# Needle-Flame Test Method â€“ Apparatus, Confirmatory Test Arrangement and Guidance IEC 60695-11-5

## Description



Needle Flame Tester

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The best method for testing electrotechnical products with regard to fire hazard is to duplicate exactly the conditions occurring in practice. In most instances this is not possible. Accordingly, for practical reasons, the testing of electrotechnical products with regard to fire hazard is best conducted by simulating as closely as possible the actual effects occurring in practice.

Parts of electrotechnical equipment which might be exposed to excessive thermal stress due to electric effects, the deterioration of which might impair the safety of the equipment, should not be unduly affected by heat and by fire generated within the equipment.

Parts of insulating material or of other combustible material which are liable to propagate flames inside the equipment may be ignited by flames produced by a failing component. Under certain conditions, for example a fault current flowing over a tracking path, overloading of components or parts and bad connections, flames may also occur; such flames may impinge upon combustible parts in the vicinity.

This part of IEC 60695 should be used to measure and describe the properties of materials, products or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

This part of IEC 60695 specifies a needle-flame test to simulate the effect of a small flame which may result from fault conditions, in order to assess by a simulation technique the fire hazard.

It is applicable to electrotechnical equipment, its sub-assemblies and components and to solid electrical insulating materials or other combustible materials.

## 4 General description of the test

The test is performed to determine that, under defined conditions, the test flame does not cause ignition of parts, or that a combustible part ignited by the test flame has a limited duration of burning or a limited extent of burning, without spreading fire by flames or burning or glowing particles falling from the test specimen.

This test determines the effects on the test specimen of a small flame such as may arise from other ignited components and the relevant product specification shall specify the duration of flame application and the criteria for acceptance.

## 5 Description of the test apparatus

### 5.1 Burner

The burner to produce the test flame shall consist of a tube at least 35 mm long with a bore of 0,5 mm Â± 0,1 mm and an outer diameter not exceeding 0,9 mm.

NOTE The tubing specified in ISO 9626 [1]2 (0,8 mm normal walled or thin walled) meets the requirements in this standard for an internal diameter of 0,5 mm Â± 0,1 mm and an outside diameter no greater than 0,9 mm.

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The burner is supplied with butane or propane gas having a purity of at least 95 %. There shall be no air admitted to the burner tube.

### 5.2 Flame

With the axis of the burner in the vertical position, the gas supply is adjusted so that the length of the flame is 12 mm Â± 1 mm, when viewed in subdued light against a dark background (see Figure 1a). The flame shall be confirmed using the apparatus and procedure detailed in Annex

A. The test time for the temperature to increase from 100 Â°C Â± 5 Â°C to 700 Â°C Â± 3 Â°C shall be 23,5 s Â± 1,0 s.

### 5.3 Laboratory fumehood/chamber

The laboratory fumehood/chamber shall have an inside volume of at least 0,5 $m^3$. The chamber shall provide a draught-free environment, whilst allowing normal thermal circulation of air past the test specimen. The chamber shall permit observation of the test in progress. The inside surfaces of the walls shall be of a dark colour.
For safety and convenience, it is desirable that this enclosure (which can be completely closed) be fitted with an extraction device, such as an exhaust fan, to remove products of combustion, which may be toxic. The extraction device shall be turned off during the test and turned on immediately after the timing measurements have been made. A positive closing damper may be needed.

## 6 Test specimen

If possible, the test specimen shall be a complete equipment, sub-assembly or component. If it is necessary to take away parts of an enclosure or to cut off a suitable part to perform the test, care shall

be taken to ensure that the test conditions are not significantly different from those occurring in normal use with regard to shape, ventilation conditions, effect of thermal stresses and possible flames occurring, or burning or glowing particles falling in the vicinity of the test specimen.

If the test specimen is a suitable part cut from a larger unit, care shall be taken to ensure that in this particular case the test flame is not applied incorrectly, for example to an edge created by cutting.

If it is not possible to conduct the test on a sub-assembly or component within the equipment, the test is conducted on a test specimen removed from the equipment.

