

# INTERNATIONAL STANDARD



HORIZONTAL PUBLICATION

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

Document Preview

[IEC 60695-2-11:2021](#)

<https://standards.iteh.ai/catalog/standards/iec/17b5056b-b0dc-4e55-95b4-536ab552c56b/iec-60695-2-11-2021>



## 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](mailto:info@iec.ch)  
[www.iec.ch](http://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](http://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 It also gives information on projects, replaced and withdrawn publications.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 online collection - [oc.iec.ch](http://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.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://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.

#### Electropedia - [www.electropedia.org](http://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 Customer Service Centre - [webstore.iec.ch/csc](http://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](mailto:sales@iec.ch).

International Standards  
standards.iteh.ai  
Document Preview

[IEC 60695-2-11:2021](https://standards.iteh.ai/catalog/standards/iec/17b5056b-b0dc-4e55-95b4-536ab552c56b/iec-60695-2-11-2021)

<https://standards.iteh.ai/catalog/standards/iec/17b5056b-b0dc-4e55-95b4-536ab552c56b/iec-60695-2-11-2021>



IEC 60695-2-11

Edition 3.0 2021-10  
REDLINE VERSION

# INTERNATIONAL STANDARD



HORIZONTAL PUBLICATION

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

iTeh Standards  
Document Preview

[IEC 60695-2-11:2021](#)

<https://standards.iteh.ai/catalog/standards/iec/17b5056b-b0dc-4e55-95b4-536ab552c56b/iec-60695-2-11-2021>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 13.220.40; 29.020

ISBN 978-2-8322-4419-7

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

## CONTENTS

FOREWORD .....	3
INTRODUCTION .....	2
1 Scope .....	6
2 Normative references .....	6
3 Terms and definitions .....	6
4 Test specimens .....	9
4.1 General .....	9
4.2 Complete end product .....	9
4.3 Partial end product (alternative) .....	9
4.4 Test considerations and limitations associated with the specimen configuration .....	9
5 Test apparatus .....	10
6 Verification of the temperature measuring system .....	10
7 Conditioning .....	10
7.1 Conditioning of test specimens .....	10
7.2 Conditioning of specified layers .....	11
7.3 Testing conditions .....	11
8 Test procedure .....	11
8.1 General .....	11
8.2 Test temperatures .....	11
8.3 Number of test specimens .....	12
9 Observations and measurements .....	12
10 Evaluation of test results .....	12
11 Test report .....	13
12 Information to be given in the relevant product standard .....	13
Annex A (informative) Suggested GWEPT temperatures .....	14
Bibliography .....	16
Figure 1 – Small parts .....	10
Figure A.1 – Suggested GWEPT temperatures .....	15
Table 1 – Test temperatures .....	12

INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

**FIRE HAZARD TESTING –**

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

**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 60695-2-11:2014. 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 60695-2-11 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 2014. This edition constitutes a technical revision.

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

- a) Numerous terms and definitions relevant to this document have been added to Clause 3.

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

FDIS	Report on voting
89/1536/FDIS	89/1544/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.

This standard is to be used in conjunction with IEC 60695-2-10.

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

In this standard, the following print types are used:

- terms defined in Clause 3: in **bold** type

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,
- 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

~~The purpose of this Introduction is to provide background regarding the basic guidance that prompted the preparation of this International Standard and how it relates to the Scope.~~

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 within the design of component, circuit, and product design, as well as the choice of the 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 [1]<sup>1</sup>, together with its companion IEC 60695-1-11 [2], has been developed 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 to:

- a) prevent ignition caused by an electrically energized component part, and
- b) confine any resulting fire within the bounds of the enclosure of the electrotechnical product in the event of ignition.

Secondary aims of IEC 60695-1-10 and IEC 60695-1-11 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~~ are normally dealt with in the overall fire hazard 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.

IEC 60695-2-10 describes a glow-wire test apparatus and common test procedure, IEC 60695-2-12 [3] describes a glow-wire flammability index (GWFI) test method for materials, and IEC 60695-2-13 [4] describes a glow-wire ignition temperature (GWIT) test method for materials.

This document is used to assess the reaction of end products to heat caused by contact with an electrically heated wire under controlled laboratory conditions. This may be useful for the evaluation of end products that may be exposed to excess thermal stress such as a fault current flowing through a wire, overloading of components, and/or ~~poor electrical~~ bad connections. It should not be used to solely describe or appraise the fire hazard or fire risk of products, or assemblies under actual fire conditions. However, results of this test ~~may~~ can be used as elements of a fire hazard assessment which takes into account all of the factors which are pertinent to a particular end use.

