IEC 60695-2-10

Edition 2.0 2013-04

INTERNATIONAL STANDARD

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BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Fire hazard testing –
Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure

Essais relatifs aux risques du feu –
Partie 2-10: Essais au fil incandescent/chauffant – Appareillage et méthode commune d'essai

IEC 60695-2-10:2013

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –

Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure

FOREWORD

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International Standard IEC 60695-2-10 has been prepared by IEC technical committee 89: Fire hazard testing.

This second edition of IEC 60695-2-10 cancels and replaces the first edition of IEC 60695-2-10 published in 2000. This edition constitutes a technical revision.

It has the status of a basic safety publication in accordance with IEC Guide 104:2010 and ISO/IEC Guide 51:1999.

This standard is to be used in conjunction with IEC 60695-2-11, IEC 60695-2-12, and IEC 60695-2-13.

The main changes with respect to the previous edition are listed below. The rationale can be found in 89/960A/CC, 89/944A/CC, and 89/1030/CC.

– A table of contents has been added.
– The introduction has been updated to align with other TC89 documents.
– The scope has been clarified to align with other documents in the IEC 60695-2 Glow-wire series.
– Terms and definitions relevant to this document have been added.
– Clause 4 has been deleted and the remaining clauses renumbered.
– The description of the power supply has been updated with additional details (see 4.1).
– The temperature measuring system (see 4.3) and the description of the specified layer has been updated (see 4.4).
– New guidance has been introduced to assist in the verification of the temperature measuring system (see 5.2 and Annex C).
– The common test produced has been clarified (see Clause 7).
– The tolerances have been changed for the dimensions of the glow-wire (see Figure 1).
– New guidance on flaming observations has been added (see Annex B).

The text of this standard is based on the following documents:

FDIS	Report on voting
89/1154/FDIS	89/1163/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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, reasonable foreseeable abnormal use, malfunction, and/or failure. IEC 60695-1-10 was developed, together with its companion, IEC 60695-1-11, to provide guidance on how this is to be accomplished.

The primary aims of IEC 60695-1-10 and IEC 60695-1-11 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.

In electrotechnical equipment, overheated metal parts can act as ignition sources. In glow-wire tests, a glowing wire is used to simulate such an ignition source.

This part of IEC 60695 gives recommendations with regard to the glow-wire test apparatus and describes a common test procedure for tests applicable to end products and materials to be used with IEC 60695-2-11 which describes a glow-wire flammability test for end products (GWEPT), IEC 60695-2-12 which describes a glow-wire flammability index test for materials (GWFI), and IEC 60695-2-13 which describes a glow-wire ignition temperature test method for materials (GWIT).

FIRE HAZARD TESTING –

Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure

1 Scope

This part of IEC 60695 specifies the glow-wire apparatus and common test procedure to simulate the effects of thermal stresses which may be produced by heat sources such as glowing elements or overloaded resistors, for short periods, in order to assess the fire hazard by a simulation technique.

The test procedure described in this standard is a common test procedure intended for the small-scale tests in which a standardized electrically heated wire is used as a source of ignition.

It is a common part of the test procedures applied to end products and to solid electrical insulating materials or other solid combustible materials.

A detailed description of each particular test procedure is given in the respective standards IEC 60695-2-11, IEC 60695-2-12 and IEC 60695-2-13.

This basic safety publication is intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

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.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable 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.

IEC 60584-1, *Thermocouples – Part 1: Reference tables*

IEC 60584-2, *Thermocouples – Part 2: Tolerances*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

IEC Guide 104:2010, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:1999, *Safety aspects – Guidelines for their inclusion in standards*

ISO 4046-4:2002, *Paper, board, pulps and related terms – Vocabulary – Part 4: Paper and board grades and converted products*

ISO 13943:2008, *Fire safety – Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:2008, some of which are reproduced below for the user's convenience, as well as the following apply.

3.1
combustible, adjective
capable of being ignited and burned

[SOURCE: ISO 13943:2008, definition 4.43]

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 remains essentially undisturbed. Quantitative examples are small-scale fire tests in which a maximum air speed of 0,1 m × s^{-1} or 0,2 m × s^{-1} is sometimes specified.

[SOURCE: ISO 13943:2008, definition 4.70]

3.3
fire hazard
physical object or condition with a potential for an undesirable consequence from fire

[SOURCE: ISO 13943:2008, definition 4.112]

3.4
fire test
test that measures behaviour of a fire or exposes an item to the effects of a fire

Note 1 to entry: The results of a fire test can be used to quantify fire severity or determine the fire resistance or reaction to fire of the test specimen.

