

## **Reaction to fire tests for building products — Determination of a building product's propensity to undergo continuous smouldering**

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## Foreword

This document (FprEN 16733:2015) has been prepared by Technical Committee CEN/TC 127 “Fire safety in buildings”, the secretariat of which is held by BSI.

This document is currently submitted to the Formal Vote.

This standard is produced in response to the EC mandate M/385. CEN/TC 127 was requested to develop this test method to determine possible glowing combustion behaviour in building products. This test method forms part of the present EC classification system for the reaction to fire.

Task Group 6 of CEN TC 127/WG4 was created to develop this test method. In the early stages of its development, it was found that the term ‘glowing combustion’ as defined in EN ISO 13943 does not completely characterise the specific combustion behaviour of a building product. In particular, the increase of temperature which is considered as typical for the process of smouldering is not considered in the EN ISO 13943 definition. Therefore the task group made a clarification and changed the term glowing combustion to smouldering combustion. Smouldering is defined in this standard as ‘combustion of a material without flame and with or without visible light’. This includes glowing combustion.

## **Introduction**

This test method has been developed considering methods NT FIRE 002 and NT FIRE 035 and standards BS 5803-4 and Önorm B 3800. It specifies a test for determining the propensity of products to smoulder continuously when tested in a vertical orientation. The method does not impose a mechanically influenced airflow through the test specimens since this would not represent most end-use conditions.

### **Safety warning**

The attention of all persons concerned with managing and carrying out this test is drawn to the fact that fire testing may be hazardous and that there is a possibility that toxic and/or harmful smoke and gases may be evolved during the test. Operational hazards may also arise during the testing of specimens and the disposal of test residues.

An assessment of all potential hazards and risks to health should be made and safety precautions should be identified and provided. Written safety instructions should be issued. Appropriate training should be given to relevant personnel. Laboratory personnel should ensure that they follow written safety instructions at all times.

Adequate means of extinguishing the specimen should be provided, bearing in mind that some specimens may produce severe flaming during the test. A hand water spray or an inert gas suppression system e.g. compressed nitrogen which can be directed to the burning area should be available together with other means, such as fire extinguishers etc.

In some cases, smouldering may be difficult to extinguish completely and immersion in water may be necessary.

## 1 Scope

This standard specifies a test method to determine the propensity (ability) of a building product to smoulder continuously when exposed to an open flame under the influence of natural convective airflow.

It is intended for all building products classified according to EN 13501-1. Details as to how the products shall be mounted and fixed for this test are given in the relevant product standards. The field of application of the test results shall be defined in the product standards.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are relevant for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13238 *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

EN 13501-1 *Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests*

EN 60584-1 *Thermocouples — Part 1: EMF specifications and tolerances*

EN ISO 13943 *Fire safety — Vocabulary (ISO 13943)*

## 3 Terms and definitions

For the purposes of this document, the definitions given in EN ISO 13943 apply, together with the following:

### 3.1

#### **product**

material, composite or assembly about which information is required

### 3.2

#### **material**

basic single substance or a uniformly dispersed mixture of substances e.g. metal, stone, wood, concrete, mineral wool

### 3.3

#### **composite**

combination of materials which are generally recognised as discrete entities e.g. coated or laminated materials

### 3.4

#### **assembly**

fabrication of materials and/or composites e.g. sandwich panels

### 3.5

#### **exposed surface**

surface of the product which is subjected to the heating conditions of the test

### 3.6

#### **test specimen**

representative piece of the sample (prepared for testing in accordance with instruction)

### **3.7**

#### **smouldering**

combustion of a material without flame and with or without visible light. This includes glowing combustion

Note to entry: Smouldering is generally evidenced by an increase in temperature and/or by the presence of effluents.

### **3.8**

#### **progressive smouldering**

self-propagating exothermic oxidation that is not accompanied by flaming combustion

Note to entry: It can be accompanied by glowing.

### **3.9**

#### **sustained flaming**

persistence of flaming for a period greater than 10 seconds

### **3.10**

#### **flame spread**

propagation of flame away from the source of sustained flaming

### **3.11**

#### **glowing combustion**

combustion of a material in the solid phase without flame but with emission of light from the combustion zone

## **4 Principle**

One test specimen is vertically mounted and exposed to constant heat from a propane gas burner with its flame impinging on the specimen surface. Smouldering is detected by measuring temperatures by using thermocouples installed at defined distances within the vertical test specimen and the observation of sustained flaming following re-ignition.

## **5 Test apparatus**

### **5.1 Main apparatus**

NOTE All dimensions given in the following description are nominal unless tolerances are specified.

The main apparatus is shown in Figures 1, 2 and 3. The apparatus includes:

- specimen holder;
- propane burner;
- wire mesh box (Figure 4);
- six thermocouples inside the specimen connected to a recording device (Figure 5);
- specimen holder frame to hold flexible or thin products in place (Figure 6).

#### **5.1.1 Test specimen holder**

The specimen mounting frame shall hold the specimen 50 mm above the test floor. This shall be accomplished by the use of two spacers or supporting devices, maximum 50 mm high x 50 mm wide and 100 mm long placed at the outer edge of the specimen, mounted on the floor upon which the bottom edge of the test specimen shall be located. (See Figures 1, 2 and 3).

