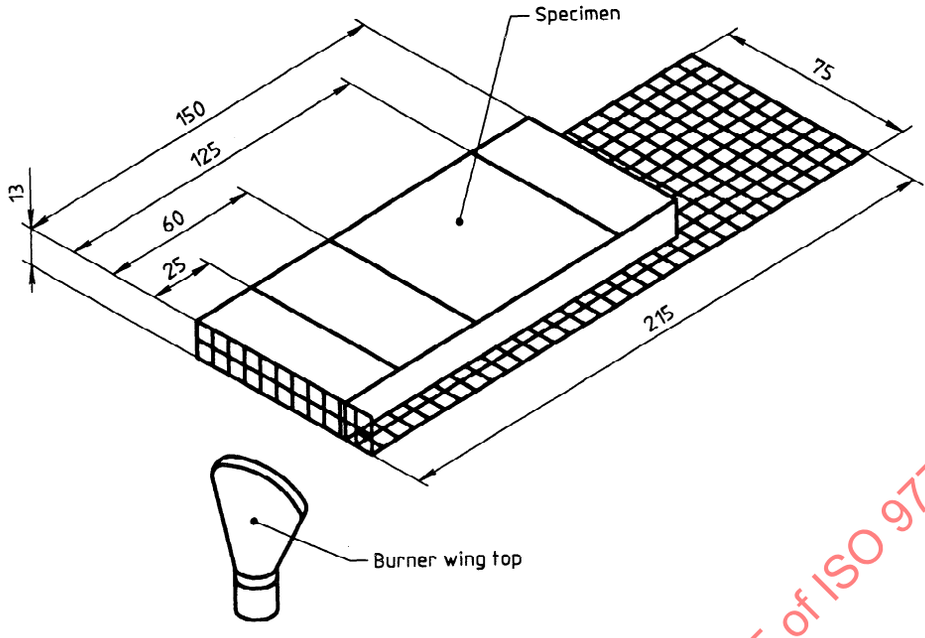


Figure 2 — Test specimen and specimen-support gauze (5.4)