[SOURCE: ISO 13943:2008, definition 4.132]

3.5
flame, noun
rapid, self-sustaining, sub-sonic propagation of combustion in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:2008, definition 4.133]

3.6
flammability
ability of a material or product to burn with a flame under specified conditions

[SOURCE: ISO 13943:2008, definition 4.151]

3.7
ignition
DEPRECATED: sustained ignition
⟨general⟩ initiation of combustion

[SOURCE: ISO 13943:2008, definition 4.187]

3.8
test temperature
temperature to which the tip of the glow-wire is heated and stabilized prior to any contact with the test specimen

4 Description of the test apparatus

4.1 Glow-wire

The glow-wire is formed from nickel/chromium (> 77 % Ni/20 ± 1 % Cr) wire, having an overall diameter of 4,00 mm ± 0,07 mm (before bending). The dimensions of the glow wire loop are as detailed in Figure 1.

A new glow-wire shall be annealed for a total of at least 10 h by being subjected to a current of at least 120 A before being used for a test run. The total annealing time may be achieved cumulatively. To avoid damage, the thermocouple shall not be installed during annealing. At the end of annealing, the depth of the thermocouple pocket hole shall be verified.

NOTE 1 The temperature of a new glow-wire which has not been annealed gradually lowers during the first few hours when subjected to a flow of current. After a period of time the temperature then reaches equilibrium.

The test apparatus shall be designed so that the glow-wire is kept in a horizontal plane and applies a force of 0,95 N ± 0,10 N to the test specimen during the application of the glow-wire. The force shall be maintained at this value when the glow-wire or the test specimen is moved horizontally one towards the other. The penetration of the tip of the glow-wire into and through the test specimen shall be limited to 7 mm ± 0,5 mm.

The test apparatus shall be so designed that burning or glowing particles falling from the test specimen are able to fall without obstruction onto the layer as specified in 4.4.

Two typical examples of the test apparatus are shown in Figures 3a and 3b.

NOTE 2 The apparatus shown in Figure 3b has been found useful when testing heavy and/or awkwardly shaped test specimens.

4.2 Test circuit and connections

The glow-wire is heated by a simple electric circuit as shown in Figure 2. There shall be no feedback mechanism or circuit to maintain the temperature. The power supply for the glow-wire test apparatus shall be a stabilized voltage source (± 2 % rms). The test circuit shall contain a current measuring device which indicates a true rms value with a maximum error of 1,0 %.

Due to the high currents involved, it is essential that all electrical connections for the glow-wire are capable of carrying the current without affecting the performance or long-term stability of the circuit. For the glow-wire to stud connection, a sufficient contact area (typically at least 60 mm^2 at each end) is necessary for the stable and loss-less current necessary for the test. The glow-wire to stud connection shall be tightly screwed, soldered, or brazed between the glow-wire and studs.

NOTE The typical current necessary for heating the tip to a temperature of 960 °C is between 120 A and 150 A.

4.3 Temperature measuring system

The temperature of the tip of the glow-wire shall be measured by a class 1 (see IEC 60584-2) mineral-insulated metal-sheathed fine-wire thermocouple with an insulated junction. It shall have an overall nominal diameter of 1,0 mm. The thermocouple wires shall be suitable for continuous operation at temperatures up to 960 °C (e.g. chromel/alumel (Type K) – see IEC 60584-1). The welded point shall be located inside the sheath as close to the tip as practicable. The sheath shall consist of a metal resistant to continuous operation at a temperature of at least 1 050 °C.

NOTE A sheath made from a nickel-based heat-resistant alloy satisfies the above requirements.

The glow-wire, with the thermocouple inserted, is shown in Figure 1, Detail Z.

The thermocouple is arranged in a pocket hole, drilled in behind the tip of the glow-wire, and maintained as a close fit as shown in detail Z of Figure 1. The pocket hole shall be the smallest diameter that can accommodate the inserted thermocouple in order to reduce the occurrence of contamination during testing. The thermal contact between the tip of the thermocouple and the end of the drilled hole shall be maintained. Care shall be taken to ensure that the thermocouple is able to follow the dimensional changes of the tip of the glow-wire caused by heating.

The instrument for measuring the thermocouple voltages may consist of any commercial digital thermometer with a built-in reference junction.

Other temperature measuring instrumentation may be used, but, in case of dispute, the thermocouple method must be used.

4.4 Specified layer

To evaluate the possible spread of fire, for example by burning or glowing particles falling from the test specimen, a specified layer is placed underneath the test specimen.

Unless otherwise specified, a single layer of wrapping tissue resting on, and in close contact with the upper surface of a piece of wooden board (flat and smooth and having a minimum thickness of 10 mm) is positioned at a distance of 200 mm ± 5 mm below the place where the glow-wire is applied to the test specimen. See Figures 3a and 3b.

Wrapping tissue (as specified in ISO 4046-4:2002 Clause 4.215) is a soft and strong lightweight wrapping tissue with a mass per unit area of between 12 g/m^2 and 30 g/m^2.

4.5 Test chamber

The apparatus shall be operated in a draught-free environment having sufficient volume such that

- oxygen depletion during the test does not significantly affect the result; and
- the test specimen can be mounted at least 100 mm from any surface.

NOTE 1 A chamber having a volume of at least 0,5 m^3 is considered to have sufficient volume for the test.

Within the test location, the ambient light falling on the test specimen, not counting that from the glow-wire, shall not exceed 20 lx. This is measured with a lux meter positioned in place of the test specimen facing towards the rear part of the location.

NOTE 2 Use of a dark background material will usually help in achieving the 20 lx limit.

After each test, the test location shall be vented to replace any depleted oxygen.

4.6 Timing device

The timing device shall have a resolution of 0,2 s or less.

5 Verification of the apparatus

5.1 Verification of the glow-wire tip

Before each series of tests, it is necessary to inspect the glow-wire tip by measuring and recording dimension "A" as shown in detail Z of Figure 1. The glow-wire shall be replaced once this measurement is reduced to 97,5 % or less of the measurement taken before its initial use.

On completion of each test, clean the tip, if necessary, to remove any residue of previously tested material, for example by means of a wire brush, and then inspect the tip of the glow-wire for any cracks. If it is not possible to clean the tip without damaging it (for example when there is molten glass fibre residue), then the glow-wire shall be replaced.

5.2 Verification of the temperature measuring system

The temperature measuring system described in 4.3 shall be verified periodically using the procedure described below.

A one-point verification of the temperature of the glow-wire can be performed using a foil of silver with a purity of at least 99,8 %, approximately 2 mm^2 in area and approximately 0,06 mm thick, placed upon the upper surface of the tip of the glow-wire. The glow-wire shall be initially set at a temperature slightly lower than the melting point of the foil and allowed to stabilize. The glow-wire temperature is then increased at a slow heating rate so that the melting point may be accurately observed. When the silver starts to melt the thermometer shall indicate 960 °C ± 10 °C. The glow-wire, while still hot, shall be cleared of all traces of silver immediately after this verification process to reduce the probability of alloying. In case of dispute, this verification method using a silver foil shall be used.

NOTE Annex C provides guidance to complement the one-point verification procedure of the glow-wire temperature measuring system by defining the relationship between the heating current and the glow-wire temperature. In order to assist in setting test temperatures, it has been found useful to develop a reference chart immediately after verification indicating the current for each temperature. This reference chart can be referred to on each use to verify that the current-temperature relationship remains consistent. A variation to this relationship of more than 2 % would suggest that something in the apparatus has changed. In this situation, a verification and recalibration of the test apparatus is indicated.

6 Conditioning

Before testing, the wooden board and wrapping tissue shall be stored for a minimum of 24 h in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 %.

7 Common test procedure

7.1 Test specimen support

The test specimen shall be mounted or clamped so that

a) the heat losses due to the supporting or fixing means are insignificant (see Figure 4);

b) the planar area of the surface is vertical;

c) the tip of the glow-wire is applied to the centre of the planar area of the surface.

Prior to each set of tests, the glow wire application force shall be checked with a suitable device. In addition, the free movement of the carriage along the full path shall be checked.

7.2 Glow-wire temperature

CAUTION:

Precautions shall be taken to safeguard the health of personnel conducting tests against

– the risks of explosion, burning or fire;
– the risk of burns and electric shock;
– the inhalation of smoke and/or toxic products; and
– the risks of toxic residues.

The glow-wire is heated to the specified temperature which is measured by means of the calibrated temperature measurement system. Before bringing the tip of the glow-wire into contact with the test specimen, care shall be taken to ensure that

a) this temperature is constant within 5 K for a period of at least 60 s;
b) there is no contamination in the thermocouple hole drilled in the glow-wire and there is appropriate thermocouple to glow-wire contact. Appropriate contact shall be accomplished by gently pushing the thermocouple into the full depth of the drilled hole;
c) heat radiation does not influence the test specimen during this period by providing an adequate distance between the specimen and glow-wire i.e. 5,0 cm minimum, or by using an appropriate screen; and
d) no further adjustment to the heating current is to be made until after the test is completed.

7.3 Application of the glow-wire

The tip of the glow-wire is then brought smoothly into contact with the test specimen for a duration of 30 s ± 1 s. An approximate rate of approach and withdrawal of 10 mm/s to 25 mm/s has been found to be satisfactory. However, the rate of approach shall be reduced to near zero upon contact to avoid impact forces exceeding 1,05 N. In those cases where the material melts away from the glow-wire, the glow-wire shall not be kept in contact with the test specimen. Following the application time, the glow-wire and the test specimen are slowly separated, avoiding any further heating of the test specimen and any movement of air which might affect the result of the test. The penetration of the tip of the glow-wire into and through the test specimen shall be limited to 7 mm ± 0,5 mm.

NOTE During the tests conducted in accordance with IEC 60695-2-11, IEC 60695-2-12 and IEC 60695-2-13, guidance on the observation of ignition and flaming can be found in Annex B.