IEC 60695-2-10

Edition 3.0 2021-10

INTERNATIONAL STANDARD

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HORIZONTAL PUBLICATION
PUBLICATION HORIZONTALE

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 60695-2-10:2021-10(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 13.220.40; 29.020

ISBN 978-2-8322-1010-9

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

This third edition cancels and replaces the second edition published in 2013. This edition constitutes a technical revision.

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

a) New terms and definitions with regards to times and durations have been added to Clause 3.
b) Previous Annex A of Equipment manufacturers and suppliers has been deleted.
c) Annex A (previous Annex B) for ignition and flaming observations has been changed from informative to normative.
d) New Annex C has been added, which visualizes times and durations, and gives examples for the behaviour of specimens, and how to evaluate them.

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

FDIS	Report on voting
89/1535/FDIS	89/1547/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/standardsdev/publications.

It has the status of a basic safety publication in accordance with IEC Guide 104.

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

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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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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. IEC 60695-1-10 [1][1] was developed, together with its companion, IEC 60695-1-11 [2], 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).

[1] Numbers in square brackets refer to the Bibliography.

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 document 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 IEC 60695-2-11, IEC 60695-2-12 and IEC 60695-2-13.

This basic safety publication focusing on safety test method(s) is primarily intended for use by technical committees in the preparation of safety publications 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.

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

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*

ISO 4046-4:2016, *Paper, board, pulps and related terms – Vocabulary – Part 4: Paper and board grades and converted products*

ISO 13943:2017, *Fire safety – Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:2017, some of which are reproduced below for the user's convenience, and the following apply.

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

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

3.1
combustible, adjective
capable of being ignited and burned

[SOURCE: ISO 13943:2017, 3.52]

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 $m \cdot s^{-1}$ or 0,2 $m \cdot s^{-1}$ is sometimes specified.

[SOURCE: ISO 13943:2017, 3.83]

3.3
fire hazard
potential for harm associated with fire

Note 1 to entry: Alternatively, fire hazard can be a physical object or condition with a potential for an undesirable consequence from fire.

[SOURCE: ISO 13943:2017, 3.131]

3.4
fire test
test that measures fire behaviour 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 13943:2017, 3.157]

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

[SOURCE: ISO 13943:2017, 3.159]

3.6
flame event
sustained flaming and/or glowing combustion

3.7
flammability
ability of a material or product to burn with a flame under specified conditions

[SOURCE: ISO 13943:2017, 3.178]

3.8
ignition
DEPRECATED: sustained ignition
<general> initiation of combustion

[SOURCE: ISO 13943:2017, 3.217]

3.9
test temperature
temperature to which the tip of the glow-wire is heated and stabilized prior to any contact with the test specimen

3.10
time of application
t_{APP}
application time of the glow-wire

Note 1 to entry: Time of application constitutes the first 30 s of the test.

Note 2 to entry: t_{APP} was originally designated as t_A in Editions 1 and 2 of IEC 60695-2.

Note 3 to entry: See Annex C.

3.11
time of observation
t_{OBS}
observation time of the specimen and/or specified layer, starting immediately after t_{APP}

Note 1 to entry: Time of observation constitutes the second 30 s of the test.

Note 2 to entry: See Annex C.

3.12
time of ignition
t_I
time (to the nearest 0,5 s), from the start of test, at which the longest persisting flame event starts

Note 1 to entry: This is a measured value.

Note 2 to entry: See Annex C.

3.13
time of extinguishing
t_E
time (to the nearest 0,5 s), from the start of the test, at which the longest persisting flame event ends

Note 1 to entry: This is a measured value.

Note 2 to entry: See Annex C.

3.14
total flame event time
t_T
duration of the longest persisting flame event

$t_T = t_E - t_I$

Note 1 to entry: This is a calculated value.

Note 2 to entry: See Annex C.

3.15
flame time after removal
t_R
time elapsed after the removal of the glow-wire tip from the test specimen to the end of the longest persisting flame event

$t_R = t_E - 30$ s

Note 1 to entry: If t_E is less than 30 s then t_R is zero.

Note 2 to entry: This is a calculated value.

Note 3 to entry: See Annex C.

