

# INTERNATIONAL STANDARD

COMMENTED VERSION

HORIZONTAL PUBLICATION

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

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IEC Secretariat  
3, rue de Varembeé  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

## FOREWORD

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This commented version (CMV) of the official standard IEC 60695-2-10:2026 edition 4.0 allows the user to identify the changes made to the previous IEC 60695-2-10:2021 edition 3.0. Furthermore, comments from IEC TC 89 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 60695-2-10 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 2021. This edition constitutes a technical revision.

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

- a) Revision of 4.3 to add reference to new Annex D;
- b) Addition of new normative Annex D on "Use of pyrometer for glow-wire test";
- c) Revision of Clause 3 references to align with ISO 13943:2017.

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

FDIS	Report on voting
89/1650/FDIS	89/1657/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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

It has the status of a basic safety publication in accordance with IEC GUIDE 104:2019 [1].

This International 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](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

## 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 [2] was developed, together with its companion, IEC 60695-1-11 [3], to provide guidance on how this is accomplished.

The primary aims of IEC 60695-1-10 [2] and IEC 60695-1-11 [3] 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 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 104:2019 [1]** and **ISO/IEC Guide 51 [4]**.

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.

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*

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*

### 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 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

##### **combustible**

capable of being ignited and burned

[SOURCE: ISO 13943:2017, 3.52]

#### 3.2

##### **combustion**

exothermic reaction of a substance with an oxidizing agent

Note 1 to entry: Combustion generally emits fire effluent accompanied by flame (3.6) and/or glowing.

[SOURCE: ISO 13943:2017, 3.55]

#### 3.3

##### **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 (3.6) remains essentially undisturbed. Quantitative examples are small-scale fire tests (3.5) in which a maximum air speed of  $0,1 \text{ m} \times \text{s}^{-1}$  or  $0,2 \text{ m} \times \text{s}^{-1}$  is sometimes specified.

[SOURCE: ISO 13943:2017, 3.83]

#### 3.4

##### **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]

#### 3.5

##### **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]

#### 3.6

##### **flame**

rapid, self-sustaining, sub-sonic propagation of combustion (3.2) in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:2017, 3.159]

**3.7****flame event**

~~sustained~~ persistent 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** (3.2)

[SOURCE: ISO 13943:2017, 3.217]

**3.10****test temperature**

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

**3.11****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 32 to entry: See [Annex C](#).

**3.12****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](#).

**3.13****time of ignition**

$t_I$

time (to the nearest 0,5 s), from the start of test, at which the longest persisting **flame event** (3.7) starts

Note 1 to entry: This is a measured value.

Note 2 to entry: See [Annex C](#).

### 3.14 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 (3.7) ends

Note 1 to entry: This is a measured value.

Note 2 to entry: See Annex C.

### 3.15 total flame event time

$t_T$

duration of the longest persisting flame event (3.7)

$$t_T = t_E - t_I$$

Note 1 to entry: This is a calculated value.

Note 2 to entry: See Annex C.

### 3.16 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 (3.7)

$$t_R = t_E - 30s$$

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.

### 3.17 flame time during application

$t_B$

duration of the longest persisting flame event (3.7) 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.

### 3.18 emissivity

ratio of the radiation emitted by a radiant source to the ratio of radiation that would be emitted by a black body radiant source at the same temperature

Note 1 to entry: Emissivity is dimensionless.

[SOURCE: ISO 13943:2017, 3.89]

### 3.19 focal length

distance between the centre of the pyrometer optic lens and its focal point (3.20)

**3.20****focal point**

point where light rays converge

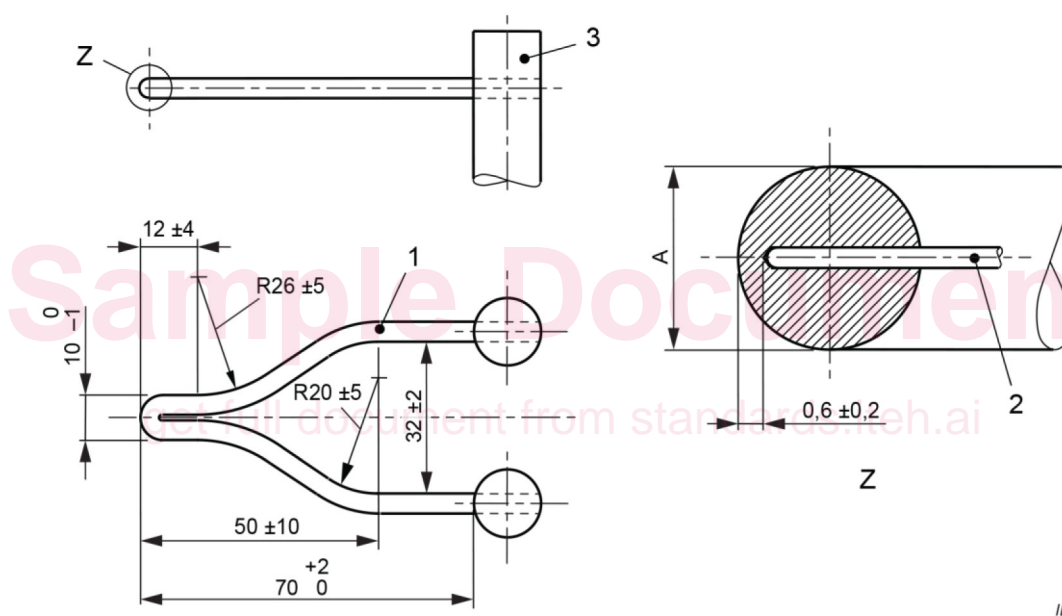
Note 1 to entry: For lens application, the focal point is commonly known as the point where in a captured image, the subject is clearly visible without blur.

