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Fire hazard testing -
Part 11-2: Test flames - 1 kW ~~nominal~~ pre-mixed flame - Apparatus, confirmatory test arrangement and guidance

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CONTENTS

FOREWORD 2
INTRODUCTION 5
1 Scope 6
2 Normative references 6
3 Terms and definitions 6
4 Burner/supply arrangement 7
4.1 Requirements 7
4.2 Apparatus and fuel 7
4.2.1 Burner 7
4.2.2 Flow control 7
4.2.3 Copper block 8
4.2.4 Thermocouple 8
4.2.5 Temperature/time indicating/recording devices 8
4.2.6 Laboratory fume hood/chamber 8
5 Production of the test flame 8
5.1 Selection of the method 8
5.2 Method A 9
5.3 Method B (alternative) 9
6 Confirmation of the test flame 9
6.1 Principle 9
6.2 Frequency of confirmatory tests 9
6.3 Procedure 9
7 Recommended arrangements for use of the test flame 11
Annex A (normative) Burner details, arrangements and confirmatory test 12
A.1 Burner construction 12
A.2 Gas supply arrangement 18
A.3 The copper block 19
A.4 Confirmatory test 20
Bibliography 22

Figure 1 – Flame dimensions 10
~~Figure A.1 – General assembly ..... 14~~
Figure A.1 – General Please move it back to the original position. 14
Figure A.2 – Burner details (1) 15
Figure A.3 – Burner details (2) 16
Figure A.4 – Burner details (3) 17
Figure A.5 – Burner details (4) 18
Figure A.6 – Example of supply arrangement for burner 19
Figure A.7 – Copper block 20
Figure A.8 – Confirmatory test arrangement 21

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Fire hazard testing - Part 11-2: Test flames - 1 kW ~~nominal~~ pre-mixed flame - Apparatus, confirmatory test arrangement and guidance

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IEC 60695-11-2 has been prepared by IEC technical committee 89: Fire hazard testing. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2017. This edition constitutes a technical revision.

This document has been given the status of a horizontal document in accordance with the ISO/IEC Directives, Part 1. It has the status of a basic safety publication in accordance with IEC GUIDE 104 [1] and ISO/IEC Guide 51 [2].

This edition includes the following significant technical changes with respect to the previous edition:

a) correction of errors in notes of Subclauses 5.2 and 5.3.

The text of this International Standard is based on the following documents:

Draft	Report on voting
89/1675/FDIS	89/1686/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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A list of all the parts in the IEC 60695 series, under the general title *Fire hazard testing,* can be found on the IEC web site.

IEC 60695-11 consists of the following parts:

– IEC 60695-11-2 [3], *Test flames – 1 kW nominal pre-mixed flame – Apparatus, confirmatory test arrangement and guidance*
– IEC 60695-11-3 [4], *Test flames – 500 W flames – Apparatus and confirmational test methods*
– IEC 60695-11-4 [5], *Test flames – 50 W flame – Apparatus and confirmational test method*
– IEC 60695-11-5 [6], *Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*
– IEC 60695-11-10 [7], *Test flames – 50 W horizontal and vertical flame test methods*
– IEC 60695-11-11 [8], *Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source*
– IEC 60695-11-20 [9], *Test flames – 500 W flame test methods*
– IEC TS 60695-11-21 [10], *Test flames - 500 W vertical flame test method for tubular polymeric materials*
– IEC TR 60695-11-30 [11], *Test flames – History and development from 1979 to 1999*
– IEC TR 60695-11-40 [12], *Test flames – Confirmatory tests – Guidance*

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INTRODUCTION

In the design of any electrotechnical product, the risk of fire and the potential hazards associated with fire need to be considered. In this respect the objective of component, circuit, and product design, as well as the choice of materials, is to reduce to acceptable levels the potential risks of fire during normal operating conditions, reasonably foreseeable abnormal use, malfunction, and/or failure. The IEC has developed IEC 60695-1-10 [13], together with its companion, IEC 60695-1-11 [14], to provide guidance on how this is to be accomplished.

