International Standard

ISO 9773

Third edition
2024-09

Plastics — Determination of burning behaviour of thin flexible vertical specimens in contact with a small flame ignition source

Plastiques — Détermination du comportement au feu d'éprouvettes minces verticales souples au contact d'une petite flamme comme source d'allumage

Reference number
ISO 9773:2024(en)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 9773:1998), which has been technically revised. It also incorporates the Amendment ISO 9773:1998/Amd. 1:2003.

The main changes are as follows:

— the required light level in the chamber has been added;

— informations on conditioning, laboratory and timing have been amended;

— conditioning of cotton prior to testing has been added;

— information on specimen thickness has been amended;

— information on retesting has been amended;

— mandatory information is provided throughout the document;

— normative references clause has been updated.

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.

Plastics — Determination of burning behaviour of thin flexible vertical specimens in contact with a small flame ignition source

1 Scope

1.1 This document specifies a small-scale laboratory screening procedure for comparing the relative burning behaviour of vertically oriented thin and relatively flexible plastics specimens exposed to a low-energy-level flame ignition source.

NOTE These specimens cannot be tested using method B of IEC 60695-11-10:2013 since they distort or shrink away from the applied flame source without igniting.

1.2 This test method determines the afterflame and afterglow times of specimens.

1.3 The classification system described in Annex A is intended for quality control and the preselection of component materials for products. The classification established by this method of test is applicable only to the material used for the specimens.

NOTE Test results are influenced by material components, e.g. pigments, fillers, concentrations of fire retardants.

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 845:2006, *Cellular plastics and rubbers — Determination of apparent density*

ISO 10093:2020, *Plastics — Fire tests — Standard ignition sources*

ISO 13943:2023, *Fire safety — Vocabulary*

IEC 60695-11-4:2011, *Fire hazard testing — Part 11-4: Test flames — 50 W flame — Apparatus and confirmational test method*

IEC 60695-11-5:2016, *Fire hazard testing — Part 11-5: Test flames — Needle-flame test method — Apparatus, confirmatory test arrangement and guidance*

IEC 69695-11-10:2013, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 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
afterflame
flame that persists after the ignition source has been removed

[SOURCE: ISO 13943:2023, 3.12]

3.2
afterflame time
length of time for which an *afterflame* (3.1)persists under specified conditions

[SOURCE: ISO 13943:2023, 3.13]

3.3
afterglow
persistence of glowing combustion after both removal of the ignition source and the cessation of any flaming combustion

[SOURCE: ISO 13943:2023, 3.14]

3.4
afterglow time
length of time for which an *afterglow* (3.3) persists under specified conditions

[SOURCE: ISO 13943:2023, 3.15]

4 Principle

A test specimen having a nearly cylindrical form is supported vertically by one end and the free end is exposed to two successive applications of a specified gas flame. The burning behaviour of the test specimen is assessed by measuring the afterflame and/or afterglow time,

5 Significance of test

5.1 Tests made on a material under the conditions specified in this document can be of considerable value when comparing the relative burning behaviour of different materials, controlling manufacturing processes or assessing any change in burning characteristics prior to, or during, use. The results obtained from this method are dependent upon the shape, orientation and insulation of the test specimen and the conditions of ignition. Correlation with performance under actual service conditions is not implied.

5.2 Results obtained in accordance with this document shall not be used to describe or appraise the fire hazard presented by a particular material or shape under actual fire conditions. Assessment for fire hazard requires consideration of factors, such as fuel contribution, intensity of burning (rate of heat release), products of combustion and environmental factors such as the intensity of source, orientation of exposed material and ventilation conditions.

5.3 Burning behaviour as measured by this test method is affected by factors, such as density, colour and anisotropy of the material and thickness of the test specimen.

5.4 The effects on the burning behaviour of additives, deterioration, and possible loss of volatile components are measurable using this method. It is acceptable to use results obtained using this method for comparing the relative performance of materials and, potentially, in material assessment.

