

INTERNATIONAL STANDARD



HORIZONTAL PUBLICATION

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



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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

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

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.



IEC 60695-2-10

Edition 3.0 2021-10
REDLINE VERSION

INTERNATIONAL STANDARD



HORIZONTAL PUBLICATION

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.220.40; 29.020

ISBN 978-2-8322-1046-0

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	8
4 Description of the test apparatus	10
4.1 Glow-wire	10
4.2 Test circuit and connections Electrical circuit of the glow-wire apparatus	12
4.3 Temperature measuring system	14
4.4 Specified layer	15
4.5 Test chamber	19
4.6 Timing device	19
5 Verification of the apparatus	20
5.1 Verification of the glow-wire tip	20
5.2 Verification of the temperature measuring system	20
6 Conditioning	20
7 Common test procedure	20
7.1 Test specimen support	20
7.2 Glow-wire temperature	21
7.3 Application of the glow-wire	21
8 General test observations and evaluations of test results	21
Annex A (informative) Equipment manufacturers and suppliers	
Annex B A (informative normative) Guidance on Requirements for "ignition" and "flaming" observations	23
A.1 General	23
A.2 Examples of ignition and non-ignition	23
Annex C B (informative) Guidance on the verification procedure of the glow-wire temperature measuring system by the heating current	25
B.1 Objective	25
B.2 Preparation	25
B.3 Verification procedure	25
B.3.1 Observation and measurement	25
B.3.2 Correlation chart	25
B.3.3 Frequency of revising the correlation chart	26
Annex C (informative) Supplement – Times and durations, and examples of evaluations	27
C.1 Times and durations (in accordance with Clause 3)	27
C.2 Examples of evaluations	27
Bibliography	29
Figure 1 – Glow-wire and position of thermocouple	12
Figure 2 – Test circuit Electrical circuit of the glow-wire apparatus	14
Figure 3 – Test apparatus examples	19
Figure A.1 – Example of a brightly shining flame	23
Figure A.2 – Example of a blue corona at the glow-wire tip	24



Figure A.3 – Example of ionized gases in the form of a blue corona tail near the glow wire tip.....	24
Figure B.1 – Correlation curve between the heating current and the glow-wire temperature (example).....	26
Figure C.1 – Times and durations (Example: ignition occurs at 5 s and extinguishing occurs at 50 s).....	27
Figure C.2 – Evaluation scheme with examples	28

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60603-7:2013. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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.

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, 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 ~~standards~~ 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. ~~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 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: Reference tables~~

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

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

~~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 4046-4:20022016, Paper, board, pulps and related terms – Vocabulary – Part 4: Paper and board grades and converted products

ISO 13943:20082017, Fire safety – Vocabulary

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:20082017, 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 13943:2008, definition 4.43~~ 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 $0,1 \text{ m}\cdot\text{s}^{-1}$ or $0,2 \text{ m}\cdot\text{s}^{-1}$ is sometimes specified.

[SOURCE: ~~ISO 13943:2008, definition 4.70~~ 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 13943:2008, definition 4.112~~ ISO 13943:2017, 3.131]

3.4

fire test

test that measures fire 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~~ 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 13943:2008, definition 4.133~~ 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 13943:2008, definition 4.151~~ ISO 13943:2017, 3.178]

3.8**ignition**

DEPRECATED: sustained ignition

<general> initiation of combustion

[SOURCE: ~~ISO 13943:2008, definition 4.187~~ 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

$$t_R = t_E - 30 \text{ s}$$

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.