The test specimen shall not be continuously covered from top to bottom on the vertical side edges. The maximum cover on the vertical edges of the specimens shall consist of two clamps on each side each not

more than 40 mm in height. Neither the top nor the bottom edges of the specimen shall be covered in any way.

**NOTE** For thin or flexible test specimens, a planar surface shall be maintained. This can be achieved either by clamping between the sections of flat steel frame, 800 x 300 mm, with a frame width of 10 mm and a thickness of 3 mm or by using a single frame with pins on all four edges upon which the specimen shall be supported. (See Figure 6).

### 5.1.2 Wire mesh box

For loose fill material the specimen holder shown in Figure 4 shall be used. The specimen holder shall consist of a steel framed wire mesh box, 800 mm high, 300 mm wide and 100 mm deep. The top of the wire mesh box is open and remains open for the test. The wire mesh shall be zinc-coated with a width of mesh  $9 \pm 1$  mm and a wire size  $1 \pm 0.2$  mm. (See Figure 4).

### 5.1.3 Propane burner

The burner shall be of the Teclu type (see Figure 7). The nominal inner diameter of the burner is 10.3 mm and the nominal inner diameter of the outer tube is 14.95 mm. The gas nozzle shall have an inner diameter of  $0.5 \pm 0.1$  mm. The straight part of the burner tube shall have a length of  $100 \pm 10$  mm, the conical part shall have a length of  $35 \pm 3$  mm. The lower part of the opening of the conical part shall have an inner diameter of  $30 \pm 5$  mm.

Propane having a purity of at least 95 % shall be used.

The air supply to the burner shall be fully open. The propane flow rate of the burner shall be  $100 \pm 5$  g/h. ( $0.85 \pm 0.05$  l/min).

### 5.1.4 Thermocouples in the test specimen

Six sheathed type K thermocouples according to EN 60584-1 with outer diameter of 1.5 mm shall be positioned within the test specimen. The thermocouples shall be located in the positions as shown in Figure 5.

The tips of the thermocouples shall be positioned on the centre line of the test specimen at 100 mm intervals measured vertically from the centre line of the burner (see Figure 5). These thermocouples shall be within the test specimen at half the actual specimen thickness. The thermocouples shall be mounted from the reverse face of the test specimen.

The thermocouples shall be supported by a framework at the rear of the test specimen, 40 mm x 80 mm x 855 mm. This framework shall be positioned at least 50 mm from the reverse face of the test specimen.

### 5.1.5 Recording device

A recording device shall be used to record the temperatures during the test. The recording device shall be capable of recording data at least every 30 seconds.

## 5.2 Additional equipment

### 5.2.1 Flowmeter

The flow of propane to the burner shall be controlled and measured with a flowmeter. This shall have an accuracy of  $\pm 3\%$ .

### 5.2.2 Timing device

This shall have an accuracy of  $\pm 1$  s per h.

### 5.2.3 Anemometer

A hot wire anemometer with an accuracy of  $0.1 \text{ ms}^{-1}$ .

#### **5.2.4 Fire extinguishing board**

A calcium silicate board (suggested size 850 x 320 x 10 mm) shall be used to extinguish any flaming established after removal of the burner. The board shall be placed over the face of the specimen to extinguish any flaming.

### **6 Test specimens**

The test specimens shall be cut from a sample which is representative of the product to be tested.

#### **6.1 Dimensions and number of test specimens**

6.1.1 At least two specimens shall be cut for test.

6.1.2 The test specimens shall be rectangular with the dimensions  $800 \times 300 \pm 3$  mm.

6.1.3 The test specimen shall be tested at its end-use thickness up to a maximum of 100 mm. If the test specimen is symmetrical reduce the thickness from the reverse side to 100mm. If the specimen is unsymmetrical then the thickness shall be reduced from the reverse side however both sides of the specimen shall be tested.

A product with directional properties shall be tested in both directions. In this case test one specimen in each direction and complete the test using the worst orientation.

6.1.4 The test specimen shall be positioned in the test specimen holder.

6.1.5 If the material under test is too small to obtain a test specimen in the correct dimensions, the test specimen may be produced from several small pieces. However, the portion exposed to the gas flame shall be in one piece. The dimensions of the pieces making up such a test specimen shall be specified in the test report.

#### **6.2 Loose fill materials**

Loose fill products shall be fitted into a wire mesh box (see Figure 4) in such a way that the density specified by the manufacturer is achieved (see clause 5.1.2).

### **7 Conditioning of specimens**

Test specimens shall be conditioned as described in EN 13238.

### **8 Test procedure**

8.1 The test shall be carried out in an environment essentially free from air currents. The room temperature shall be  $20 \pm 10$  °C and the air velocity measured using the hot wire anemometer according to 5.2.3 at 100 mm and 600 mm above the test floor and 100 mm away from the front and rear edges of the test pieces shall not exceed  $0.2 \text{ ms}^{-1}$  in any direction. The effluent gases shall be extracted without causing any draught near the test specimen to exceed  $0.2 \text{ ms}^{-1}$  in any direction.

8.2 The test specimen shall be positioned in the specimen holder and six thermocouples shall be positioned within the test specimen (see 5.1.4 and Figure 5)

8.3 The burner shall be ignited and allowed to stabilize for at least 2 minutes.

8.4 Start the data logger or chart recorder.

8.5 The test shall commence when the burner is placed in position. The burner shall be placed centrally with the axis horizontal and perpendicular to the surface of the test specimen and 100 mm above the bottom edge



of the specimen. The distance from the front surface of the burner head to the exposed surface of the specimen shall be  $60 \pm 2$  mm. (See Figure 1)

At the same time as the burner is positioned, the timing device shall be started.