Dimensions in millimetres

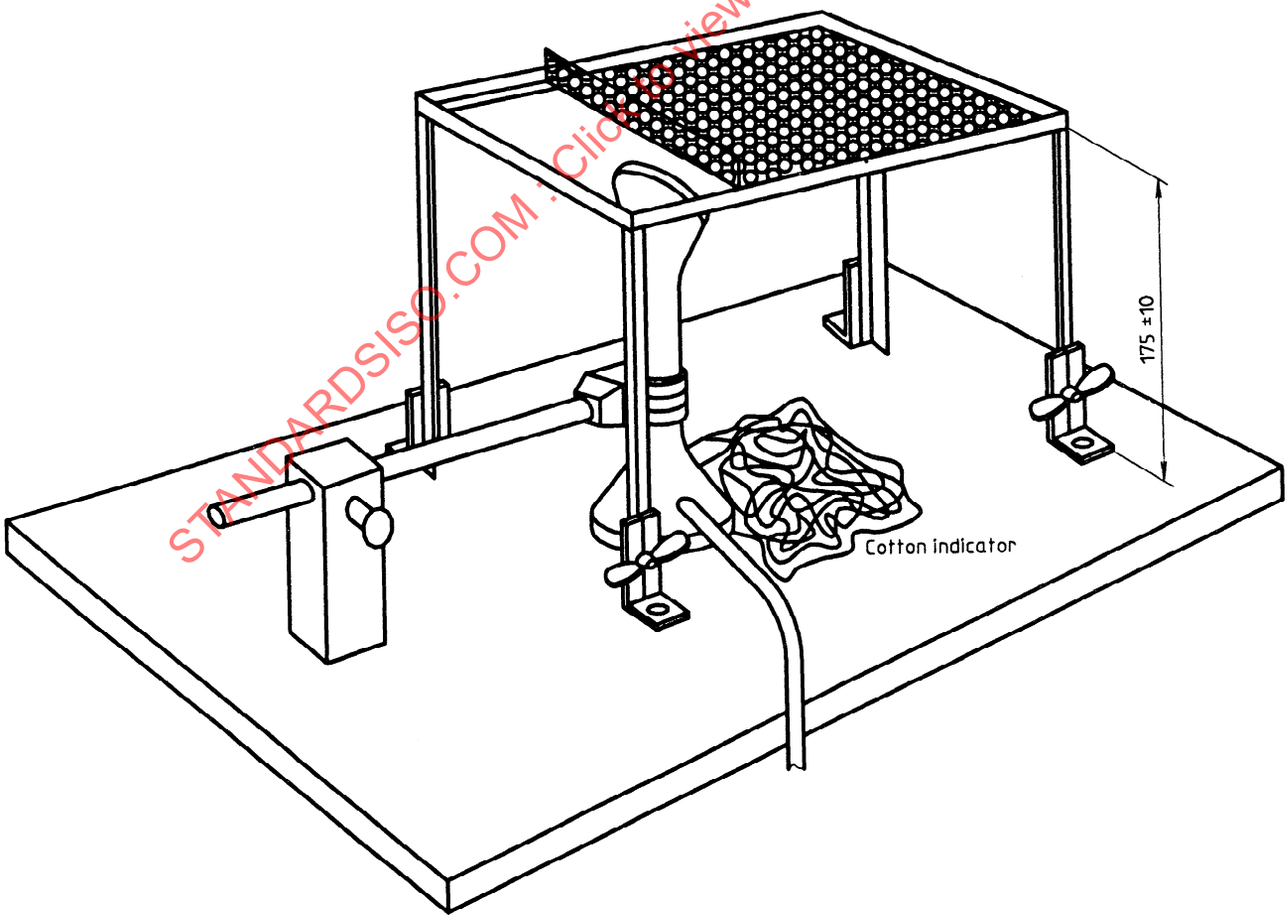


Figure 3 — Support-gauze holder (5.5)

Dimensions in millimetres

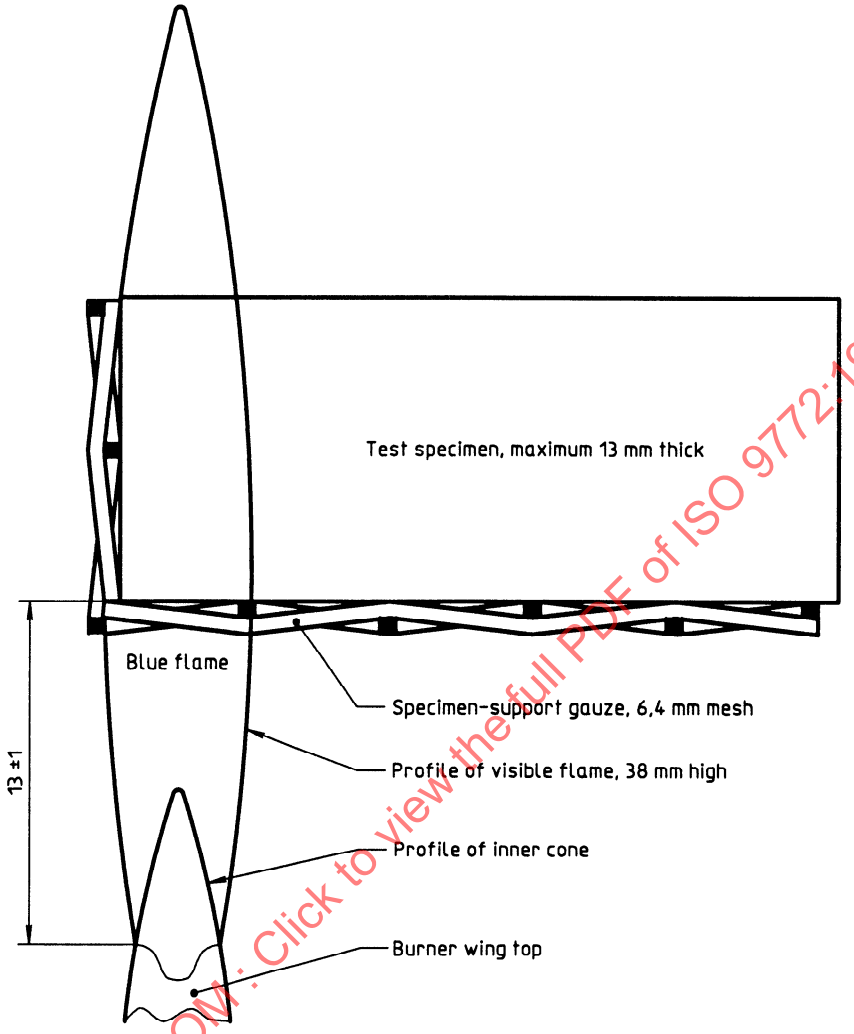


Figure 4 — Details of flame and relative positions of burner wing top, test specimen and specimen-support gauze

5.8 Gas supply, preferably of technical-grade methane gas, with regulator and meter for uniform gas flow. Other gas mixtures having a heat content of approximately 37 MJ/m^3 have been found to provide similar results; however, in cases of dispute, technical-grade methane shall be used.