**7 Severities**

Preferred values of duration of application ($t_a$) of test flame are as follows:

â€“ 5 s, 10 s, 20 s, 30 s, 60 s, 120 s.

The tolerance for all values is 0/-1 s

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**8 Conditioning**

If not otherwise specified in the relevant specification, the test specimen, the wooden board and the tissue paper shall be conditioned for not less than 24 h in an atmosphere having a temperature between 15 Â°C and 35 Â°C and a relative humidity between 45 % and 75 % before starting the test.

**9 Test procedure**

**9.1 Position of test specimen**

Unless otherwise specified in the relevant specification, the test specimen is arranged in a position of normal use such that ignition is most likely to occur during the test. The means to fix the test specimen shall not influence the effect of the test flame or the propagation of flames in a way other than that occurring under normal conditions of use.

**9.2 Application of needle-flame**

The test flame is applied to that part of the surface of the test specimen which is most likely to be affected by flames resulting from normal use or from fault conditions. Examples of flame test positions are shown in Figures 1b and 1c.

The duration of application of the test flame shall be as specified in the relevant specification.

The test flame is positioned so that the tip of the flame is in contact with the surface of the test specimen. The test flame is removed after the specified time.

If the test specimen drips molten or flaming material during the application of the flame, the burner may be tilted up to 45 Â° from the vertical to prevent material from dripping into the burner tube while maintaining an 8 mm Â± 1 mm spacing between the centre of the top of the burner and the remaining portion of the test specimen, ignoring any strings of molten material.

When required by the relevant specification, the test is applied at more than one point on the same test specimen, in which case care shall be taken to ensure that any deterioration caused by previous tests will not affect the result of the test to be conducted.

### 9.3 Number of test specimens

Unless otherwise specified in the relevant specification, the test is performed on three test specimens.

## 10 Observations and measurements

In the case of ignition of the test specimen and/or the specified layer and/or the surrounding parts, the duration of burning ($t_b$) is measured and reported.

Duration of burning denotes the time interval from the moment the test flame is removed from the test specimen, until the last flames have extinguished and the glowing of the test specimen, the specified layer and/or the surrounding parts is no longer visible.

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## 11 Evaluation of test results

Unless otherwise prescribed in the relevant specification, the test specimen is considered to have satisfactorily withstood the needle-flame test if one of the following situations applies:

a)There is no flame and no glowing of the test specimen and no ignition of the specified layer or wrapping tissue.

b)Flames or glowing of the test specimen and the surrounding parts extinguish within 30 s after the removal of the needle-flame, that is $t_b < 30$ s. Also, the surrounding parts have not burnt away completely and there has been no ignition of the specified layer or wrapping tissue.



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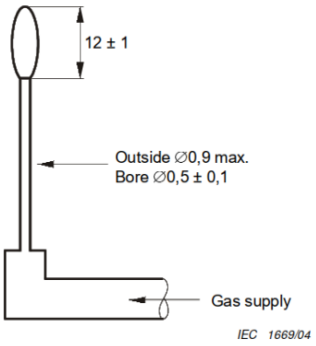



Figure 1a – Flame adjustment

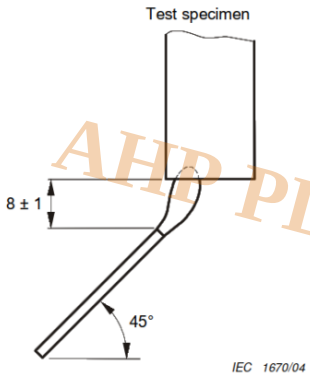



Figure 1b – Test position (example)

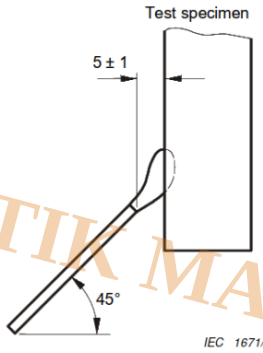



Figure 1c – Test position (example)

Figure 1 – Needle burner

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## Confirmatory test arrangement

### A.1 Confirmation of the test flame â€“ Principle

The time for the temperature of the copper block, described in Figure A.1 to increase from 100 Â°C Â± 5 Â°C to 700 Â°C Â± 3 Â°C shall be 23,5 s Â± 1,0 s, when the flame confirmatory test arrangement of Figure A.2 is used.