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

---

<sup>1</sup> Numbers in square brackets refer to the bibliography.

## FIRE HAZARD TESTING –

### Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end products (GWEPT)

#### 1 Scope

This part of IEC 60695 specifies a test method on an end product. It is intended to simulate the effects of thermal stresses produced by an electrically heated source to represent a fire hazard.

This test method is used to check that, under defined test conditions, an end product exposed to an electrically heated source has either a limited ability to ignite or, if it ignites, a limited ability to propagate flame. However, the fire hazard analysis, the flammability aspects and the flame spreading to other products are not covered by this document.

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 60695-2-10, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-4:2012, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

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

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

ISO 13943:2017, *Fire safety – Vocabulary*

#### 3 Terms and definitions

For the purpose of this document, the ~~following~~ terms and definitions given in ISO 13943:2017 and IEC 60695-4:2012, some of which are reproduced below for the user's convenience, and in IEC 60695-2-10 regarding times and durations, 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

**burn**, intransitive verb  
undergo combustion

[SOURCE: ~~ISO/IEC 13943:2008, definition 4.28~~ ISO 13943:2017, 3.34]

### 3.2

**combustible**, adjective  
capable of being ignited and burned

[SOURCE: ~~ISO/IEC 13943:2008, definition 4.43~~ ISO 13943:2017, 3.52]

### 3.3

**combustion**  
exothermic reaction of a ~~substation~~ substance with an oxidizing agent

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

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

### 3.4

**enclosure**  
<electrotechnical> external casing protecting the electrical and mechanical parts of apparatus

Note 1 to entry: The term excludes cables.

[SOURCE: ~~ISO/IEC 13943:2008, definition 4.78~~ ISO 13943:2017, 3.93]

### 3.5

**end product**  
product that is ready for use without modification

Note 1 to entry: An end product can be a component of another end product.

[SOURCE: IEC 60695-4:2012, 3.2.7]

### 3.6

**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/IEC 13943:2008, definition 4.112~~ ISO 13943:2017, 3.131]

### 3.7

**fire hazard assessment**  
evaluation of the possible causes of fire, the possibility and nature of subsequent fire growth, and the possible consequences of fire

[SOURCE: IEC 60695-4:2012, 3.2.10]

### 3.8

**fire risk**  
~~probability of a fire combined with a quantified measure of its consequence~~

~~Note 1 to entry: It is often calculated as the product of probability and consequence.~~

~~[SOURCE: ISO/IEC 13943:2008, definition 4.124]~~

estimation of expected fire loss that combines the potential for harm in various fire scenarios that can occur with the probabilities of occurrence of those scenarios

Note 1 to entry: An alternative definition of fire risk is, "combination of the probability of a fire and a quantified measure of its consequence".

Note 2 to entry: Fire risk is often calculated as the product of probability and consequence.

[SOURCE: ISO 13943:2017, 3.145]

### 3.9

#### **flame**

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

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

### 3.10

#### **flame spread**

propagation of a flame front

[SOURCE: ~~ISO/IEC 13943:2008, definition 4.142~~ ISO 13943:2017, 3.168]

### 3.11

#### **flammability**

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

[SOURCE: ~~ISO/IEC 13943:2008, definition 4.151~~ ISO 13943:2017, 3.178]

### 3.12

#### **glowing, adjective**

emitting light without flame from the combustion of a material in the solid phase

### 3.13

#### **ignition**

DEPRECATED: sustained ignition

<general> initiation of combustion

[SOURCE: ~~ISO/IEC 13943:2008, definition 4.187~~ ISO 13943:2017, 3.217]

### 3.14

#### **insignificant mass**

insufficient combustible material to constitute a fire hazard

Note 1 to entry: A default value is 2 g, but product TCs may assign a different value appropriate to the product type and scale.

[SOURCE: IEC 60695-4:2012, 3.2.16]

### 3.15

#### **small part**

part with a dimension less than the minimum specified for the relevant test method

[SOURCE: IEC 60695-4:2012, 3.2.25]

## 4 Test specimens

### 4.1 General

It is not necessary to test **end products** or parts of **end products** which have **insignificant mass**. Additionally, this test method is not suitable for testing **small parts** (see 4.4).

### 4.2 Complete end product

~~It is preferred that~~ Whenever possible, the test specimen should be a complete **end product** as opposed to a partial **end product** (see 4.3). The test specimen shall be chosen so that the conditions of the test will not be significantly different from those occurring in normal use with regard to shape, ventilation, effect of thermal stresses, and eventually, the effects of burning or **glowing** particles falling from the test specimen.