5.5 The burning behaviour of some plastic materials has the potential to change with time. It is accordingly advisable to make tests before and after oven conditioning by an appropriate procedure that is described in the test report. The preferred oven conditioning conditions shall be 7 days at 70 °C. However, it is acceptable to use other oven conditioning times and temperatures if agreed to by all parties.

6 Apparatus and materials

6.1 Test chamber. An enclosure or a laboratory fume hood (cupboard) having an internal volume of at least 0,5 m^3, shall be used when testing the test specimens. The test chamber shall permit observation and shall be draught free while permitting normal thermal circulation of air past the test specimen during burning. This enclosure shall be fitted with an evacuation device, such as an exhaust fan, to remove products of combustion which are toxic. However, it is important to turn off the device during the actual test and to start it again immediately after the test to remove the products of combustion.

WARNING — Toxic products are produced during combustion.

6.1.1 The inside surfaces of the chamber shall be of a dark colour. When a light meter, facing towards the rear of the chamber, is positioned in place of the test specimen, the recorded light level shall be less than 20 lux.

6.2 Laboratory burner. The burner shall be a laboratory burner, as described in ISO 10093:2020, 11.3, (as well as in IEC 60695-11-4:2011 and IEC 60695-11-10:2013 for a 50 W flame) as a 50 W diffusion burner ignition source, having a barrel length of 100 mm ± 10 mm and an inside diameter of 9,5 mm ± 0,3 mm. The barrel shall not be equipped with an end attachment such as a stabilizer. The burner shall be calibrated in accordance with IEC 60695-11-5:2016 and IEC 60695-11-10:2013.

6.3 Ring stand. An adjustable ring stand, with clamps, or the equivalent, shall be used for positioning of the test specimen.

6.4 Timing device. A stopwatch or other suitable timing device, accurate to 0,5 s in one hour with a resolution of 0,1 s.

6.5 Measuring scale. A measuring scale, graduated in millimetres, shall be used to measure the length, width, and thickness of the test specimen.

6.6 Gas supply. Technical grade methane gas, of minimum purity 98 %, shall be used as the igniting fuel. It shall be supplied by means of a regulator and a meter for uniform gas flow.

Other gas mixtures having a heat content of 37 MJ/m^3 ± 1 MJ/m^3 have been found to provide similar results. However, technical-grade methane, having a minimum purity of 98 percent, shall be used in cases of dispute.

6.7 Desiccator. A desiccator, containing anhydrous calcium chloride or another suitable drying agent and capable of maintaining a relative humidity not exceeding 20 % at 23 °C ± 2 °C, shall be used for conditioning the test specimens.

6.8 Conditioning room or chamber. A conditioning room or chamber, capable of being maintained at 23 °C ± 2 °C and a relative humidity of (50 ± 10) %, shall be available.

6.9 Micrometer. A micrometer, capable of being read to 0,01 mm, shall be available for assessing test specimen thickness..

6.10 Mandrel. A specimen mandrel form, made from 13 mm ± 0,5 mm diameter rod, shall be used for preparing the test specimens.

6.11 Pressure-sensitive adhesive tape. Pressure-sensitive adhesive tape, of a commercially available type, shall be used for marking the test specimens.

6.12 Wire. Stainless steel or nichrome wire, of diameter 0,2 mm to 0,5 mm, shall be used for winding the test specimens.

6.13 Cotton wool. Cotton wool, 100 % absorbent, shall be used after being kept in the desiccator (see 6.7) for at least 24 h. The cotton wool shall be used within 30 min of being removed from the desiccator.

6.14 Air-circulating oven, An air-circulating oven, capable of being maintained at 70 °C ± 2 °C with a minimum of five air changes/hour, shall be used for oven conditioning of plastic materials.

6.15 Weighing scale or balance, A balance, or weighting scale, having an accuracy and resolution of 0,01 g, shall be available for weighing test specimens.

7 Test specimens

7.1 It is possible that the results of tests carried out on test specimens taken from materials of different densities, colours, thicknesses, melt flow abilities and directions of anisotropy, or with different additive or filler/reinforcement contents, will be different. For materials with properties or compositions which vary over a range, the test specimens shall be representative of the whole range.