**4 Description of the test apparatus****4.1 Glow-wire**

The glow-wire is formed from nickel/chromium  $> 77\% \text{ Ni}/(20 \pm 1)\% \text{ Cr}$  wire, having an overall diameter of  $4,00 \text{ mm} \pm 0,07 \text{ mm}$  (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 1 Annealing is a suitable process for prevention of fine cracking at the tip.

Dimensions in millimetres



- 1 Glow-wire
- 2 Thermocouple
- 3 Stud
- Z Enlarged view of Z section
- A Overall diameter of the wire 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 2 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  $0,95 \text{ N} \pm 0,10 \text{ N}$  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  $7,0 \text{ mm} \pm 0,5 \text{ mm}$ .

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 3 and Figure 4.

NOTE 23 The apparatus shown in Figure 4 has been found useful when testing heavy and/or awkwardly shaped test specimens.

#### 4.2 Electrical circuit of the glow-wire apparatus

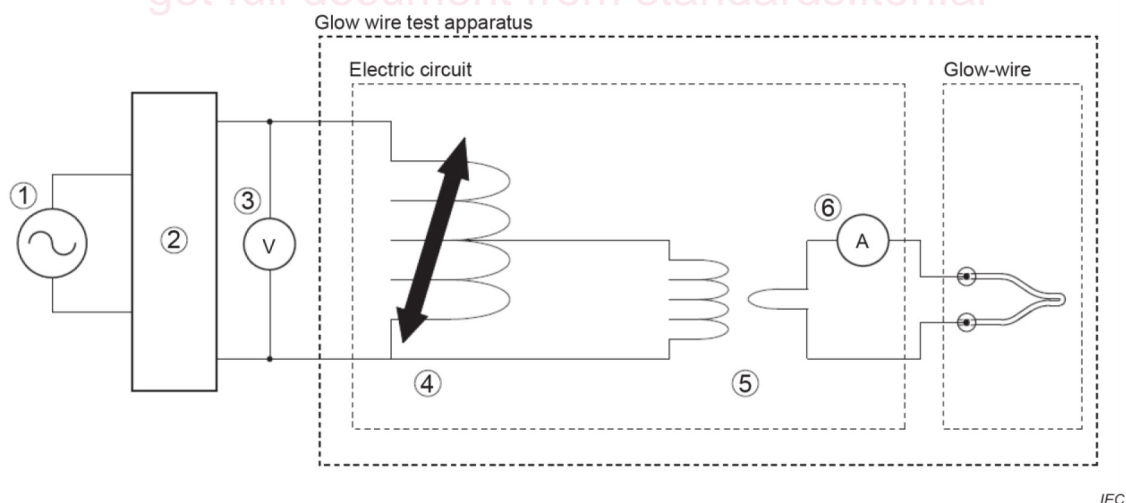
The glow-wire shall be heated by an electric circuit. There shall be no feedback mechanism or circuit to maintain the temperature. The input voltage supplying the glow-wire test apparatus shall be stable ( $\pm 2 \%$ ) during the test. A typical example of electric circuit is shown in Figure 2.

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 (root mean square) value having an accuracy of  $\pm 2,5 \%$  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  $60 \text{ mm}^2$  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  $960 \text{ }^\circ\text{C}$  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 1 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.

NOTE 2 Slight bending of the thermocouple, in order to create a spring load force towards the pocket hole, is an example of methodology that can be used to ensure that the thermocouple follows the dimensional changes of the glow-wire. **1**

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.~~

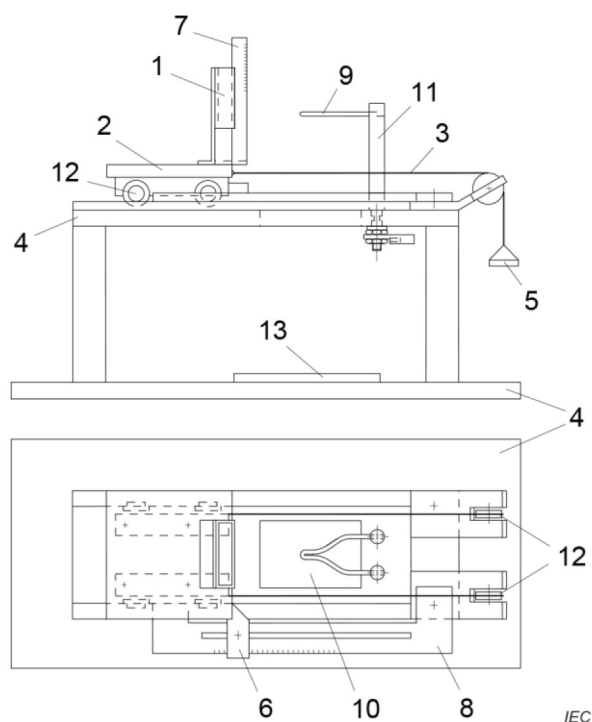
An alternative temperature measurement instrumentation to the thermocouple, that has been verified and found effective, is the pyrometer. If the pyrometer is used as an alternative to the thermocouple, it shall meet the characteristics and usage conditions specified in Annex D. **2**

In case of dispute, the thermocouple method shall 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 [Figure 3](#) and [Figure 4](#). 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<sup>2</sup> and 30 g/m<sup>2</sup>.

**Key**

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

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