8.6 Expose the specimen to the flame for 15 minutes.

8.6.1 If the product ignites whilst the burner is being applied, monitor the burning. If the specimen needs to be extinguished due to flame reaching 200 mm above the top of the specimen for a period of more than 30 s, this test method is not suitable for the product being evaluated.

8.6.2 After 15 minutes the burner shall be removed. The fire extinguishing board shall be applied to the face of the specimen for a period of 20 s.

If the specimen ignites again within 60 s after removal of the fire extinguishing board, apply the board again for a further 40 s. If the specimen again ignites after removal of the fire extinguishing board, the test shall be stopped. This test method shall be deemed to be not suitable for the product being evaluated.

NOTE This process has to be done carefully to avoid any interference in the test specimen behaviour.

8.7 If the specimen ignites within 5 minutes after removal of the burner the fire extinguishing board shall be reapplied for a further 20 secs.

8.8 The behaviour of the test pieces during the test and their condition after the test shall be observed. This includes sustained flaming, distance of flame spread, melting, spalling, charring, expansion, shrinkage, delamination or any other behaviour.

8.9 At least two test specimens shall be tested for a formal test. Further specimens shall be tested where the product has directional properties (see 6.1.3).

8.10 The apparatus shall be cooled to ambient temperature between successive tests.

## 9 Termination of test

9.1 The test shall be terminated:

- a) after 6 hours or
- b) after all thermocouples have shown no further increase in temperature for at least 60 minutes and all recorded temperatures are below 50 °C,

whichever is the shorter.

9.2 The test should also be terminated if any of the conditions defined in Clause 10 of this standard are deemed to have occurred.

## 10 Expression of results

Continuous smouldering has occurred if any one or more of the following has been observed:

- a) sustained flaming at the top or either vertical side of the specimen has occurred which has not been caused by a visible spread of flame on the surface of the specimen;
- b) re-ignition of the specimen has occurred on any surface or edge 5 minutes or more after removal of the burner and after all sustained flaming on the surface of the specimen has ceased;
- c) after removal of the burner flame, thermocouple 6 (see Figure 5) registers a temperature rise of more than 250 °C.

- d) after the maximum test duration of 6 hours any of the thermocouples registers more than 50 °C or increasing temperatures for at least 60 minutes.

An assessment is not possible if the test has been stopped according to clause 8.6.2.

In addition to reporting the results as given above, the following shall be reported for each specimen:

- 1) the maximum temperature recorded for each thermocouple and the time at which this occurs;
- 2) graphs of the temperatures recorded by each thermocouple with time;
- 3) record of sustained flaming of the specimen surface and time it occurs;
- 4) record of time of second application of extinguishing board within the 5 minutes period after removal of the burner flame, if required;
- 5) time to flaming at an edge.

## **11 Performance criteria and declaration**

Based upon the results described in clause 10, the following shall be reported and declared:

- test has been passed; the product does not show propensity for continuous smouldering combustion, or
- test has been failed; the product shows propensity for continuous smouldering combustion, or
- assessment of the propensity for continuous smouldering combustion is not possible.

## **12 Direct and extended application of test results**

The field of application which includes direct and extended application of test results is defined in the relevant product standards.

It is assumed that the following product parameters have an influence on the smouldering behaviour of a product:

- density;
- thickness;
- composition;
- orientation.

These and other parameters should be addressed in the relevant product standard.

The test result is valid for the product which was tested.