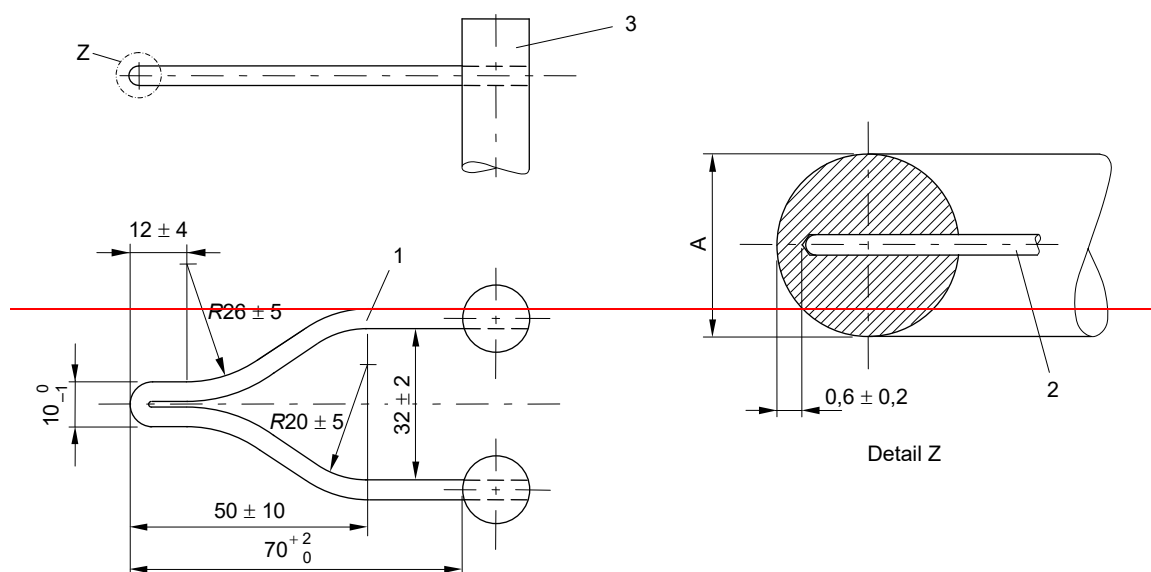
Note 2 to entry: See Annex C.

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.



IEC 632/13

Dimensions in millimetres

Glow-wire material: ~~Nickel/Chromium (>77 %Ni/20 ± 1 %Cr)~~

Diameter: ~~4,0 mm ± 0,07 mm (before bending)~~

Dimension A: ~~(after bending) see 5.1~~

When forming the glow-wire, care shall be taken to avoid fine cracking at the tip.

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

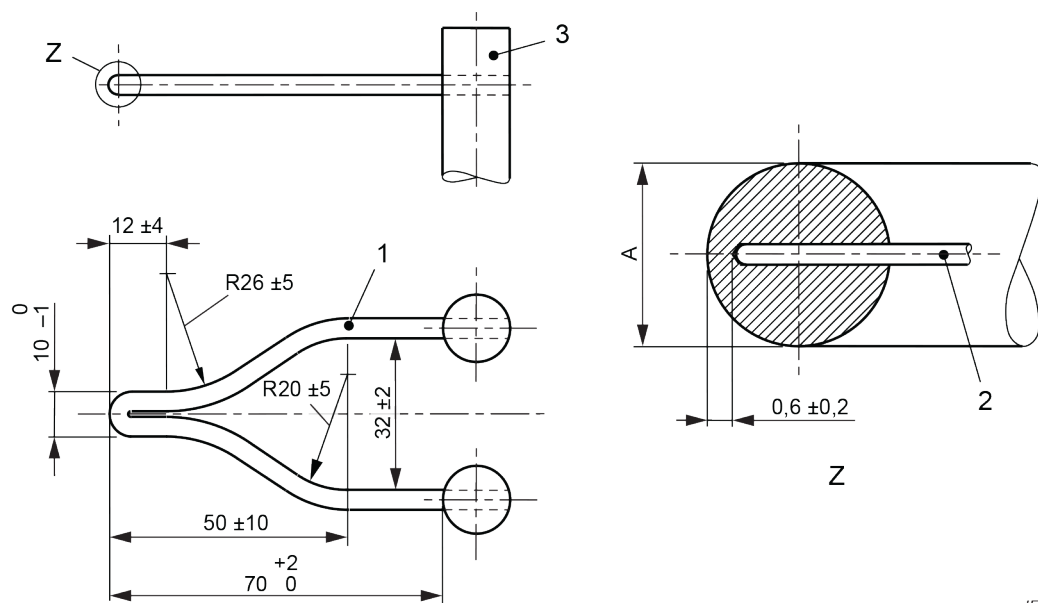
Key

1—Glow-wire

2—Thermocouple

3—Stud

Dimensions in millimetres



IEC

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 $0,95 \text{ N} \pm 0,10 \text{ N}$ 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 $7 \text{ mm} \pm 0,5 \text{ mm}$.