3.16
flame time during application
t_B
duration of the longest persisting flame event whilst the glow-wire tip is in contact with the test specimen

$t_B = t_T - t_R$

Note 1 to entry: This is a calculated value.

Note 2 to entry: See Annex C.

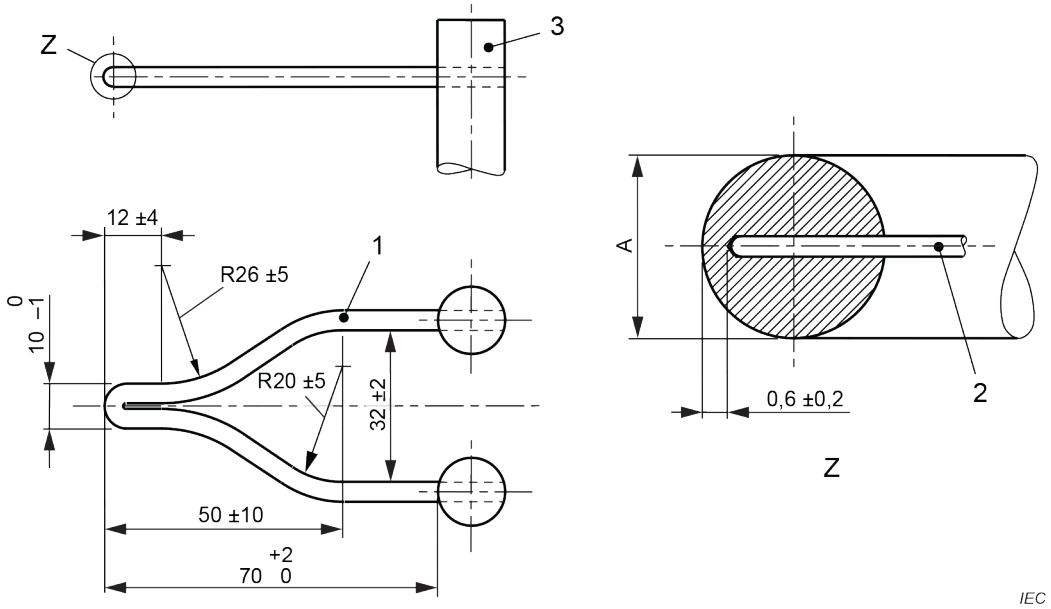
4 Description of the test apparatus

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. When forming the glow-wire, ensure that fine cracking at the tip is avoided.

NOTE Annealing is a suitable process for prevention of fine cracking at the tip.

Dimensions in millimetres



Key

1 Glow-wire

2 Thermocouple

3 Stud

Dimension A (after bending): see 5.1.

Figure 1 – Glow-wire and position of thermocouple

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 designed in such a way 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 Figure 3a) and Figure 3b).

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

4.2 Electrical circuit of the glow-wire apparatus

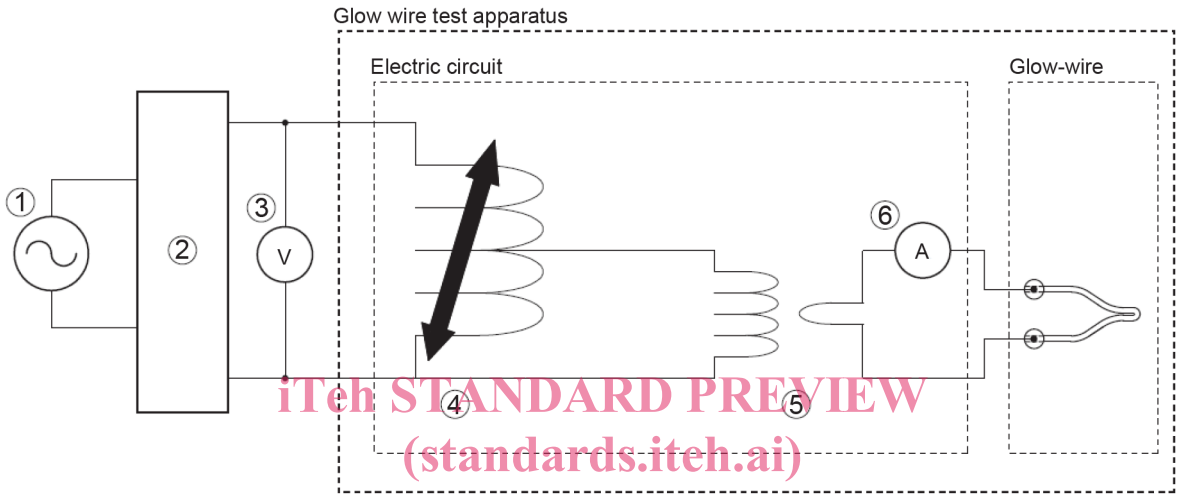
The glow-wire shall be heated by an electric circuit as shown in Figure 2. There shall be no feedback mechanism or circuit to maintain the temperature. The input voltage supplying the glow-wire test apparatus shall be stable (±2 %) during the test.