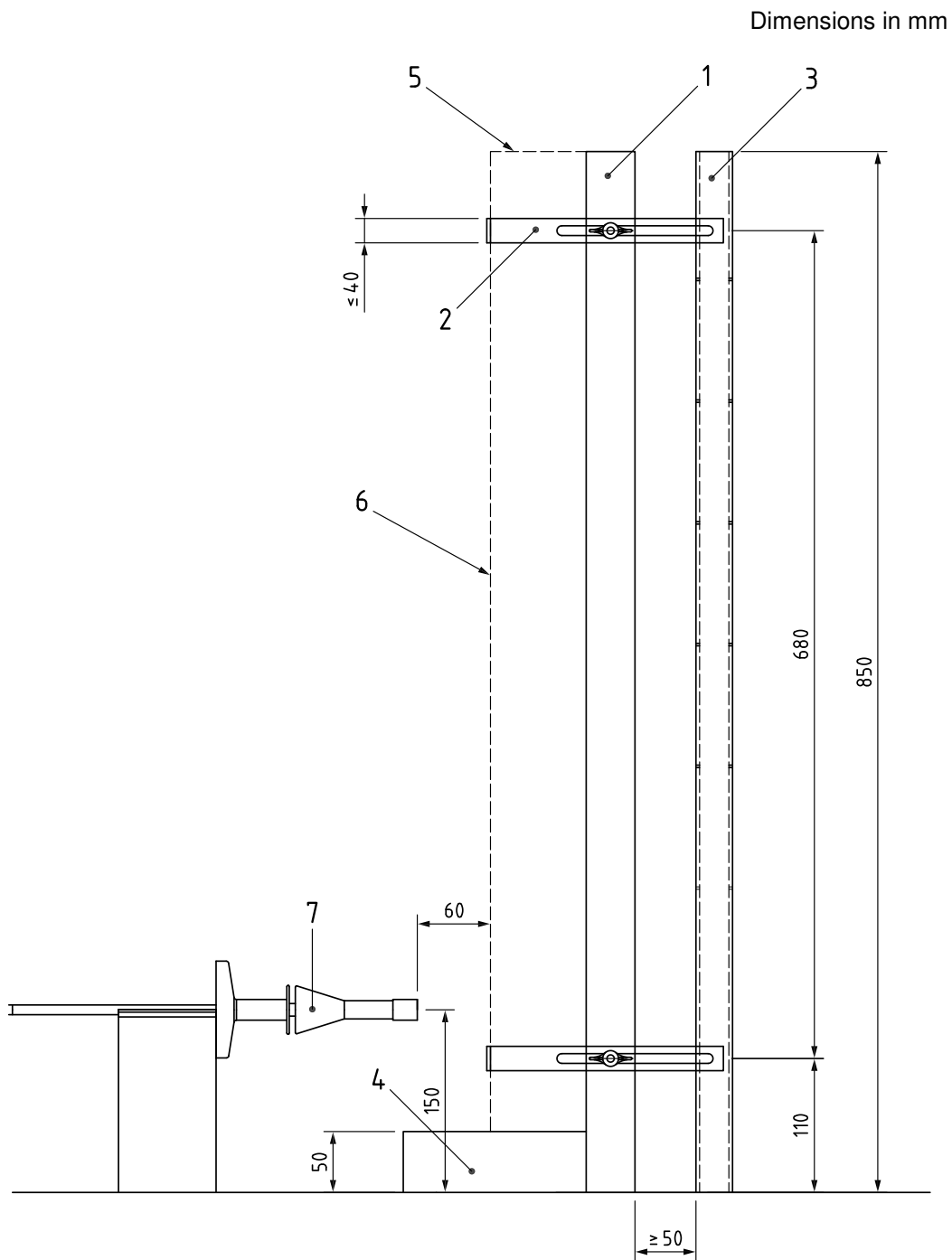
The test result shall also be valid for products of greater thickness when the test specimen has been tested at a thickness of 100mm.

## **13 Test report**

The test report shall include the following information as a minimum. A clear distinction shall be made between the data provided by the sponsor and data determined by the test:

- a) reference that the test was carried out in accordance with EN 16733;
- b) any deviations from the test method;

- c) name and address of the testing laboratory;
- d) date and identification number of the report;
- e) name and address of the sponsor;
- f) name and address of the manufacturer/supplier, if known;
- g) date of test specimen arrival;
- h) identification of the product;
- i) for asymmetrical products, face tested;
- j) for directional products, orientation;
- k) description of the sampling procedure, where relevant;
- l) a general description of the product tested including density, mass per unit area and thickness, together with the details of construction of the test specimen;
- m) details of conditioning;
- n) date of test;
- o) test results and assessment expressed in accordance with clauses 10, 11 and 12;
- p) all observations made during the test;
- q) photographs of the test specimens after test cut vertically through to show extent of smouldering;
- r) information on the intended application of the building product, if known;
- s) the statement 'the test results relate to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use'.