NOTE Detailed background information for the confirmation of a test flame can be found in IEC 60695-11-40 [2]. **A.2 Test apparatus**

### A.2.1 Burner

The burner shall be in accordance with 5.1.

### A.2.2 Control valve

One control valve is required to set the gas flow rate.

### A.2.3 Copper block



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The copper block material shall be specified as: Cu-ETP UNS C11000 (see ASTM-B187). The diameter of the copper block shall be 4 mm Â± 0,01 mm with a mass of 0,58 g Â± 0,01 g in the fully machined and polished but undrilled state, see Figure A.1.

### A.2.4 Thermocouple

A sheathed fine wire type K (NiCr/NiAl) with an outer sheath diameter of 0,5 mm.

The preferred method of fastening the thermocouple to the copper block is by compressing the copper around the thermocouple, after first ensuring that the thermocouple is inserted to the full depth of the hole as shown in Figure A.2.

### A.2.5 Temperature indicating, recording and timing devices

These devices shall be appropriate for the measurement of the time for the copper block to heat up from 100 Â°C Â± 5 Â°C to 700 Â°C Â± 3 Â°C with a time uncertainty of 0,1 s. The timing device shall have a tolerance of not more than 0,5 s.

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### A.3 Procedure

An example of a suitable gauge for the adjustment of flame height is given in Figure A.3. The fixture shall be constructed such that it does not rest on the flame end of the burner tube nor disturb the root of the burner flame.

â€“Set up the confirmatory test arrangement according to Figure A.2 in a draught-free environment, ensuring leak-free gas connections.

â€“Temporarily remove the burner away from the copper block to ensure no influence of the flame on the copper block during the preliminary adjustment of the gas flow rate.

â€“Ignite the gas and adjust the gas flow rate to give a flame height of 12 mm Â± 1 mm when viewed in subdued light against a dark background.

NOTE 1 In case of dispute, a light level of 20 lux should be used.

â€“Wait for a period of at least 5 min to allow the burner conditions to reach equilibrium and then readjust the flame height, if necessary.

â€“With the temperature/time indicating/recording devices operational, re-position the burner under the copper block.

â€“Conduct three determinations of the time for the temperature of the copper block to increase from 100 Â°C Â± 5 Â°C to 700 Â°C Â± 3 Â°C. Allow the copper block to cool naturally in air to below 50 Â°C between determinations.

NOTE 2 At temperatures above 700 Â°C, the thermocouple can be easily damaged, therefore it is advisable to remove the burner immediately after reaching 700 Â°C.



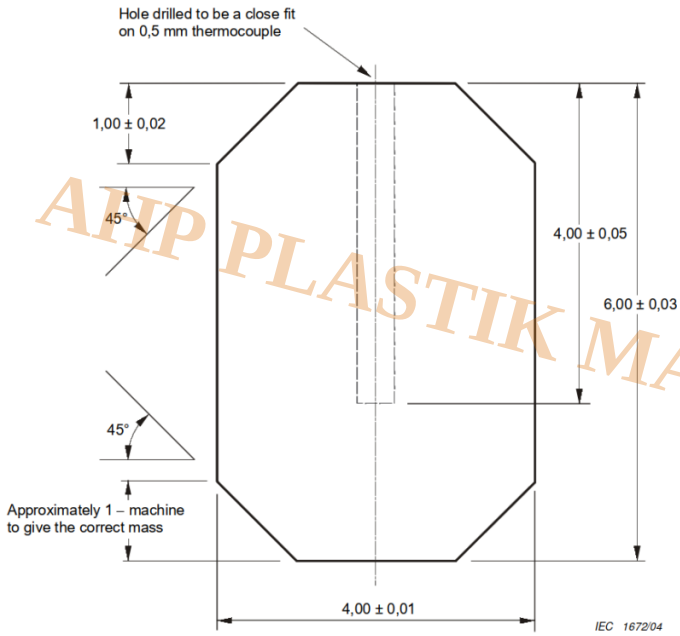
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â€“If the copper block has not been used before, conduct a preliminary run to condition the copper block surface. Discard the result.