### 4.3 Partial end product (alternative)

If the test cannot be made on a complete **end product** then, unless otherwise specified by the relevant product standard, it is acceptable to

- a) cut a piece containing the part under examination from a complete and assembled **end product**, or
- b) cut an aperture in the complete **end product** to allow the glow-wire access, or
- c) remove the part under examination in its entirety and test it separately.

Technical committees should define in their relevant product standards what may be removed to achieve access. So far as possible, these product standards should strive to replicate actual service locations and conditions.

### 4.4 Test considerations and limitations associated with the specimen configuration

When cutting an opening for access purposes, a small aperture may affect the results by leading to the **ignition** of the surroundings and/or reducing the temperature of the tip of the glow-wire. The opening should be large enough to ~~supply~~ allow an adequate supply of air for **combustion**.

If, during the test, any part of the ~~equipment~~ **end product** containing the test specimen is ignited by extraneous heat from the glow-wire which in turn influences the thermal conditions at the test specimen, the test ~~shall be~~ is invalid.

The glow-wire **flammability** test method for **end products** shall not be used for testing **small parts**. This is because such parts cannot be effectively supported to avoid heat losses (see IEC 60695-2-10), and they are not able to accommodate the penetration of the glow-wire.

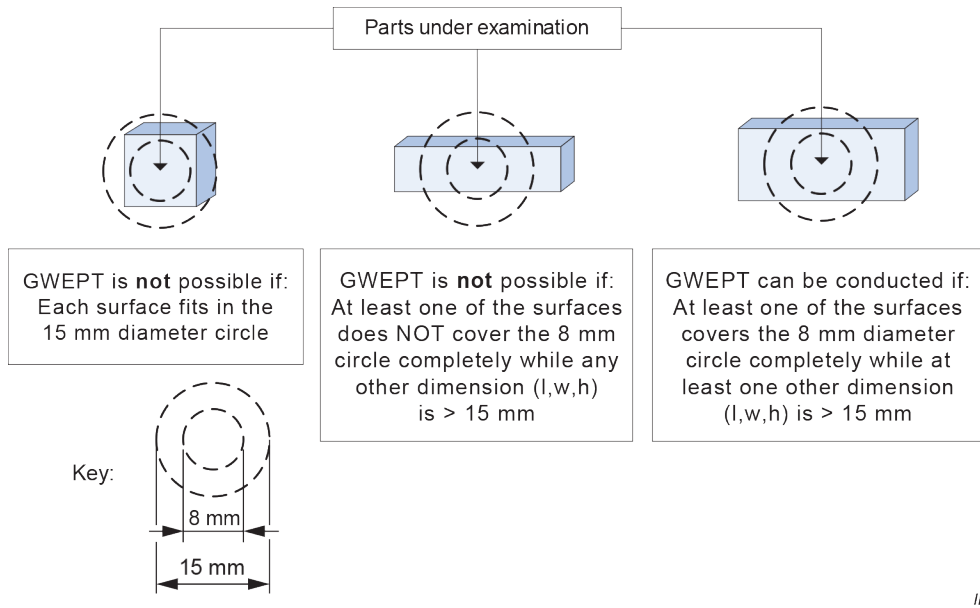
The following are considered to be **small parts**:

- a) where each surface lies completely within a circle of 15 mm in diameter; or
- b) where it is not possible to fit a circle of 8 mm in diameter completely on at least one of the surfaces while, at least one part dimension is > 15 mm.

See Figure 1.

When checking a surface,

- 1) projections on the surface are disregarded, and
- 2) holes or recesses which are not greater than 2 mm in any dimension are disregarded.



IEC

Figure 1 – Small parts

## 5 Test apparatus

The test apparatus ~~is specified in~~ of IEC 60695-2-10 shall be used except that the reference to a specified layer may not apply.

To evaluate the possibility of the spread of fire, for example by burning or **glowing** particles falling from the test specimen, a specified layer as described in IEC 60695-2-10, or the material or components normally surrounding or situated underneath the test specimen, are placed underneath the test specimen. The distance between the test specimen and the specified layer representing the surrounding material or components shall be equal to that which occurs in end use. ~~If the test specimen is a component such that surrounding materials and distances are unknown, then the wrapping tissue / wooden board~~ specified layer described in IEC 60695-2-10 shall be placed 200 mm ± 5 mm below the glow-wire point of contact.