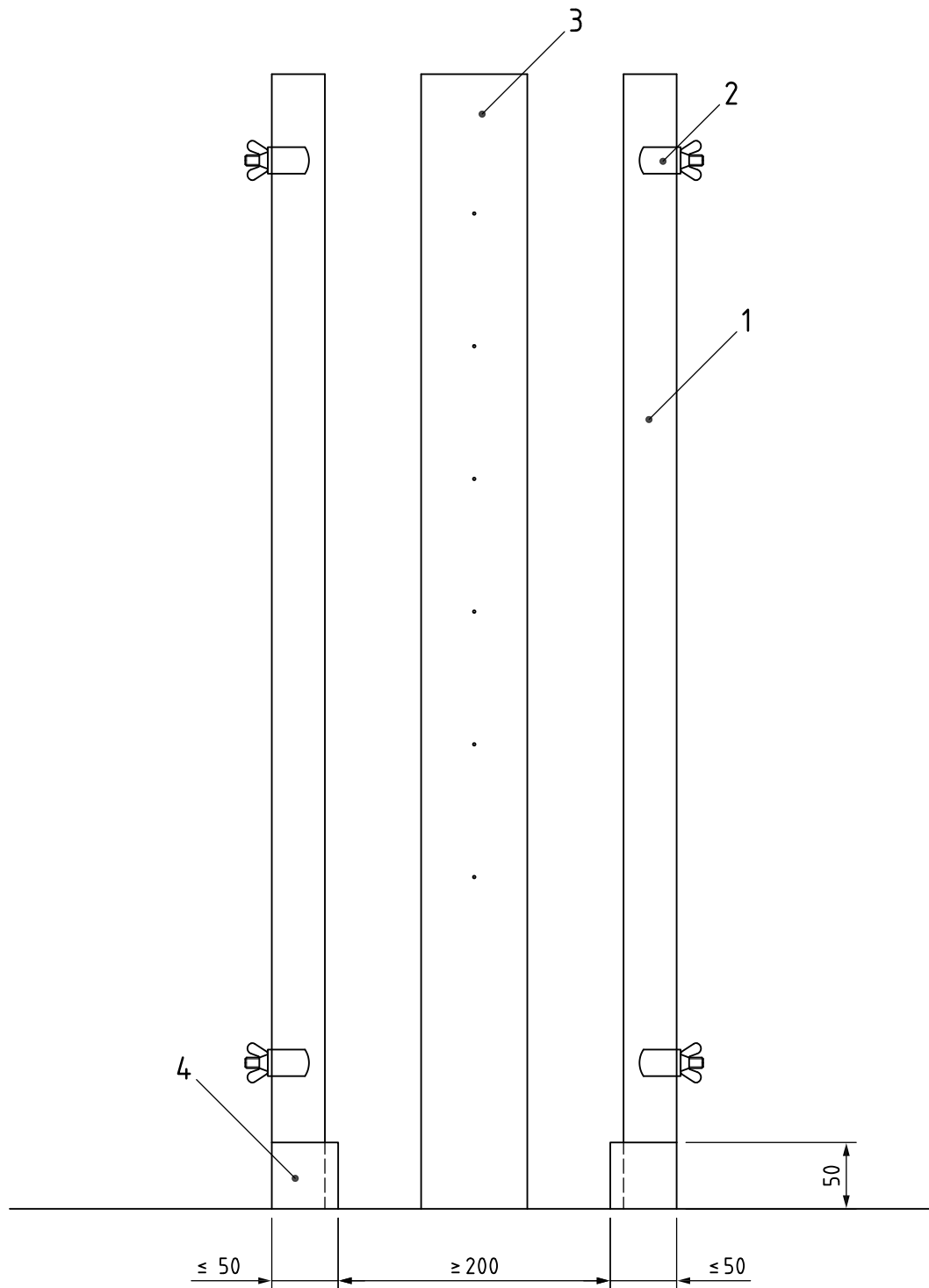


## Key

- 1 Sample support frame (40 x 40 x 850 mm)
- 2 Clamps
- 3 TC support frame (40 x 80 x 850 mm)
- 4 Support devices (50 x 50 x 100 mm)
- 5 Free top edge test specimen
- 6 Front of test specimen
- 7 Teclu burner (see Figure 7)

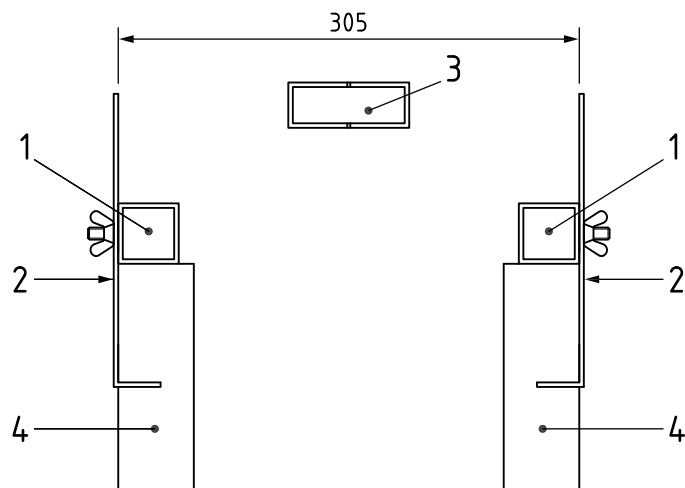
**Figure 1 — Test apparatus – Side elevation**

Dimensions in mm

**Key**

- 1 Sample support frame
- 2 Clamps
- 3 TC support frame (40 x 80 x 850 mm)
- 4 Support devices (50 x 50 x 100 mm)