NOTE 3 Propane having a heat content of approximately 94 MJ/m^3 and butane having a heat content of approximately 120 MJ/m^3 provide similar results when using the procedure described in clause 8.

5.9 Manometer and gas-flow meter, calibrated for the gas used and capable of reading the values shown in table 1.

5.10 Cotton indicator, consisting of dry absorbent surgical 100 % cotton.

5.11 Desiccator, containing anhydrous calcium chloride or another drying agent.

5.12 Conditioning room or chamber, capable of being maintained at 23 °C ± 2 °C and a relative humidity of (50 ± 5) %.

5.13 Air-circulating oven, with a minimum of five air-changes per hour, capable of being maintained at 70 °C ± 1 °C or another agreed temperature.

5.14 Dial-gauge micrometer, for measuring thickness, with a 650 mm^2 pressure foot exerting a pressure of 0,175 kPa ± 0,035 kPa.

6 Specimens

6.1 All specimens shall be cut from a representative sample of the material. Care shall be taken to remove all dust and any other particles from the surface.

6.2 The standard test specimen shall be 150 mm ± 1 mm long by 50 mm ± 1 mm wide. Materials supplied in thicknesses over 13 mm shall be cut to 13 mm ± 1 mm thickness with any skin removed. Materials supplied in thicknesses of 13 mm or less shall be tested at the thickness supplied, without removing any skin (see 6.5). If materials with adhesive applied are to be tested, specimens having adhesive on one side only shall be used (see 6.5).

NOTE 4 Tests made on test specimens of different thicknesses, densities or directions of anisotropy are not comparable.

6.3 Prepare a minimum of 20 specimens for the test. This includes 10 additional specimens in the event that the situations described in 4.4, 4.5 or A.3 are encountered.

6.4 Mark each specimen across its width with lines at 25 mm, 60 mm and 125 mm from one end, referred to hereafter as gauge marks (see figure 2).

6.5 Test specimens of thickness < 13 mm and with a high-density exterior (skin) on one side shall be tested with this side facing down. Test specimens of thickness < 13 mm with adhesive on one side shall be tested with this side facing up.

7 Conditioning

7.1 Specimens

7.1.1 The specimens shall not be conditioned until at least 24 h after their fabrication.

Table 1 — Gas sources

Type	Approximate heat content MJ/m^3	Flow rate ml/min	Line back pressure[1] mm H_2O column
Methane[2]	37	1 070	65 ± 5
Propane	94	421	25 ± 5
Butane	120	333	15 ± 5

1) The needle valve of the burner shall be adjusted to provide the line back pressure indicated.

2) Natural gas having a heat content of 37 MJ/m^3 has been found to produce similar results.

7.1.2 Condition two sets of five specimens for at least 48 h at 23 °C ± 2 °C and (50 ± 5) % relative humidity as indicated in ISO 291. One set is for possible retests as described in 4.4, 4.5 or A.3.

7.1.3 Condition two sets of five specimens for 168 h ± 2 h at 70 °C ± 1 °C and then place in a desiccator (5.11) for at least 4 h to cool to room temperature. One set is for possible retests as described in 4.4, 4.5 or A.3.

NOTE 5 Other heat-ageing times and temperatures may be used if agreeable to all parties.

7.2 Cotton

Condition an adequate supply of cotton indicator (5.10) in a desiccator (5.11) for at least 48 h prior to use.

8 Test procedure

8.1 Adjustment of flame

8.1.1 Ensure that the fume hood fan is off.

8.1.2 Adjust the gas-flow rate and line pressure to the values shown in table 1 for the gas supply (5.8), using the arrangement shown in figure 5. In a position remote from the specimen support, adjust the burner (5.2) with its wing top (5.3) attached to provide a blue flame 38 mm ± 1 mm high when measured in subdued light. The flame is obtained by adjusting the gas-flow rate and the air port of the burner until a 38 mm high yellow-tipped blue flame is produced and then increasing the air supply until the yellow tip just disappears. Measure the height of the flame again and, if necessary, readjust.