If the test specimen is a complete free-standing equipment, it is placed in its normal position of use on the specified layer as described in IEC 60695-2-10 extending for at least 100 mm outside the base of the equipment in all directions.

If the test specimen is a complete wall-mounted equipment, it is fixed in its normal position of use 200 mm ± 5 mm above the specified layer as described in IEC 60695-2-10.

## 6 Verification of the temperature measuring system

~~The method of verification of~~ The temperature measuring system ~~is~~ shall be verified as specified in IEC 60695-2-10.

## 7 Conditioning

### 7.1 Conditioning of test specimens

Unless otherwise specified in the relevant product standard, the test specimens shall be conditioned for 24 h in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 %.

## 7.2 Conditioning of specified layers

If the wrapping tissue ~~+~~ or wooden board is used as specified layer ~~is used~~, the conditioning shall be carried out according to IEC 60695-2-10. If the material or components normally surrounding or situated underneath the test specimen is used, the material or components shall be conditioned in the same way as the test specimen (see 7.1).

## 7.3 Testing conditions

The test specimens shall be tested in a laboratory atmosphere having a temperature between 15 °C and 35 °C and a relative humidity less than or equal to 75 %. Testing shall be completed within 30 minutes after the specimens and the specified layers (if any) ~~is~~ are removed from the conditions specified in 7.1 and 7.2, respectively.

# 8 Test procedure

## 8.1 General

In addition to the common test procedure specified in IEC 60695-2-10, if not otherwise specified, the test specimen shall be so arranged that the tip of the glow-wire is applied to the part of the surface of the test specimen which is likely to be subjected to thermal stresses in normal use. The glow-wire shall be maintained as close to the horizontal as is practicable.

~~In cases where the test shall be made at more than one point on the same test specimen, care shall be taken that any deterioration caused by previous tests will not affect the result of the test to be made.~~

In cases where the test shall be made at more than one point on the same test specimen, ensure that any deterioration caused by previous tests does not affect the result. In this case, the test shall be made at a minimum distance from the edges of the previous burnt area of 30 mm (two times the size of **small parts**).

In cases where the areas subjected to thermal stresses during normal use of the equipment are not specified in detail, the tip of the glow-wire is applied at a place where the section is thinnest, but if possible not less than 15 mm from the upper edge of the test specimen.

Clamping the test specimen onto the test apparatus shall not introduce excessive internal mechanical stresses in the test specimen during the test.

## 8.2 Test temperatures

The glow-wire is heated to the test temperature specified in the relevant product standard. This temperature should preferably be one of the temperatures shown in Table 1.

**Table 1 – Test temperatures**

Test temperatures °C	Tolerances °C
550	±10
600	±10
650	±10
700	±10
750	±10
800	±15
850	±15
900	±15
960	±15

When selecting test temperatures, product committees should consider Annex A and its Figure A.1, which gives suggested glow-wire **end product** test (GWEPT) temperatures.

### 8.3 Number of test specimens

If not otherwise specified by the relevant product standard, the test is made on one test specimen.

NOTE More test specimens can be required.

## 9 Observations and measurements

During the time of application of the glow-wire,  $t_A$   $t_{APP}$  (30 s ± 1 s), and during a further period of 30 s, time of observation  $t_{OBS}$ , the test specimen, the parts surrounding the test specimen ~~and~~ or the specified layer placed below it shall be observed and the following shall be ~~reported~~ recorded:

- ~~a) whether there is no ignition; or, if there is ignition, the duration,  $t_i$  (to the nearest 0,5 s), from the beginning of tip application up to the time at which the test specimen or the specified layer placed below it ignites;~~
- ~~b) the duration,  $t_E$ , (to the nearest 0,5 s) from the beginning of tip application up to the time when all flames extinguish, during or after the period of application;~~
- ~~c) whether the test specimen extinguishes by virtue of most of the flaming material being withdrawn with the glow wire;~~
- ~~d) whether the test specimen is totally burned; and~~
- ~~e) whether there is any ignition of the specified layer placed underneath the test specimen.~~
- a) whether there is no **ignition**; or, if there is **ignition**, the time of **ignition**,  $t_i$  for the test specimen;
- b) the time of extinguishment  $t_E$ ; and
- c) whether there is any **ignition** of the specified layer placed underneath the test specimen.

## 10 Evaluation of test results

The test specimen is considered to have ~~a GWEPT of  $T$  if at a test temperature of  $T$  °C~~ passed the GWEPT test if the following criteria have been met:

- a) there is no **ignition**, or
- b) all of the following situations apply when **ignition** has occurred: