

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

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

**Essais relatifs aux risques du feu – Partie 2-12: Essais au fil incandescent/chauffant – Méthode d'essai d'indice d'inflammabilité au fil incandescent (GWFI) pour matériaux**



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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## FIRE HAZARD TESTING –

**Part 2-12: Glowing/hot-wire based test methods –  
Glow-wire flammability index (GWFI) test method for materials**

## FOREWORD

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International Standard IEC 60695-2-12 has been prepared by technical committee 89: Fire hazard testing.

This second edition of IEC 60695-2-12 cancels and replaces the first edition published in 2000. It also constitutes a technical revision.

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

This standard is to be used in conjunction with IEC 60695-2-10 and IEC 60695-2-13.

The main changes with respect to the previous edition are listed below:

- modified title;
- addition of an Introduction;
- clarification of Scope;

- expansion of Clause 2: Normative references;
- definitions added to Clause 3;
- revision of Clause 4 to alignment with the IEC 60695-11 series to introduce guidance on test programs for material variations;
- clarification of Clause 8: Conditioning (now Clause 7);
- deletion of Clause 9 “Initial measurements”;
- expansion of Clause 10: Test procedures (now Clause 8);
- expansion of Clause 11: Observation and measurement (now Clause 9);
- clarification of Clause 12: Evaluation of test results (now Clause 10);
- expansion of Clause 13: Test report (now Clause 11).

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

FDIS	Report on voting
89/1017/FDIS	89/1034/RVD

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

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

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

(standards.iteh.ai)

Part 2 consists of the following parts:

- Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure
- Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products
- Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials
- Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials

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

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

## INTRODUCTION

In the design of any electrotechnical product, the risk of fire and the potential hazards associated with fire need to be considered. In this respect the objective of component, circuit, and product design, as well as the choice of materials, is to reduce to acceptable levels the potential risks of fire during normal operating conditions, reasonable foreseeable abnormal use, malfunction and/or failure. IEC/TC 89 has developed IEC 60695-1-10, together with its companion, IEC 60695-1-11, to provide guidance on how this is to be accomplished.

The primary aims of IEC 60695-1-10 and IEC 60695-1-11 are to provide guidance on how:

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

Secondary aims of 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 the 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 red-hot 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 60695-2-11 describes a glow-wire flammability test for end products, and IEC 60695-2-13 describes a glow-wire ignition temperature test method for materials.

This part of IEC 60695 describes a glow-wire flammability index test for materials. It should be used to measure, describe, and rank the properties of materials in response to heat caused by contact with an electrically heated wire under controlled laboratory conditions. This may be useful for the evaluation of materials for use in products that may be exposed to excess thermal stress such as a fault current flowing through a wire, overloading of components, and/or bad connections. It should not be used to solely describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors pertinent to a fire hazard assessment of a particular end use.

This International Standard 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

## FIRE HAZARD TESTING –

### Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials

#### 1 Scope

This part of IEC 60695 specifies the details of the glow-wire test to be applied to test specimens of solid electrical insulating materials or other solid materials for flammability testing to determine the glow-wire flammability index (GWFI).

GWFI is the highest temperature, determined during this standardized procedure, at which the tested material

- a) does not ignite or, if it does, extinguishes within 30 s after removal of the glow-wire and is not totally consumed,
- and
- b) molten drips, if they occur, do not ignite the wrapping tissue.

This test method is a materials test carried out on a series of standard test specimens. The data obtained, along with data from the glow-wire ignition temperature (GWIT) test method for materials, IEC 60695-2-13, can then be used in a preselection process in accordance with IEC 60695-1-30 to judge the ability of materials to meet the requirements of IEC 60695-2-11.

NOTE As an outcome of conducting a fire hazard assessment, an appropriate series of preselection flammability and ignition tests may allow a reduction of end product testing.

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

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. The requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the relevant publications.

#### 2 Normative references

The following referenced documents are indispensable for the application 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 60695-1-30:2008, *Fire hazard testing – Part 1-30: Guidance for assessing the fire hazard of electrotechnical products – Preselection testing process – General guidelines*

IEC 60695-2-10:2000, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

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 104:1997, *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 inclusion in standards*

ISO/IEC 13943:2008, *Fire safety – Vocabulary*

ISO 291:2008, *Plastics – Standard atmospheres for conditioning and testing*

ISO 293:2004, *Plastics – Compression moulding of test specimens of thermoplastic materials*

ISO 294 (all parts), *Plastics – Injection moulding of test specimens of thermoplastic materials*

ISO 295:2004, *Plastics – Compression moulding of test specimens of thermosetting materials*

### 3 Terms and definitions

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

#### 3.1

##### **combustion**

exothermic reaction of a substance with an oxidizing agent

NOTE Combustion generally emits fire effluent accompanied by flames and/or glowing.

[ISO/IEC 13943:2008, definition 4.46]

#### 3.2

##### **flame**, noun

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

[ISO/IEC 13943:2008, definition 4.133]

#### 3.3

##### **flammability**

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

[ISO/IEC 13943:2008, definition 4.151]

#### 3.4

##### **glowing**, noun

luminosity caused by heat

[ISO/IEC 13943:2008, definition 4.168]

#### 3.5

##### **glowing combustion**

combustion of a material in the solid phase without flame but with emission of light from the combustion zone

[ISO/IEC 13943:2008, definition 4.169]

#### 3.6

##### **ignition**

sustained ignition (deprecated)

<general> initiation of combustion

[ISO/IEC 13943:2008, definition 4.187]

### 3.7

#### **ignition**

sustained ignition (deprecated)

<flaming combustion> initiation of sustained flame

[ISO/IEC 13943:2008, definition 4.188]

### 3.8

#### **molten drip**

falling droplet of material that has been softened or liquefied by heat

NOTE The droplets can be flaming or not flaming.

[ISO/IEC 13943:2008, definition 4.232]

### 3.9

#### **preselection**

process of assessing and choosing candidate materials, components or sub-assemblies for making an end-product

[IEC 60695-1-30:2008, definition 3.2]

## 4 Test specimens

### 4.1 Test specimen preparation

Test specimens shall be fabricated using the appropriate ISO method, e.g. casting and injection moulding in accordance with ISO 294 series, compression moulding in accordance with ISO 293 or ISO 295, or transfer moulding to the necessary shape. Where this is not possible, the test specimen shall be cut and/or sliced from a representative sample of the material (for example, produced using the same fabrication process as would be used to mould a part of a product).

After any fabrication or cutting operation, care shall be taken to remove all dust and any particles from the surface; cut edges shall be fine sanded to a smooth finish.

### 4.2 Test specimen dimensions

The dimensions of the planar sections of the test specimens shall be at least 60 mm in length and 60 mm in width (measured inside the clamping areas) and shall be provided in all thicknesses under consideration. The preferred values include 0,1 mm ± 0,02 mm, 0,2 mm ± 0,02 mm, 0,4 mm ± 0,05 mm, 0,75 mm ± 0,1 mm, 1,5 mm ± 0,15 mm, 3,0 mm ± 0,2 mm, or 6,0 mm ± 0,4 mm.

NOTE A set of 15 test specimens per thickness will, in general, be adequate to concurrently establish the glow wire ignition temperature, GWIT (See IEC 60695-2-13) and GWFI.

### 4.3 Testing ranges in formulations

#### 4.3.1 General

The results of tests carried out on test specimen sets of different colour, thickness, density, molecular mass, anisotropic type/direction, additives, fillers, and/or reinforcements can vary. When agreed between the parties involved, the test programs outlined in 4.3.2 and 4.3.3 may be employed in order to evaluate these variations.

#### 4.3.2 Density, melt flows and filler/reinforcement

Test specimens covering all combinations of minimum and maximum levels of density, melt flows and filler/reinforcement content may be provided and considered representative of the range if the test results yield the same GWFI. If the test results do not yield the same GWFI for all test specimens representing the range, evaluation shall be limited to the materials with the specific levels of density, melt flows and filler/reinforcement tested. In addition, test specimens with intermediate density, melt flows, and filler/reinforcement content shall be tested to determine the representative range for each GWFI determination. However, as an alternative, the least favourable performance of the specific levels of density, melt flows and filler/reinforcement tested may be considered representative of intermediate levels without additional testing.

#### 4.3.3 Colour

When evaluating a range of colours, test specimens that

- a) contain no colouring,
- b) contain the highest level of organic pigments/colorants/dyes and/or carbon black,
- c) contain the highest level of inorganic pigments, and
- d) contain pigments/colorants/dyes which are known to adversely affect flammability characteristics

are considered representative of the colour range if the test results yield the same GWFI.

### 5 Apparatus

The description of the test apparatus is specified in Clause 5 of IEC 60695-2-10.

The wrapping tissue and wooden board to be placed underneath the test specimen are specified in 5.3 of IEC 60695-2-10.

### 6 Temperature measuring system verification

The method of verification of the temperature measuring system is specified in 6.2 of IEC 60695-2-10.

### 7 Conditioning and test conditions

#### 7.1 Conditioning of test specimens

The test specimens shall be conditioned for a minimum of 48 h at  $23\text{ °C} \pm 2\text{ °C}$  and at a relative humidity between 40 % and 60 %. Once removed from the conditioning atmosphere, the test specimens shall be tested within 4 h (see ISO 291, Clause 6, Table 2, Class 2).

#### 7.2 Conditioning of the wrapping tissue and the wooden board

The wrapping tissue and the wooden board to be placed underneath the test specimen are specified in 5.3 of IEC 60695-2-10. They shall be conditioned for a minimum of 48 h at  $23\text{ °C} \pm 2\text{ °C}$  and at a relative humidity between 40 % and 60 %. Once removed from the conditioning atmosphere, the wrapping tissue and wooden board shall be used within 1 h (see ISO 291, Clause 6, Table 2, Class 2).

#### 7.3 Testing conditions

The test specimens shall be tested in a laboratory atmosphere having a temperature of  $25\text{ °C} \pm 10\text{ °C}$  and at a relative humidity between 45 % and 75 %.

## 8 Test procedure

### 8.1 General

The test specimens shall be identified and examined visually.

The general test procedure shall be as specified in Clause 8 of IEC 60695-2-10.

### 8.2 Initial test temperatures

The glow-wire is heated to one of the initial test temperatures specified in Table 1, which is considered to be just high enough to cause ignition. If unknown the initial test temperature shall not exceed 650 °C.

NOTE When determining both the GWIT and GWFI, it has been found to be useful to first perform the procedure in IEC 60695-2-13. Once the GWIT has been determined, this should be used as the initial test temperature for this test.

**Table 1 – Initial test temperatures**

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

### 8.3 Test temperatures

A set of three test specimens shall be prepared for testing at a chosen test temperature.

If one of the three test specimens fails to withstand the test criteria as defined in 10.1, the test shall be repeated with three new test specimens at a test temperature preferably 50 K (60 K for 960 °C) lower.

If the three test specimens withstands the test criteria as defined in 10.1, the test shall be repeated with three new test specimens at a test temperature preferably 50 K (60 K for 900 °C) higher.

Repeat the tests with three new test specimens each time and reduce the interval of test temperatures to 25 K (30 K for 960 °C) in the final approach to determine the maximum test temperature at which all three test specimen withstand the test criteria as defined in 10.1.

However, there is no need to go to the higher temperature if it has already been determined that at least one of the three test specimen will not withstand the test criteria as defined in 10.1.

NOTE 1 The minimum test temperature is 550 °C. The maximum test temperature is 960 °C.