â€“Calculate the mean time in seconds as the result.

â€“The flame is confirmed if the result is within the range 23,5 s Â± 1,0 s.

â€“The flame shall be confirmed in accordance with this Annex A every time the gas supply is changed or replaced.




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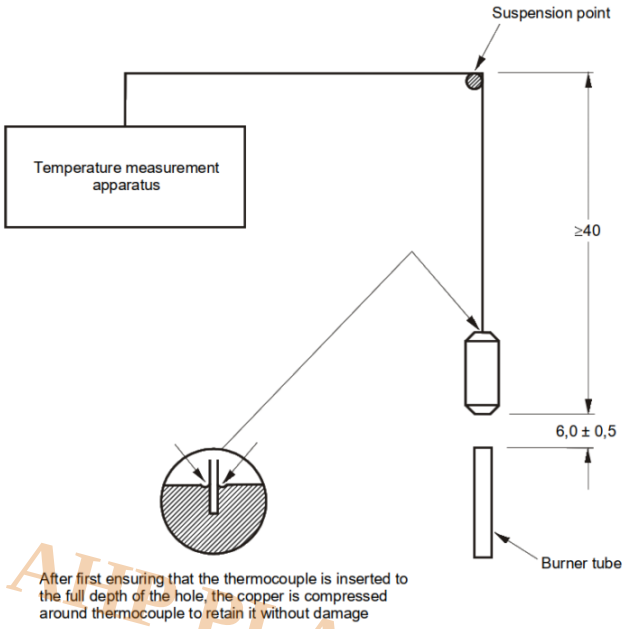
Copper block polished all over

Tolerance: ± 0,1, ± 30 min (angular), unless otherwise stated
Material: high conductive electrolytic copper Cu-ETP UNS C 11000 (see ASTM-B187)
Weight: 0,58 g ± 0,01 g before drilling

**Figure A.1 – Copper block**



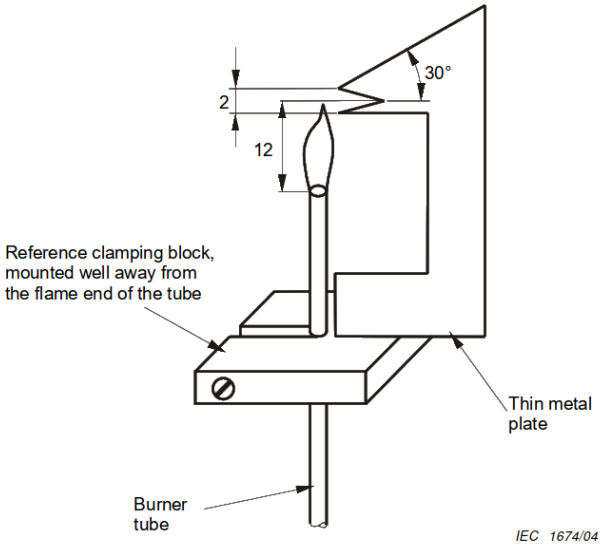
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The mode of suspension of the copper block shall be such that the block remains essentially stationary during the test.

**Figure A.2 – Confirmatory test arrangement**

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Tolerance: ± 1, ± 5 (angular), unless otherwise stated