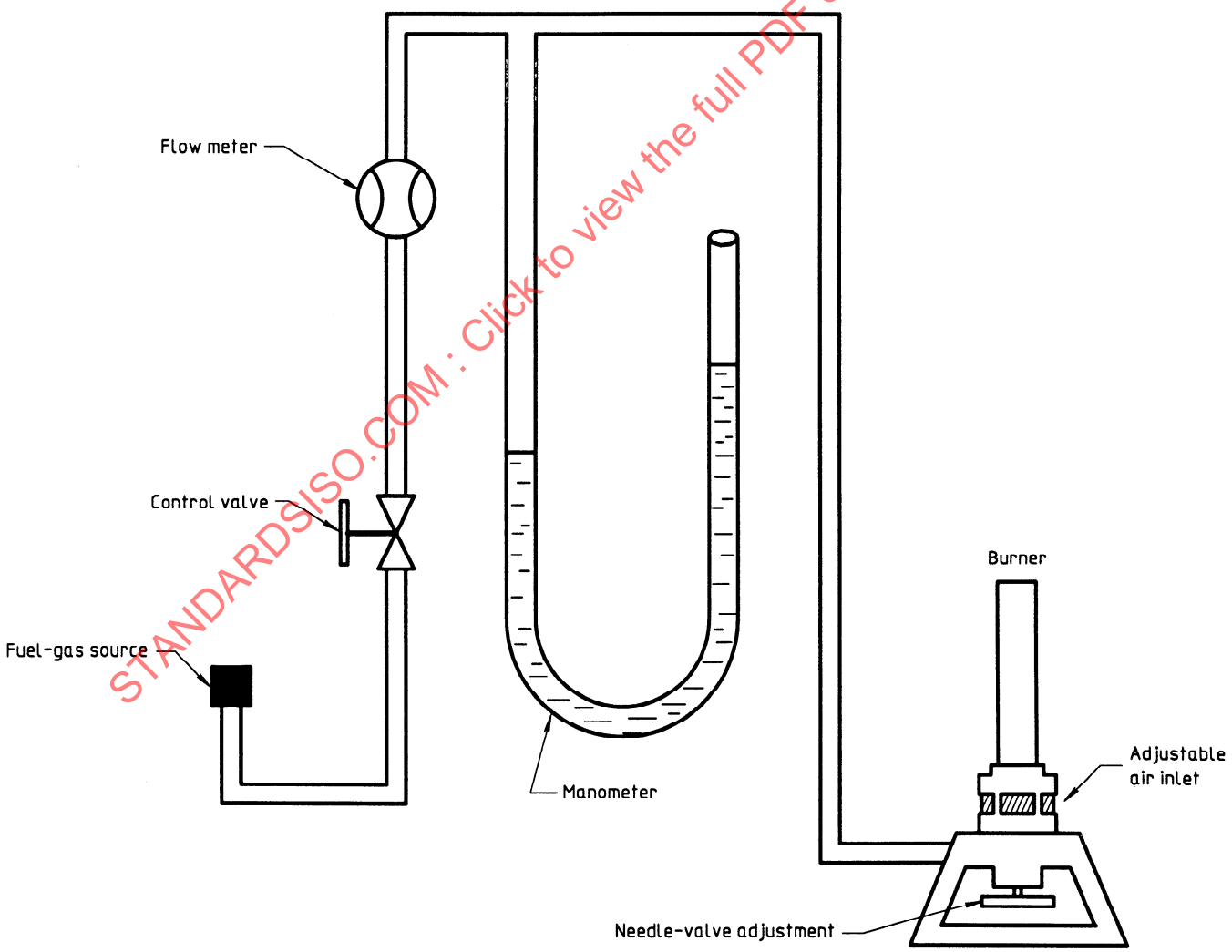


Figure 5 — Burner supply arrangement

When using either propane or butane, adjust the gas-flow rate and line pressure to the values shown in table 1. The flame will have a yellow tip.

8.2 Adjustment of specimen support

Place a clean specimen-support gauze in the holder in such a way that the lower surface of the test specimen will be 13 mm ± 1 mm above the tip of the burner wing top as shown in figure 4. The relative positions of burner and holder shall be such that, when the test specimen is in position, one edge of the flame will extend in to the test specimen as shown in figure 4. The centre of the wing top shall be directly under the longitudinal axis of the test specimen.

8.3 Positioning of cotton indicator

Remove a 50 mm × 50 mm piece of cotton (5.10) from the desiccator (5.11) and thin down to a maximum uncompressed thickness of 6 mm. Position the cotton under the front upturned portion of the support gauze as shown in figure 3.

8.4 Positioning of specimen

Place a test specimen on the support (5.5) in such a manner that:

a) the surface on which the gauge marks have been made is uppermost;

b) the end nearest to the 60 mm gauge mark is touching the 13 mm bent-up portion of the support gauze;

c) its longitudinal axis is parallel to that of the support gauze.

8.5 Burning procedure

8.5.1 Place the burner quickly in position under the upturned end of the specimen support and simultaneously start the first timing device (5.6).

8.5.2 Immediately close the front panel of the fume hood, if not already closed, so that there is only a small air-gap (e.g. height 50 mm ± 10 mm) along the base of the panel.

8.5.3 After 60 s, remove the burner a distance of 100 mm or further from the specimen.

8.5.4 Start the second timing device when the test-specimen flame reaches the 25 mm gauge mark, whether the burning is on the bottom, top or edge of the specimen.

8.5.5 Stop the first timing device when the flame or glowing combustion front reaches the 60 mm gauge mark, or when the specimen ceases to burn or glow before reaching the 60 mm gauge mark.

8.5.6 Stop the second timing device when the test specimen flame or glowing combustion front reaches the 125 mm gauge mark, or when the specimen ceases to burn before reaching the 125 mm gauge mark.

8.5.7 Observe whether the cotton indicator was ignited by flaming drips.

Ignore drips falling into the burner unless a visible change occurs in the flame. In this case, abandon the test on this specimen and, after cleaning the burner and wing top, substitute a new test specimen.

8.5.8 Switch on the fume-hood fan and, after exhausting all fumes, remove the test specimen and the support gauze.

8.6 Measurements

8.6.1 Distance burnt (L_d)**:** The distance between the 25 mm gauge mark and the point where the flame or glowing combustion front had stopped, expressed in millimetres. If the flame front does not cross the 25 mm mark, record that $L_d = 0$.

8.6.2 Burning time (t_b)**:** The time measured by the second timing device, in seconds, from when the flame or glowing combustion front passes the 25 mm gauge mark, until the flame front stops or passes the 125 mm gauge mark.

8.6.3 Elapsed time (t_e)**:** The time measured by the first timing device if the flame or glowing combustion front does not pass the 60 mm gauge mark, recorded as the time, in seconds, that the specimen continues to flame or to glow after the 60 s flame application. This is a combination of the afterflame time and afterglow time.

NOTE 6 When using the classification designation system indicated in annex A, the afterflame time and afterglow time need to be recorded individually by the first timing device.

8.7 Preparation for the next test

8.7.1 If reusing the support gauze, burn and clean off any residues remaining and allow it to cool to room temperature before reuse.

8.7.2 Examine the burner and wing top for cleanliness and clean if necessary.

8.7.3 Check the flame (see 8.1.2) at least once every five tests.

8.7.4 Switch off the fume-hood exhaust fan and repeat the procedure in 8.2 for the next test specimen.

9 Calculations

9.1 If the flame or glowing combustion front passes the 125 mm gauge mark, calculate the burning rate v, expressed in millimetres per minute, from the equation:

$$v = \frac{6\,000}{t_b}$$

where t_b is the burning time, in seconds.

9.2 If the flame or glowing combustion front does not pass the 125 mm gauge mark but does pass the 60 mm gauge mark, calculate the burning rate v, expressed in millimetres per minute, from the equation:

$$v = \frac{60\,L_d}{t_b}$$

where

L_d is the distance burnt, in millimetres;

t_b is the burning time, in seconds.

9.3 Calculate and record the average of five specimens for each conditioning treatment.

10 Precision

10.1 Data

The precision data were determined from an interlaboratory experiment conducted in 1986 involving seven laboratories, five materials (levels) and two replicates each using the average of five data points. The results were analysed using ISO 5725:1986, *Precision of test methods — Determination of repeatability and reproducibility for a standard test method by interlaboratory tests.*

10.2 Repeatability

In the normal and correct operation of the method, the difference between two averages (determined from five specimens) obtained using identical test material and the same apparatus by one operator within a short time interval will not exceed the repeatability value shown in table 2 more than once in 20 cases on average.

Table 2 — Precision

Factor	Elapsed time s		Rate of burning mm/min		
	Flame-retardant PUR	PIR	Flexible PUR foam	PS beadboard	Extruded PS
Average	22,2	0,1	105,2	257,7	87,4
Repeatability	16,4	0,7	15,3	53,3	28,3
Reproducibility	24,2	0,8	31,9	59,9	28,3

NOTE — For materials symbols, see ISO 1043-1.

10.3 Reproducibility

In the normal and correct operation of the method, the difference between two independent averages (determined from five specimens) found by two operators working in different laboratories on identical test material will not exceed the reproducibility value shown in table 2 more than once in 20 cases on average.

10.4 Averages

The two averages (determined from five specimens) are to be considered suspect and not equivalent if they differ by more than the repeatability or reproducibility shown in table 2. Any judgement per 10.2 or 10.3 would have an approximate 95 % (0,95) probability of being correct.

NOTE 7 Table 2 is only intended to present a meaningful way of considering the approximate precision of this test method for a range of materials. These data should not be rigorously applied to acceptance or rejection of material, as they are specific to the interlaboratory test and may not be representative of other lots, conditions, thicknesses or materials.

11 Test report

The test report shall include the following particulars:

a) a reference to this International Standard;

b) a complete identification of the product tested, including the manufacturer's name, number or code;

c) the nominal apparent density;

d) the thickness, determined by ISO 1923, to the nearest millimetre, of the test specimen;

e) the presence or absence of skins;

f) the presence or absence of adhesive;

g) the direction of any anisotropy relative to the test-specimen dimensions;

h) the conditioning treatment used (see 7.1.2 and 7.1.3);

i) any prior treatment before testing, other than cutting, trimming and conditioning;

j) the individual test values, including:

1) distance burnt (L_d),

2) burning time (t_b),

3) elapsed time (t_e),

4) afterflame time (for annex A only),

5) afterglow time (for annex A only),

6) burning rate (v),

7) whether the cotton indicator was ignited;

k) the gas used, if different from methane.

Annex A
(informative)

Classification system

A.1 Usage

This annex forms an optional part of the standard.

A.2 General

This annex describes a classification system that is used to characterize the burning behaviour of cellular material tested in a horizontal position. The use of a category designation code is optional and is determined by examining the test results of materials tested by this method. Each category code represents a range of performance levels that simplifies description in material designations or specifications and may assist certification bodies to determine compliance with applicable requirements.

A.3 Classification designations

A.3.1 General

Using the data determined from this method, select the one category code that best matches the material's performance using the requirements of table A.1. Optionally, record the category code in the test report.

A.3.2 Categories FH1 and FH2

If a set of five specimens does not comply with the requirements because of one of the following situations, test another set of five specimens subjected to the same conditioning.

a) a single specimen flames for more than 10 s;

b) two specimens flame for more than 2 s but less than 10 s;

c) one specimen flames for more than 2 s but less than 10 s, and a second specimen flames for more than 10 s;

d) one specimen does not comply with the criteria in table A.1.

All specimens from this second set have to comply with the category requirements.

A.3.3 Category FH3

If one specimen in a set of five specimens does not comply with the requirements, test another set of five specimens subjected to the same conditioning. All specimens from the second set have to comply with the category requirements.

Table A.1 — Classification designations

Material performance	Categories		
	FH1	FH2	FH3
Linear burning rate, v (mm/min)	NA	NA	40
Afterflame time (s) for each individual specimen	4/5: $\leqslant 2$ 1/5: $\leqslant 10$	4/5: $\leqslant 2$ 1/5: $\leqslant 10$	NA
Afterglow time (s) for each individual specimen	$\leqslant 30$	$\leqslant 30$	NA
Cotton ignition by flaming particles or drops	No	Yes	NA
Damaged length (L_d + 25 mm) for each individual specimen	$\leqslant 60$	$\leqslant 60$	$\leqslant 125$
NA = Not applicable 4/5 = Four of a set of five specimens 1/5 = One of a set of five specimens			