**Figure 2 — Test apparatus - Front elevation**

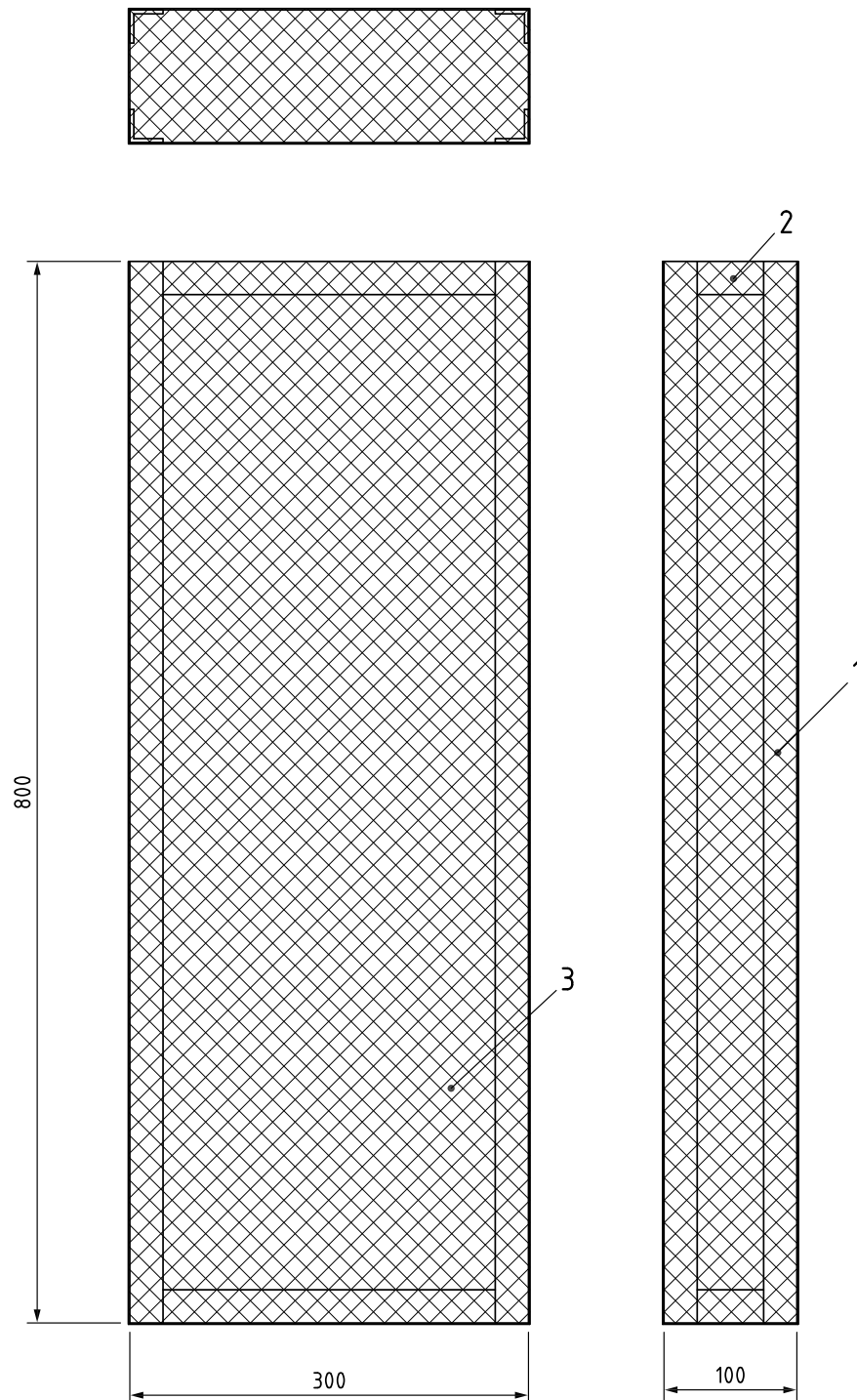


**Figure 3 — Test apparatus - Plan view**

**Key**

- 1 Sample support frame
- 2 Clamps
- 3 TC support frame
- 4 Support devices (50 x 50 x 100 mm)