7.2 Test specimens with densities, melt flow abilities and additive or filler/reinforcement contents at the extremes of the range shall be tested and, if the test results yield the same flame test classification, all test specimens within the range shall be considered representative of the range. If the burning characteristics are not essentially the same, the results of the evaluation shall be considered to apply only to the materials with the densities, melt flow abilities and additive or filler/reinforcement contents tested. Additional test specimens with intermediate densities, melt flow abilities and additive or filler/reinforcement contents shall be tested to determine the range of applicability.

7.3 Uncoloured test specimens and test specimens with the highest level of organic and inorganic pigment loading shall be tested and, if the test results yield the same flame test classification, all test specimens with this colour range shall be considered representative of the range. If a material contains pigments which are known to affect the flammability characteristics, test specimens containing these pigments shall also be tested. Thus, the test specimens tested shall be those that:

a) contain no colouring;

b) contain the highest level of organic pigments;

c) contain the highest level of inorganic pigments;

d) contain pigments which are known to adversely affect flammability characteristics.

7.4 All test specimens shall be cut from a representative sample of the material (sheets or end products). After any cutting operation, care shall be taken to remove all dust and any particles from the surface. Cut edges shall have a smooth finish.

7.5 The density of the test specimens shall be determined in accordance with ISO 845.

7.6 The standard test specimen shall be 200 mm ± 5 mm long, 50 mm ± 2 mm wide and a maximum of 0,25 mm thick. Measure the thickness of each to the nearest 0,01 mm and note the measurements.

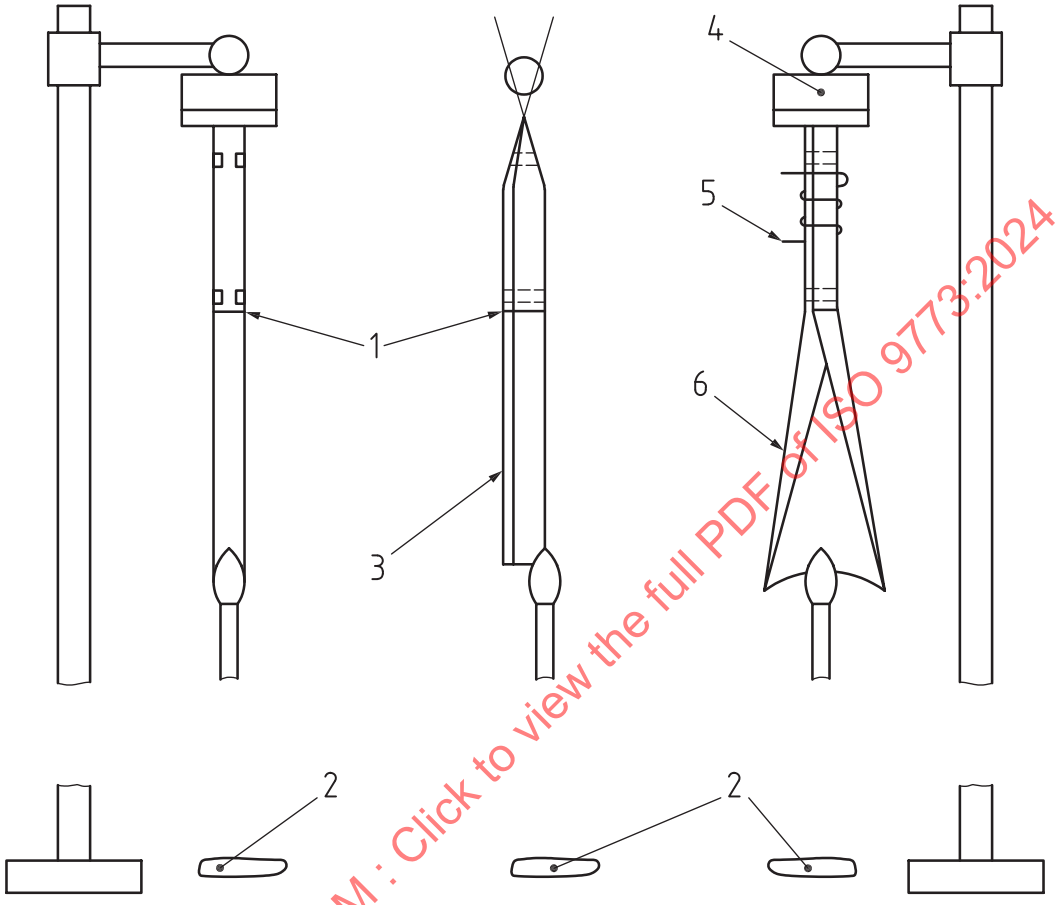
7.7 Test specimens with a thickness of more than 0,25 mm are suitable for testing with this test method if the test specimens, due to their thinness and nonrigidity, distort, shrink and/or are consumed up to holding clamp when tested using the test method in IEC 60695-11-10.