The primary aims of IEC 60695-1-10 [13] and IEC 60695-1-11 [14] are to provide guidance on how:

a) to prevent ignition caused by an electrically energized component part, and

b) to confine any resulting fire within the bounds of the enclosure of the electrotechnical product in the event of ignition.

Secondary aims of these documents include the minimization of any flame spread beyond the product's enclosure and the minimization of harmful effects of fire effluents such as heat, smoke, toxicity and/or corrosivity.

Fires involving electrotechnical products can also be initiated from external non-electrical sources. Considerations of this nature should be dealt with in the overall fire risk assessment.

This document provides a description of the apparatus required to produce a 1 kW test flame, and provides a description of the principle of a confirmation procedure to check that the effective power output of the flame is as intended. Guidance on confirmatory tests for test flames is given in IEC TR 60695-11-40 [12].

This part of IEC 60695 ~~may~~ can involve hazardous materials, operations, and equipment. It does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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1 Scope

This part of IEC 60695 gives the requirements for the production and confirmation of a nominal 1 kW propane/air pre-mixed flame for use in fire hazard testing.

This basic safety publication focusing on safety test method(s) is primarily intended for use by technical committees in the preparation of ~~standards~~ safety publications in accordance with the principles laid down in IEC GUIDE 104 [1] and ISO/IEC Guide 51 [2].

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications.

The requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the relevant publications.

This document has the status of a horizontal publication in accordance with IEC Guide 108 0.

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.

IEC 60584-1, *Thermocouples - Part 1: EMF specifications and tolerances*

IEC 60695-4:2021, *Fire hazard testing - Part 4: Terminology concerning fire tests for electrotechnical products*

ISO~~/IEC~~ 13943:~~2008~~2017, *Fire safety — Vocabulary*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in ~~ISO/IEC 13943:2008, some of which are reproduced below for the user's convenience, as well as the following~~ IEC 60695-4:2021and ISO 13943:2017 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

– IEC Electropedia: available at https://www.electropedia.org/
– ISO Online browsing platform: available at https://www.iso.org/obp

3.1
combustion
exothermic reaction of a substance with an oxidizing agent

Note 1 to entry: Combustion (3.1) generally emits fire effluent accompanied by flames (3.3) and/or glowing.

[SOURCE: ISO 13943:~~2008, definition 4.46~~2017, 3.55]

3.2
draught-free environment
space in which the results of experiments are not significantly affected by the local air speed

Note 1 to entry: A qualitative example is a space in which a wax candle flame (3.3) remains essentially undisturbed. Quantitative examples are small-scale fire tests in which a maximum air speed of $0{,}1\ m \times s^{-1}$ or $0{,}2\ m \times s^{-1}$ is sometimes specified.

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[SOURCE: ISO 13943:~~2008, definition 4.70~~2017 , 3.83]

3.3
flame
rapid, self-sustaining, sub-sonic propagation of combustion (3.1) in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:~~2008, definition 4.133~~2017, 3.159]

3.4
pre-mixed flame
flame (3.3) in which combustion (3.1) occurs in an intimate mixture of fuel and oxidizing agent

[SOURCE: ISO 13943:~~2008, definition 4.259~~2017, 3.307]

3.5
standardized 1 kW test flame
test flame (3.3) conforming to ~~this international standard and meeting all of the requirements given in Clauses 4 to 6~~ all the requirements of this document

4 Burner/supply arrangement

4.1 Requirements

A standardized 1 kW test flame, according to this document, is one that is produced

– using hardware according to Figure A.1 to Figure A.8,
– supplied with propane gas of purity not less than 95 %,
– supplied with air essentially free of oil and water.

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The ~~flame~~ test flame shall be symmetrical, stable and give a result of 46 s ± 6 s in the confirmatory test described in Clause 6.

The copper block shown in Figure A.7 and the confirmatory test arrangement shown in Figure A.8 shall be used.

4.2 Apparatus and fuel

4.2.1 Burner

The burner shall be in accordance with Figure A.1 to Figure A.5 inclusive.

NOTE The gas injector and flame stabilizer are removable for cleaning purposes.