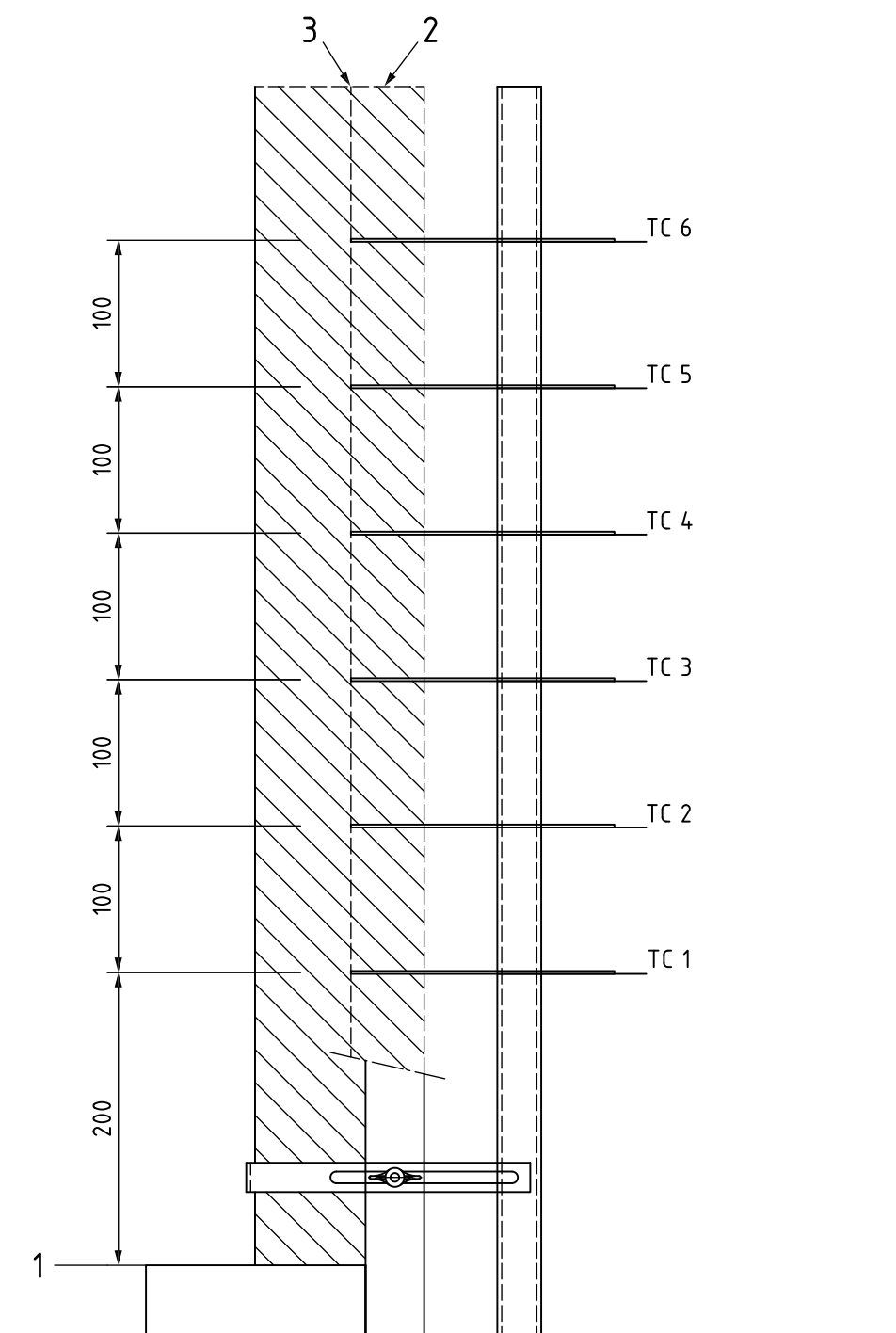
Dimensions in mm

**Key**

- 1 Steel L angle (15 x 15 x 3 mm)
- 2 Steel flat plate (15 x 3 mm)
- 3 Wire mesh (see 5.1.2 for specifications)