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

7.8 Mark each test specimen across its width with a line at 125 mm ± 5 mm from one end (the bottom end). Wrap the longitudinal axis of the test specimen tightly around the longitudinal axis of the mandrel to

form a lapped cylinder with the 125 mm line exposed. Secure the overlapping portions of the test specimen within the upper 75 mm segment above the 125 mm mark and at the upper end of the tube with pressure-sensitive adhesive tape. Then remove the mandrel.

7.9 The use of nichrome wire wound around the top 75 mm ± 2 mm of the test specimen (see Figure 1) as a reinforcement or substitute for the pressure-sensitive tape is recommended for stiff test specimens.



a) Front view of specimen, lapped at lower end **b) Side view of specimen, lapped at lower end** **c) Back view of specimen, not lapped at lower end**

Key

1 125 mm mark
2 cotton wool
3 lapped section
4 spring clamp
5 nichrome wire closure
6 unlapped section

Figure 1 — Specimen orientation

7.10 Prepare a minimum of 20 test specimens. It is advisable to prepare additional test specimens for any potentially necessary retesting.

8 Conditioning

8.1 Unless otherwise required by the material specifications, conditioning and testing shall be carried out under the following conditions.

8.2 Two sets of five test specimens shall be preconditioned for at least 48 h at 23 °C ± 2 °C and (50 ± 10) % relative humidity. Testing shall be carried out in the laboratory atmosphere (see 9.1) within one hour of being conditioned.

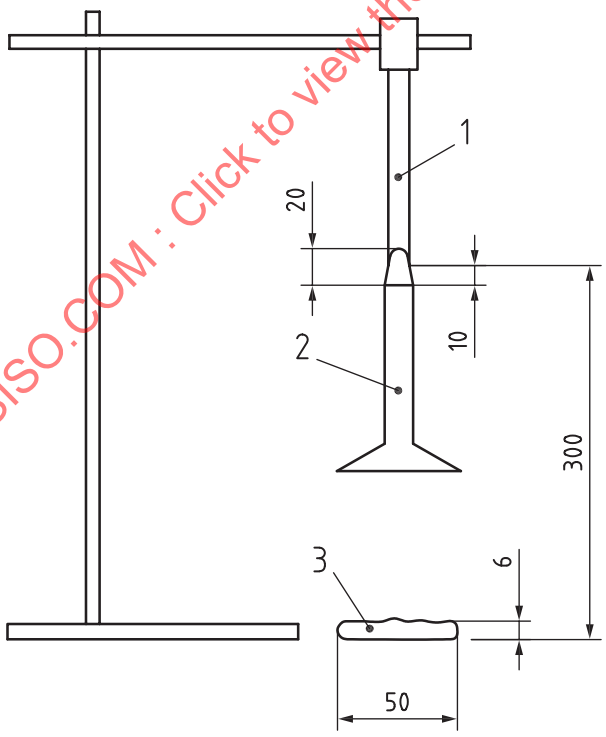
8.3 Two sets of five test specimens shall be preconditioned for 168 h at 70 °C ± 2 °C and then cooled in a desiccator for at least 4 h at room temperature, prior to testing. Once removed from the desiccator, the test specimens shall be tested in the laboratory atmosphere (see 9.1) within one hour.