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 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 ~~Test circuit and connections~~ Electrical circuit of the glow-wire apparatus

~~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 ($\pm 2\%$ rms). The test circuit shall contain a current measuring device which indicates a true rms value with a maximum error of 1,0 %.~~

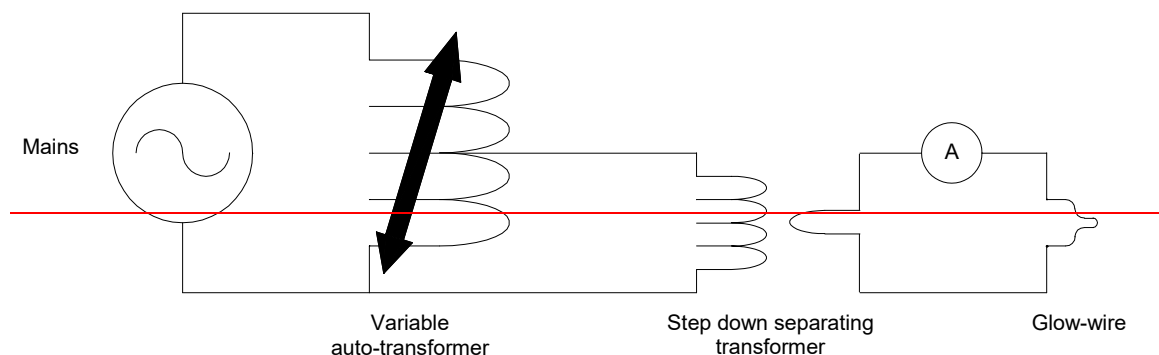
The glow-wire shall be heated by an electric circuit as shown in Figure 2. There shall be no feedback mechanism or circuit to maintain the temperature. The input voltage supplying the glow-wire test apparatus shall be stable ($\pm 2\%$) during the test.

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.

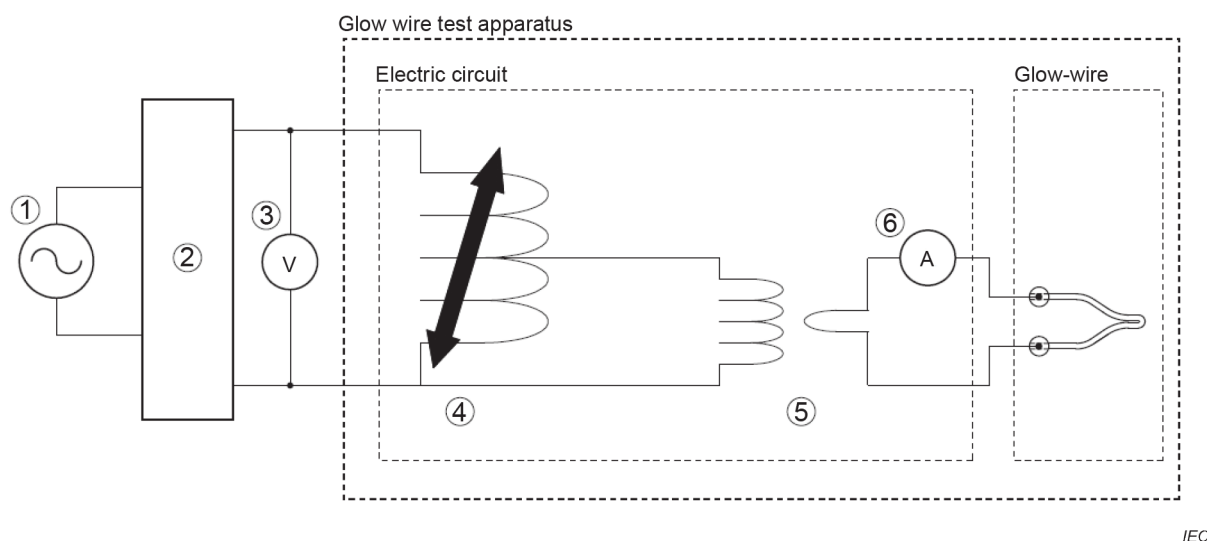
The circuit shall contain a current measuring device which indicates a true RMS value having an accuracy of $\pm 2,5\%$ or more accurate.