**Figure 4 — Wire mesh box**

Dimensions in mm

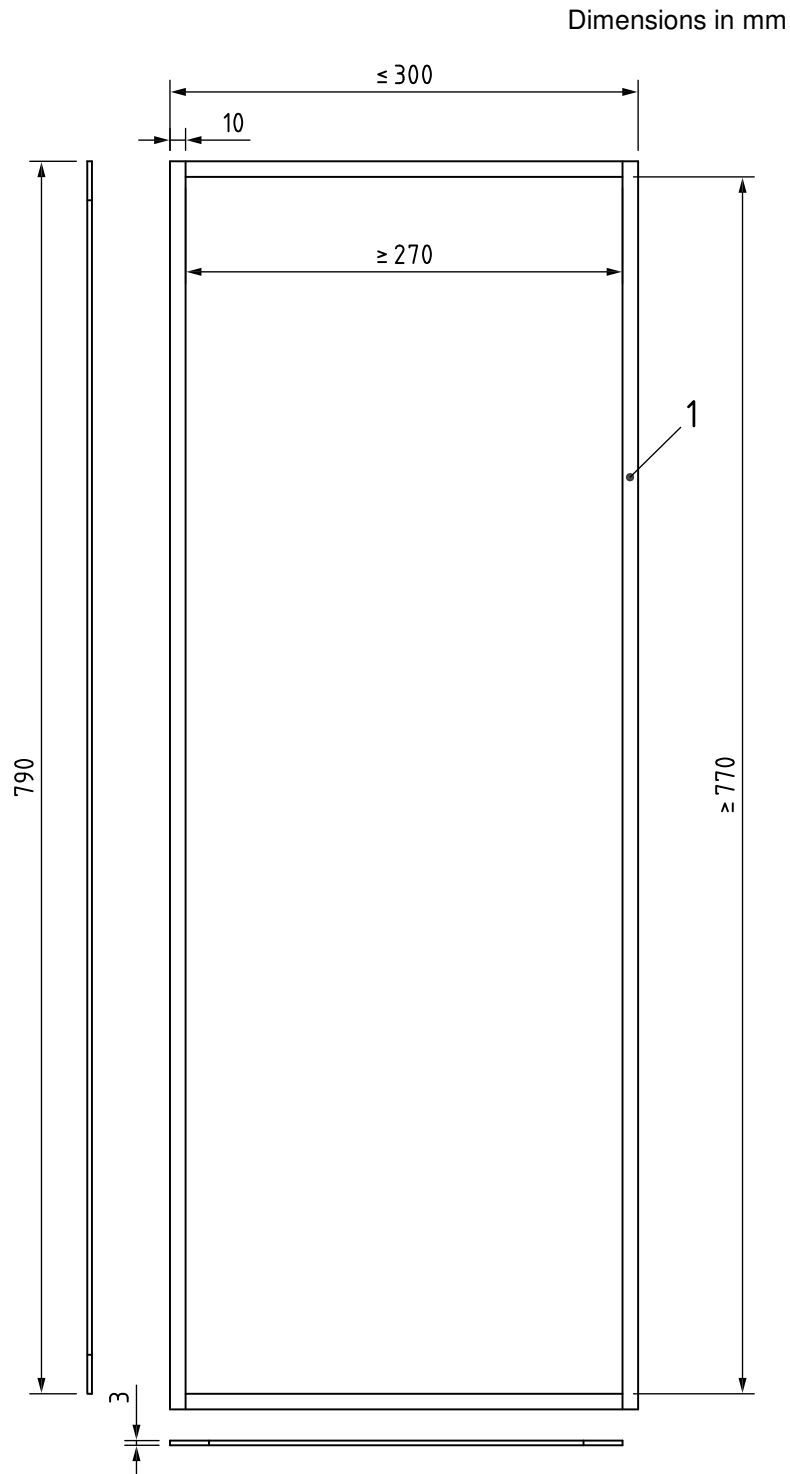


# Key

- 1 Bottom edge test specimen
- 2 Test specimen
- 3 Centre of test specimen

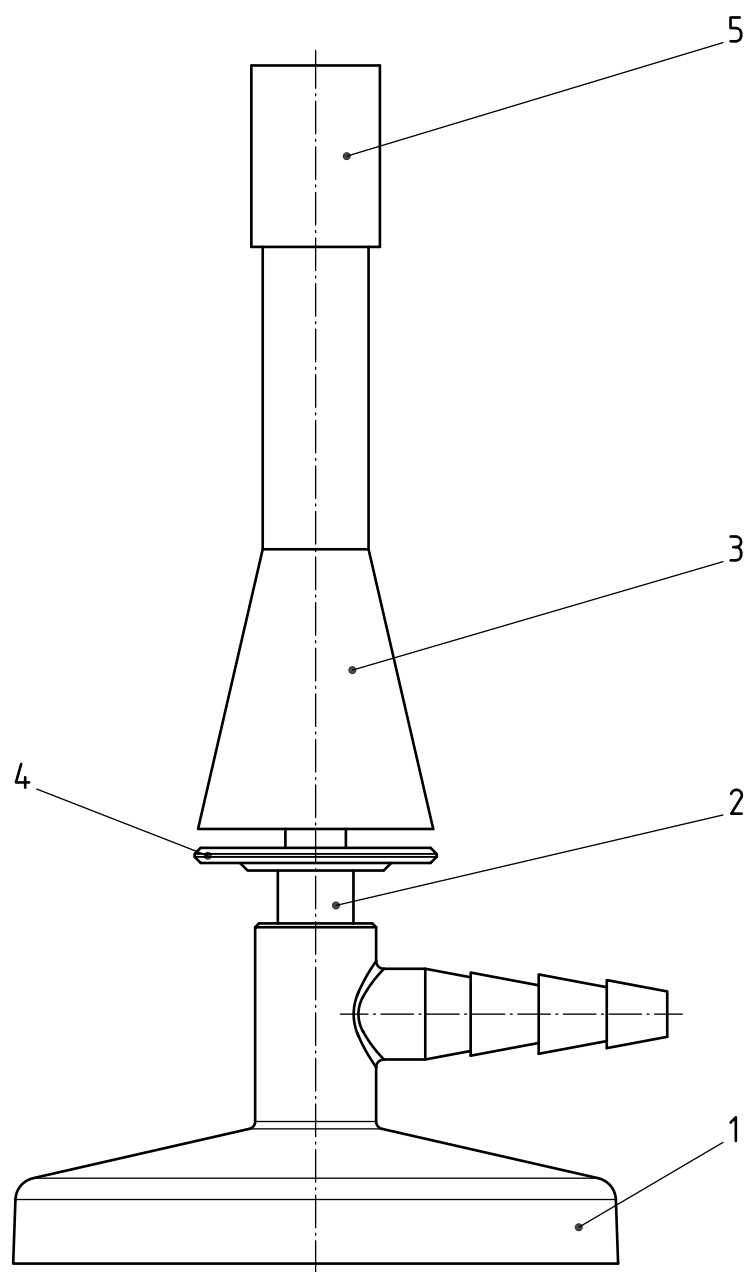
**Figure 5 — Positions of thermocouples**



**Key**

- 1 Steel strip (10 x 3 mm)

**Figure 6 — Frame for flexible and thin products**



# Key

- 1 Stand (ø 80 mm)
- 2 Nozzle (ø 0.55 mm)
- 3 Teclu tube (ø 14 x 86 mm) containing perforated disc
- 4 Regulator (ø 32 x 3 mm)
- 5 Burner outlet cap (outer ø 17 mm, inner ø 14 mm)

**Figure 7 — Teclu burner**

## Annex A (informative) Precision of the method

### A.1 General

An inter-laboratory trial was conducted on the test method described in this European Standard. The trial involved 6 laboratories and 6 building products. Statistical analysis of the results of the trials on this test method was carried out in order to determine the repeatability and reproducibility of the method.

The data generated by this method consists of yes / no answers.

For these results, the numbers of the yes and no answers, as well as their relative proportions, were evaluated. Also included was an additional non-standard parameter called 'degree of uncertainty' which attempts to combine the proportions of yes and no answers to a single number: This quantity is calculated as  $2 \times \min(\text{yes } \%, \text{no } \%)$ ; hence it equals zero if all the answers are yes or no and 100 % if half of the answers are yes and half of them are no.

The parameters analysed and other relevant details are given in Table A.1 below.

**Table A.1**

Parameter	Type
Occurrence of sustained flaming at the top edge or vertical sides	Yes/no
Re-ignition of the product 5 minutes after removal of the flame source	Yes/no
250K temperature rise recorded on Thermocouple 6	Yes/no

Table A.2 shows the results of the yes/no analysis for each of the application times and application areas. The results are consistent for some products and slightly variable for others, which has been shown to be more a function of material/product variation than test method variability.

**Table A.2**

Material	Smouldering  (% Yes)	Sustained flaming at an edge  (%)	Re-ignition more than 5 minutes after removal of flame  (%)	Temperature rise greater than 250K  (%)	Indication of uncertainty  Values for Yes/No Answers
A	0	0	0	0	0
B	100	0	0	100	0
C	27	0	0	27	54
D	0	0	0	0	0
E	100	0	0	100	0
F	17	17	17	0	34

## **A.2 Conclusions**

- a) The variability of the yes / no response for each product is generally a function of the product itself rather than the method;
- b) The relative reproducibility was good for all products tested, the differences being mainly related to product variability (see degree of uncertainty values) .