9 Test procedures

9.1 All test specimens shall be tested in a laboratory atmosphere of 15 °C to 35 °C and 45 % to 75 % relative humidity.

9.2 Clamp the test specimen from the upper 6 mm of its length with the longitudinal axis vertical by a heavy spring clamp or other device, so that the upper end of the tube is closed to prevent any chimney effects during the test. The lower end of the test specimen shall be 300 mm ± 10 mm above a horizontal layer of 0,05 g to 0,08 g of cotton wool of area approximately 50 mm x 50 mm and maximum thickness 6 mm (see Figure 2).

Dimensions in millimetres



Key

1 specimen
2 burner
3 cotton wool

Figure 2 — Application of flame

9.3 Obtain the desired burner flame by adjusting the supply and air ports of the burner until a yellow-tipped blue flame of height 20 mm ± 1 mm is produced. Increase the air supply until the yellow tip just disappears. Measure the height of the flame again and correct it to 20 mm ± 1 mm if necessary.

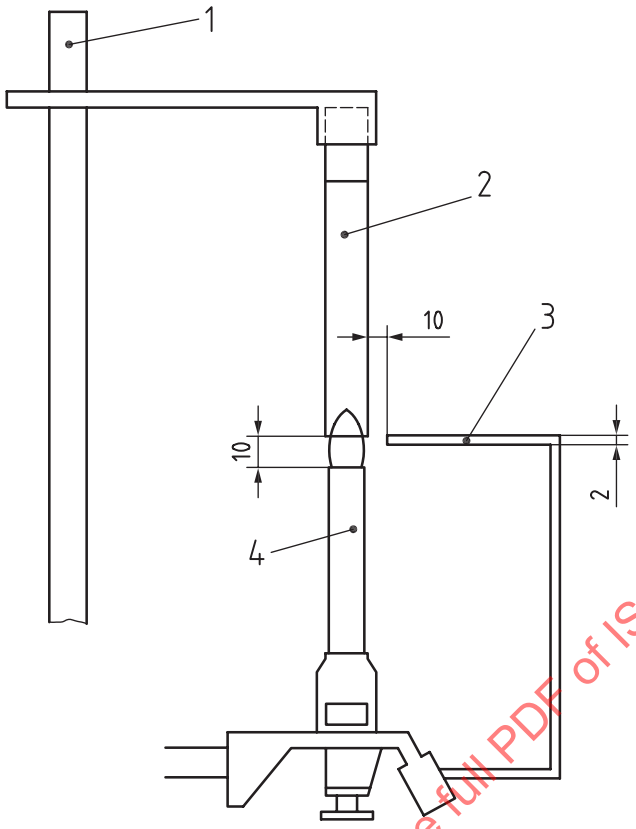
9.4 Apply the flame of the burner centrally to the middle point of the bottom edge of the unlapped section (see Note 1 for 9.5) of the test specimen so that the top of the burner is 10 mm ± 1 mm below that point of the lower end of the test specimen, and maintain it at that distance for 3 s ± 0,5 s, moving the burner as necessary in response to any changes in the length or position of the specimen (see Note 2 for Clause 9.5). If the test specimen drips molten or flaming material during the flame application, tilt the burner at an angle of up to 45° and withdraw it just sufficiently from beneath the test specimen to prevent material from dropping into the barrel of the burner while maintaining the 10 mm ± 1 mm spacing between the centre of the outlet of the burner and the remaining portion of the test specimen, ignoring any strings of molten material.

9.5 After the application of the flame to the test specimen for 3 s ± 0,5 s, immediately withdraw the burner at a rate of approximately 300 mm/s to a distance of at least 150 mm away from the test specimen and simultaneously use the timing device to commence measurement, to the nearest second, of the first afterflame time t_1. Record t_1.