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 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.



IEC 633/13



IEC

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 – ~~Test circuit~~ 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 60584-2~~ 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. ~~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.

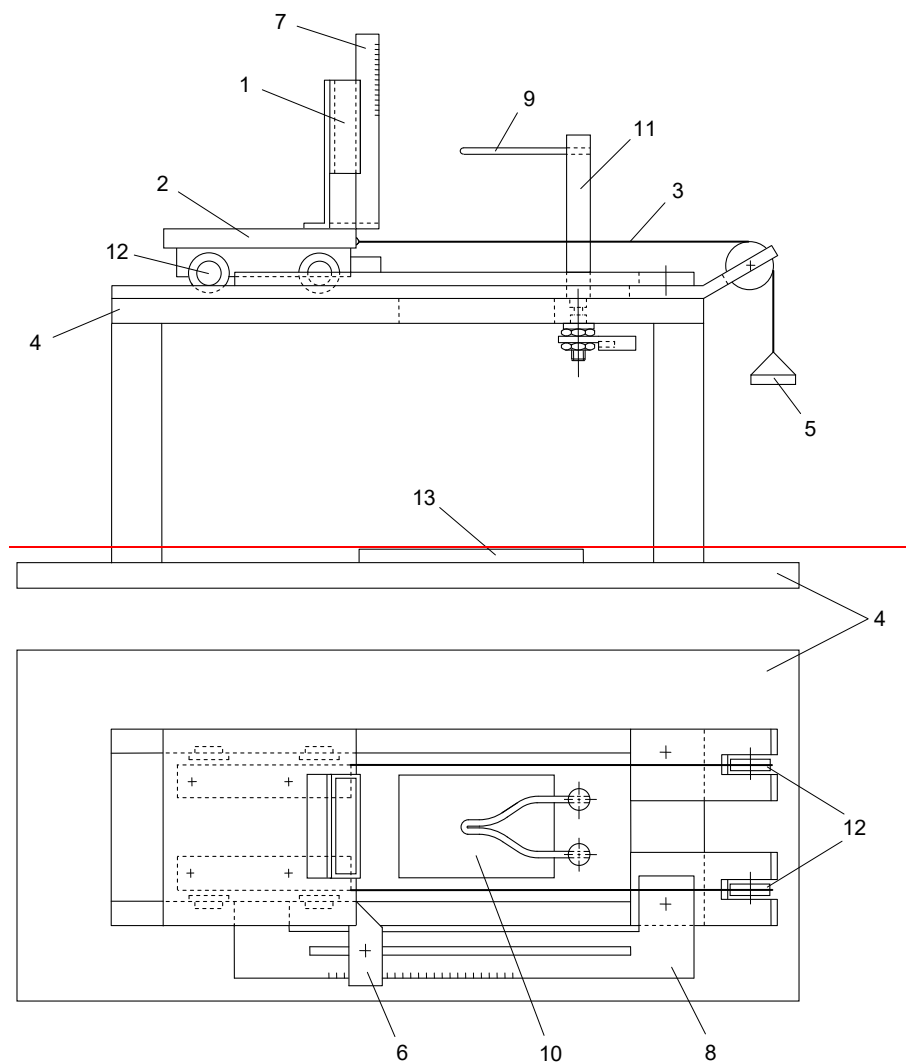
The instrument for measuring the thermocouple voltages may consist of any commercial digital thermometer with a built-in reference junction.

~~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 $200 \text{ mm} \pm 5 \text{ mm}$ below the place where the glow-wire is applied to the test specimen. See Figure 3a) and Figure 3b). Wrapping tissue (as ~~specified~~ defined in ISO 4046-4:20022016, 4.215) is a soft and strong lightweight wrapping ~~tissue~~ paper with a mass per unit area of between 12 g/m^2 and 30 g/m^2 .

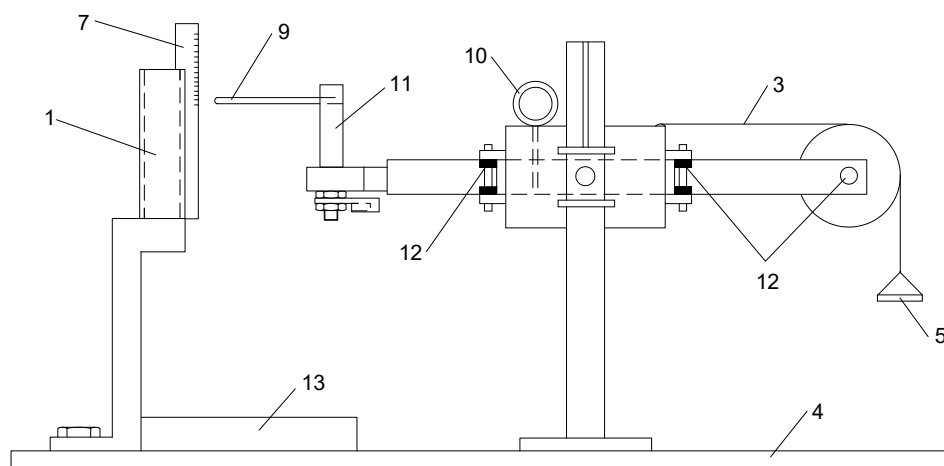
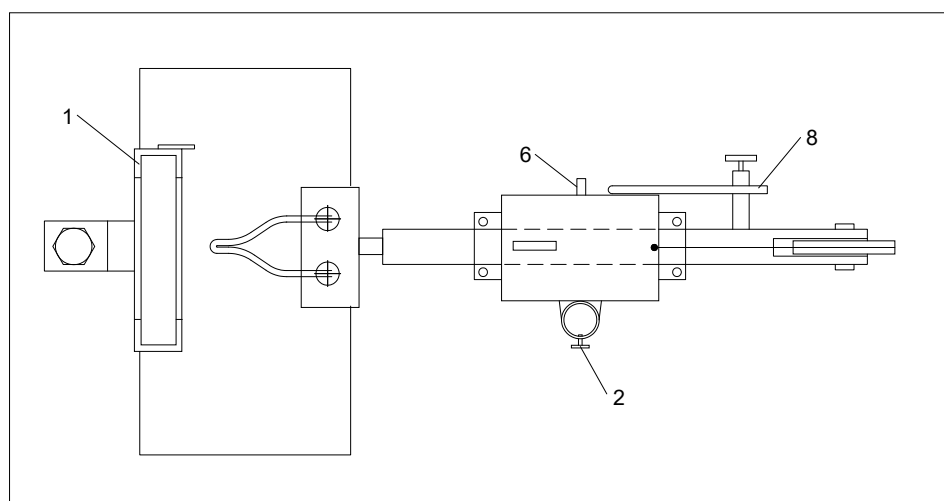


IEC 634/13

Key

- | | |
|--|--|
| 1—Test specimen support (see Figure 4) | 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 | |

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

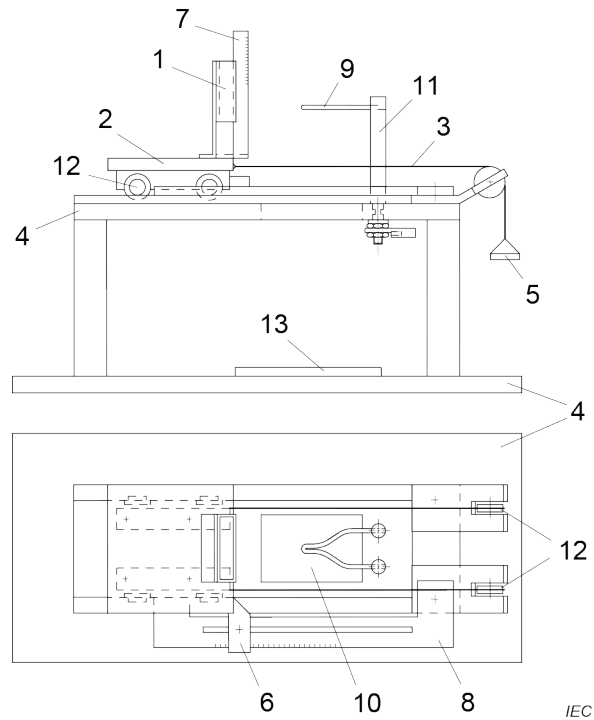


IEC 635/13

Key

- | | |
|---|-----------------------------|
| 1— Test specimen support (see Figure 4) | 8— Penetration adjustment |
| 2— Height adjustment screw | 9— Glow-wire |
| 3— Tensioning cord | 10— Restraining pin |
| 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 | |

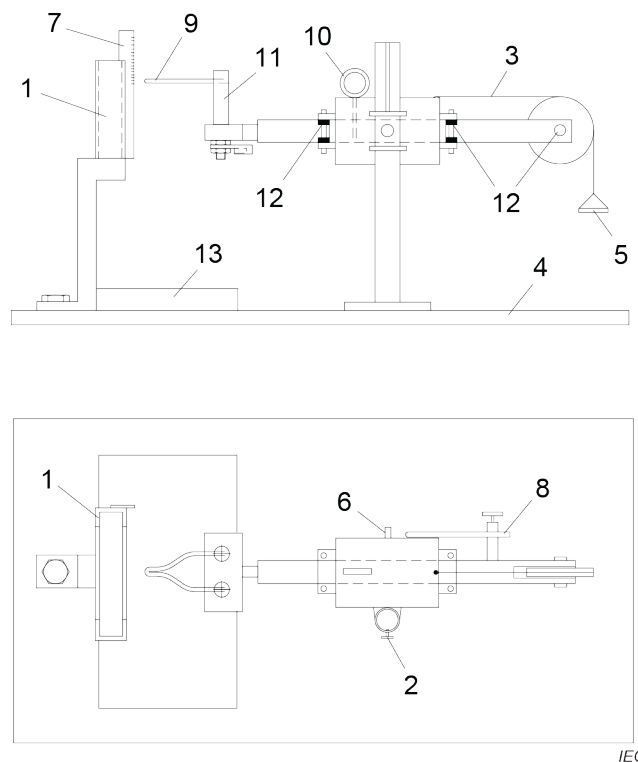
b) Test apparatus – moving glow-wire, static test specimen (example)



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)

**Key**

- | | |
|------------------------------------|----------------------------|
| 1 Test specimen support | 8 Penetration adjustment |
| 2 Height adjustment screw | 9 Glow-wire |
| 3 Tensioning cord | 10 Restraining pin |
| 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 | |

3b) Test apparatus – moving glow-wire, static test specimen (example)**Figure 3 – Test apparatus examples****4.5 Test chamber**

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

- a) oxygen depletion during the test does not significantly affect the result, and
- b) 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 m³ 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~~ shall be 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~~ 0,1 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 shall be inspected 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 (no copper or brass 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~~ shall be performed using a foil of silver with a purity of at least 99,8 %, approximately 2 mm² 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 B 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~~ installing a new glow-wire and thermocouple 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;
- d) any dripping particles can flow freely without interference from the support.

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.

Before heating the glow-wire to the specified temperature, there shall be no contamination in the thermocouple hole drilled in the glow-wire and that 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.

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;~~
- b) 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
- c) 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 $30\text{ s} \pm 1\text{ s}$. 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 $7\text{ mm} \pm 0,5\text{ mm}$.

~~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.~~

8 General test observations and evaluations of test results

During the time of application of the glow-wire (t_{APP}), and during the time of observation (t_{OBS}), the test specimen, and the parts surrounding the test specimen (for GWEPT), or the specified layer (for GWFI) placed below it, shall be observed, and t_I , t_E , t_B , t_R and t_T shall be recorded, if applicable (see Annex C for times, durations, and examples of evaluations).

Details of observation and evaluation shall follow the sub-part of IEC 60695-2-11 for the end product test and the sub-parts of IEC 60695-2-12 and IEC 60695-2-13 for the material tests.

During the tests conducted in accordance with IEC 60695-2-11, IEC 60695-2-12 and IEC 60695-2-13, requirements for the observation of ignition and flaming are to be found in Annex A.

~~Annex A~~
~~(informative)~~

~~Equipment manufacturers and suppliers~~

~~Equipment manufacturers and suppliers may be found by searching on the internet.~~