4.2.2 Flow control

Flow controllers shall be used and shall be capable of:

– the measurement and control of a propane gas flow rate of about 0,65 dm^3/min at 23ºC and 0,1 MPa, with an adequate accuracy to measure within the tolerance specified in the relevant test method (see Clause 5),
– the measurement and control of an air flow rate of about 10 dm^3/min at 23 °C and 0,1 MPa, with an adequate accuracy to measure within the tolerance specified in the relevant test method (see Clause 5).

NOTE Mass flow controllers have been found to be suitable to meet the requirements of Clause 5.

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4.2.3 Copper block

A copper block 9 mm in diameter and having a mass of 10,00 g ± 0,05 g in the fully machined but undrilled state, as described in Figure A.7, shall be made from electrolytic tough pitch copper Cu-ETP ~~USN~~ UNS C11000.

NOTE The minimum copper and silver content of electrolytic tough pitch copper Cu-ETP UNS C11000 is 99,90%.

4.2.4 Thermocouple

A mineral-insulated, metal-sheathed fine-wire thermocouple with an insulated junction, shall be used for measuring the temperature of the copper block. It shall have an overall nominal diameter of 0,5 mm and wires of, for example, NiCr and NiAl (type K), in accordance with IEC 60584-1, with the welded point located inside the sheath. The sheath shall consist of a metal resistant to continuous operation at a temperature of at least 1 050 °C. Thermocouple tolerances shall be in accordance with IEC 60584-1, class 1.

NOTE A sheath made from a nickel-based, heat resistant alloy (such as Inconel 600[1]) will satisfy the above requirements.

The preferred method of fastening the thermocouple to the copper block is by first ensuring that the thermocouple is inserted to the full depth of the hole and then by compressing the copper around the thermocouple as shown in Figure A.8.

4.2.5 Temperature/time indicating/recording devices

The temperature/time indicating/recording devices shall be appropriate for the measurement of the time for the copper block to heat up from 100 °C ± 5 °C to 700 °C ± 3 °C with a tolerance on the measured time of ± 0,5 s.

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4.2.6 Laboratory fume hood/chamber

The laboratory fume hood/chamber shall have an inside volume of at least 1,0 m^3. The chamber shall provide a draught-free environment, whilst allowing normal thermal circulation of air around the test specimen. The chamber shall permit observation of tests in progress. Unless otherwise stated in the relevant specification, the inside surfaces of the chamber shall be of a dark colour. When a lux 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 lx.

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For safety and convenience, this enclosure (which can be completely closed) should be fitted with an extraction device, such as an exhaust fan, to remove products of combustion which could be toxic. If fitted, the extraction device shall be turned off during the test and turned on immediately after ~~the test~~ each specimen tested to remove the fire effluents. A positive closing damper may be needed.

NOTE 1 The amount of oxygen available to support combustion of the test specimen is important for the conduct of this flame test. For tests conducted by this method when burning times are prolonged, it is possible that chambers having an inside volume of 1,0 m^3 ~~may not be sufficient~~ are insufficient to produce accurate results.

NOTE 2 Placing a mirror in the chamber, to provide a rear view of the test specimen, has been found to be useful.

5 Production of the test flame

5.1 Selection of the method

Unless otherwise specified in the relevant standard, method A shall be used.

[1] This information is given for the convenience of users of this international standard and does not constitute an endorsement by the IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

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5.2 Method A

Set up the burner supply arrangement according to Figure A.6 ensuring leak-free connections and place the burner in the laboratory fume hood/chamber.

Ignite the gas and adjust the gas and air flow rates to the following values.

The volume flow rate of propane gas shall be equivalent to 0,65 dm^3/min ± 0,01 dm^3/min when measured at 23 °C and 0,1 MPa.

The volume flow rate of air shall be equivalent to 10,0 dm^3/min ± 0,3 dm^3/min when measured at 23 °C and 0,1 MPa.

NOTE These volume flow rates correspond to mass flow rates of 1,184 g/min ± 0,018 g/min for propane gas (density at 23 °C and 0,1 MPa = 1,821 g/dm^3), and ~~11,64~~ 11,764 g/min ± 0,350 g/min for air (density at 23 °C and 0,1 MPa = 1,1764 g/dm^3).