NOTE 1 For test specimens that flare and therefore are not lapped at their lower end when suspended from the pinched upper end, the longitudinal axis of the test specimen material thus becomes the direction along which the flame is applied.

NOTE 2 For test specimens which move under the influence of the burner flame, the use of a small indicator rod attached to the burner (shown in Figure 3) has been found to be helpful in maintaining the 10 mm distance between the top of the burner and the major portion of the test specimen.

Dimensions in millimetres



Key

1 fixed stand
2 specimen
3 indicator rod
4 burner

Figure 3 — Burner with optional flame distance indicator

9.6 As soon as afterflaming of the test specimen ceases, even if the burner has not been withdrawn to the full 150 mm distance from the test specimen, immediately place the flame of the burner again under the specimen and maintain the burner at a distance of 10 mm ± 1 mm from the remaining portion of the test specimen for 3 s ± 0,5 s while moving the burner clear of dropping material as necessary as described in 9.4.

9.7 After this application of the flame to the test specimen for 3 s ± 0,5 s, immediately extinguish the burner or remove it at a rate of approximately 300 mm/s to a distance of at least 150 mm from the test specimen and simultaneously, using the timing device, commence measurement to the nearest second of the second afterflame time t_2 and the afterglow time t_3 of the specimen. Record t_2 and t_3. Note also whether the afterflame or afterglow progresses up to the 125 mm mark and whether the cotton wool layer below the test specimen is ignited by material dropping from the test specimen.

9.8 Repeat procedures 9.1 to 9.7 until at least five test specimens have been tested.

10 Expression of results

10.1 For each test specimen, calculate the total afterflame time using Formula (1):

$$t_{Fi} = t_1 + t_2 \quad (1)$$

where

t_{Fi} is the total afterflame time for the individual test specimen;

t_1 is the first afterflame time;

t_2 is the second afterflame time.

10.2 For each set of five test specimens from both preconditioning treatments, calculate the total set afterflame time (t_{FS}) as shown in Formula (2):

$$t_{FS} = \sum_{i=1}^{i=5} t_{Fi} \quad (2)$$

where i is the individual test specimen number and t_{Fi} is as defined in 10.1.

11 Precision

11.1 The precision data were determined from an interlaboratory experiment conducted in 1986 involving six laboratories, four materials and two replicates. Each replicate was determined by averaging the values of five measurements. The results were analysed using ISO 5725-2 and are summarized in Table 1.

Table 1 — Precision data

Stage	Parameter	Time (s)			
		FEP[a)]	PI[a)]	PET[a)]	PVF[a)]
After first flame application	Average	0	0,5	2,5	6,0
	Repeatability	0	0,36	0,71	4,46
	Reproducibility	0	0,71	0,89	4,29
After second flame	Average	0	0	0,71	2,50
application plus glowing	Repeatability	0	0	0,71	3,93
	Reproducibility	0	0	1,25	5,18

a) Symbols for plastics materials are defined in ISO 1043-1.

Table 1 is only intended to present a meaningful way of considering the approximate precision of this test method for a range of materials. Do not apply these data to acceptance or rejection of material, as they are specific to the interlaboratory test and are not necessarily representative of other lots, conditions, materials or laboratories.

12 Test report

The test report shall include at least the following information:

a) a reference to this document, i.e. ISO 9773:2024;

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

c) the conditioning treatment;

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

e) full identification of the product tested, including the manufacturer's name, number or code;

f) the gas used for the burner;

g) the name and location of the test facilities;

h) the date of the test;

i) the individual test values, including:

   1) test specimen number (i);

   2) test specimen thickness;

   3) first afterflame time (t_1);

   4) second afterflame time (t_2);

   5) total afterflame time (t_{Fi});

   6) total set afterflame time (t_{FS});

   7) afterglow time after the second flame application (t_3);

   8) whether there was afterflame or afterglow up to the 125 mm mark; and

   9) whether the cotton wool indicator was ignited;

j) any deviations from the procedure;

k) any unusual features observed.