**Figure A.3 – Gauge to measure flame height (example)**



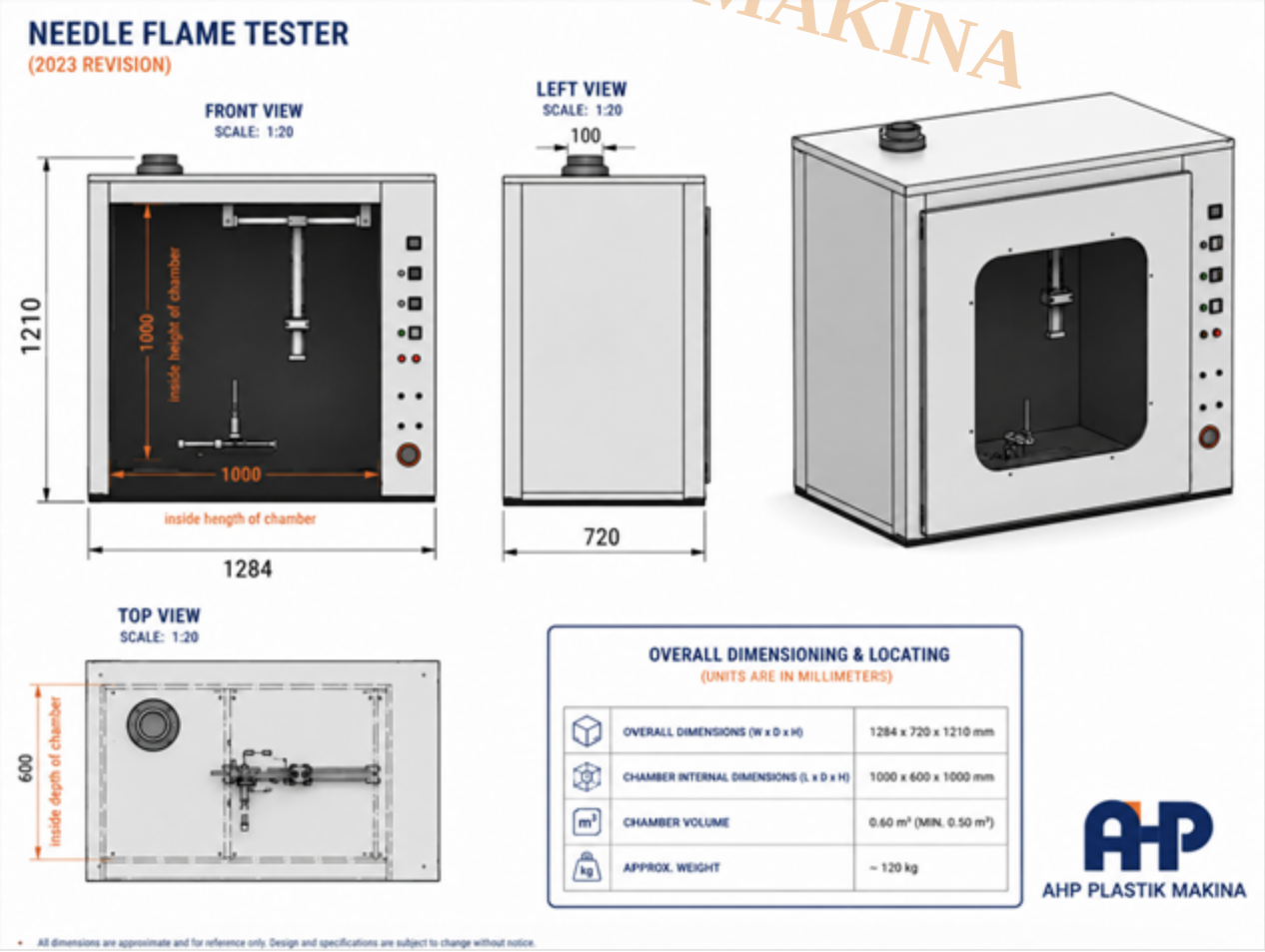


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Needle Flame Tester

- The angle of the burner is 45Â° (when in test) / 0Â° (when adjusting the flameâ€™s height)
- Needle flame-burning digital timer
- After-flame time digital timer
- Burner length at least 35 mm long with a bore of 0,5 mm Â± 0,1 mm and an outer diameter not exceeding 0,9 mm
- Flame height 12 mm Â± 1
- Door with glass
- Fume exhaust
- Gas type 95% butane (Gas balloon is not included)
- Gas flow regulator rotameter type
- Test range of temperature 0~1000â„ƒ
- The temperature rises from 100â„ƒÂ±2â„ƒ to 700â„ƒÂ±3â„ƒ within 23.5 secondsÂ±1s
- Number of burns can be set digitally
- Number of flame application can be set automatically
- Pressure gage for gas supply
- Pneumatic flame application
- Automatic flame application time

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**Category**

1. Technology

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