The ~~flame~~ test flame shall appear stable and symmetrical on examination.

5.3 Method B (alternative)

Set up the burner supply arrangement according to Figure A.6 ensuring leak-free connections and place the burner in the laboratory fume hood/chamber.

Ignite the gas and adjust the gas and air flow rates to the following values.

The volume flow rate of propane gas shall be equivalent to 0,65 dm^3/min ± 0,03 dm^3/min when measured at 23 °C and 0,1 MPa.

The volume flow rate of air shall be equivalent to 10,0 dm^3/min ± 0,5 dm^3/min when measured at 23 °C and 0,1 MPa.

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NOTE These volume flow rates correspond to mass flow rates of 1,184 g/min ± 0,054 g/min for propane gas (density at 23 °C and 0,1 MPa = 1,821 g/dm^3), and ~~11,64~~ 11,764 g/min ± 0,580 g/min for air (density at 23 °C and 0,1 MPa = 1,1 764 g/dm^3).

The flame shall appear stable and symmetrical on examination (see Clause 6 regarding the flame test).

6 Confirmation of the test flame

6.1 Principle

The time for the temperature of the copper block, described in ~~Figure A.6~~ Figure A.7, to increase from 100 °C ± 5 °C to 700 °C ± 3 °C shall be 46 s ± 6 s when the flame test arrangement of Figure A.8 is used.

6.2 Frequency of confirmatory tests

The confirmatory test shall be done:

a) when the gas supply is changed, or test equipment is replaced, or when data are questioned;
   and either
b) before use of the test flame if the period between use exceeds one month;
   or
c) at least once a month if the period between use is less than or equal to one month.

6.3 Procedure

Set up the burner supply and confirmatory test arrangement according to Figure A.8 in the laboratory fume hood/chamber, ensuring leak-free gas connections.

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Temporarily remove the burner away from the copper block to ensure there is no influence of the flame on the copper block during the preliminary adjustment of gas and air flow rates.

Ignite the gas and adjust the gas and air flow rates to the values specified in Clause 5. Ensure that the flame is symmetrical. The approximate dimensions of the flame (see Figure 1), when measured in the laboratory fume hood/chamber and viewed in subdued light, are as follows:

– blue cone height: 46 mm to 78 mm;
– overall flame height: 148 mm to 208 mm.

Wait for a period of at least 5 min to allow the burner conditions to reach equilibrium.

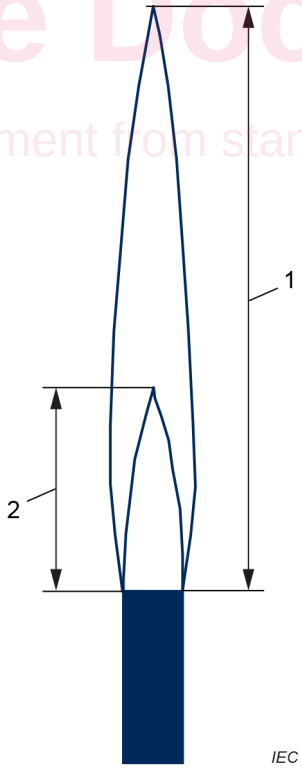
With the temperature/time indicating/recording devices operational, reposition the burner under the copper block.

Determine the time for the temperature of the block to increase from 100 °C ± 5 °C to 700 °C ± 3 °C. If the time is 46 s ± 6 s, record the gas and air flow rates and repeat the procedure two additional times until three ~~successive~~ consecutive determinations are each 46 s ± 6 s. Allow the block to cool naturally in air to below 50 °C between determinations. If the time of any determination is not 46 s ± 6 s, then all parts of the apparatus should be checked to ensure that they are in accordance with this international standard.

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

If the copper block has not been used before, make a preliminary run to condition the copper block surface. Discard the result.

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Key

1	Overall flame height (148 mm to 208 mm)
2	Blue cone height (46 mm to 78 mm)

Figure 1 – Flame dimensions

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