NOTE 1 The stable voltage can be supplied using an appropriate stabilized voltage source. As an alternative, it has been found useful to monitor the input voltage supplied to the glow-wire test apparatus during the test.

The circuit shall contain a current measuring device which indicates a true RMS value having an accuracy of ±2,5 % or more accurate.

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



Key

1 Mains input voltage supply

2 Stabilized voltage source (alternative to Key 3)

3 Input voltage measuring device (alternative to Key 2)

4 Variable auto-transformer

5 Step down separating transformer

6 Current measuring device

Figure 2 – Electrical circuit of the glow-wire apparatus

4.3 Temperature measuring system

The temperature of the tip of the glow-wire shall be measured by a class 1 (see IEC 60584-1) 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) or NiCrSi/NiSi (Type N) – 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.

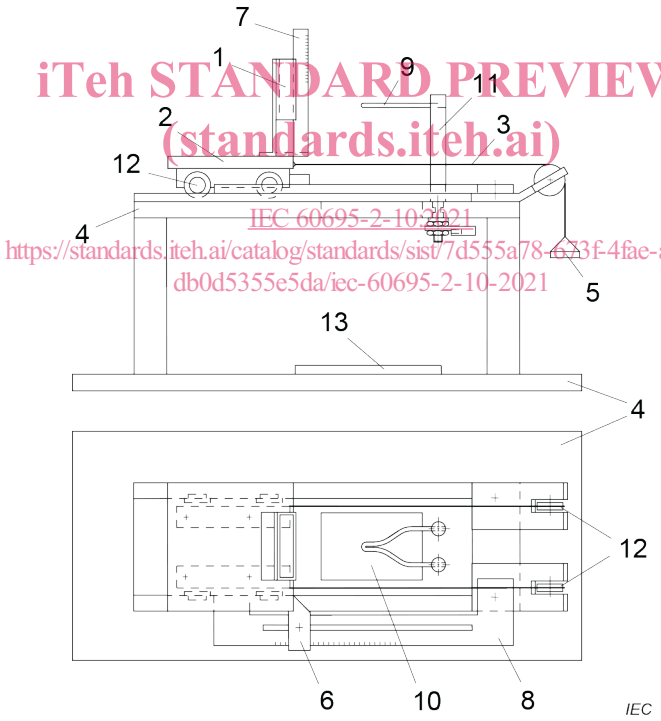
The thermocouple is arranged in a pocket hole, drilled in behind the tip of the glow-wire, and maintained as a close fit as shown in Detail Z of Figure 1. The pocket hole shall be the smallest diameter that can accommodate the inserted thermocouple in order to reduce the occurrence of contamination during testing. The thermal contact between the tip of the thermocouple and the end of the drilled hole shall be maintained. 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.

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 Figure 3a) and Figure 3b). Wrapping tissue (as defined in ISO 4046-4:2016, 4.215) is a soft and strong lightweight wrapping paper with a mass per unit area of between 12 g/m^2 and 30 g/m^2.



Key

1	Test specimen support	8	Penetration adjustment
2	Carriage	9	Glow-wire
3	Tensioning cord	10	Cut-out in base plate for falling particles
4	Base plate	11	Glow-wire mounting stud
5	Weight	12	Low-friction rollers
6	Adjustable stop	13	Specified layer
7	Scale to measure height of flame		

3a) Test apparatus – static glow-wire, moving test specimen (example)