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Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials

Essais relatifs aux risques du feu – Partie 2-13: Essais au fil incandescent/chauffant – Méthode d'essai de température d'allumage au fil incandescent (GWIT) pour matériaux

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FOREWORD

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IEC 60695-2-13 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 2010 and Amendment 1:2014. 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, with an effect on the application of the test method.

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

FDIS	Report on voting
89/1538/FDIS	89/1546/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 60695-2-10.

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.

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- withdrawn,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.

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 60695-1-10 [1] [1], 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 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 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 60695-2-11 [3] describes a glow-wire flammability test for end products, and IEC 60695-2-12 describes a glow-wire flammability index (GWFI) test method for materials.

This document describes a glow-wire ignition temperature test method for materials. It is intended to 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 is not intended to 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 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.

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1 Numbers in square brackets refer to the bibliography.

FIRE HAZARD TESTING –

Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) 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 ignitability testing to determine the glow-wire ignition temperature (GWIT).

The GWIT is the temperature which is 25 K (or 30 K) higher than the maximum test temperature, determined during this standardized procedure, at which the tested material does not ignite, or sustained flaming combustion does not occur for a time longer than 5 s for any single flame event and the specimen is not totally consumed.

This test is a materials test carried out on a series of standard test specimens. The data obtained, along with data from the glow-wire flammability index (GWFI) test method for materials, IEC 60695-2-12, can then be used in a preselection process in accordance with IEC 60695-1-30 [4] 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 can allow a reduction of end product testing.

This basic safety publication focusing on safety test method(s) is primarily intended for use by technical committees in the preparation of safety publications in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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 60695-4:2021, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

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

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

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

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

ISO 13943:2017, *Fire safety – Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:2017 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
combustion
exothermic reaction of a substance with an oxidizing agent

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

[SOURCE: ISO 13943:2017, 3.55]

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

[SOURCE: ISO 13943:2017, 3.159]

3.3
flame event
sustained flaming and/or glowing combustion

3.4
flammability
ability of a material or product to burn with a flame under specified conditions

[SOURCE: ISO 13943:2017, 3.178]

3.5
glowing, noun
luminosity caused by heat

[SOURCE: ISO 13943:2017, 3.196]

3.6
glowing combustion
combustion of a material in the solid phase without flame but with emission of light from the combustion zone

[SOURCE: ISO 13943:2017, 3.197]

3.7
ignitability
ease of ignition
measure of the ease with which a test specimen can be ignited, under specified conditions

Note 1 to entry: See also ignition temperature, flash ignition temperature, minimum ignition temperature and spontaneous ignition temperature

[SOURCE: ISO 13943:2017, 3.212]

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

[SOURCE: ISO 13943:2017, 3.217]

3.9
ignition
DEPRECATED: sustained ignition
<flaming combustion> initiation of sustained flame

[SOURCE: ISO 13943:2017, 3.218]

3.10
preselection
process of assessing and choosing candidate materials, components or subassemblies for making an end product

[SOURCE: IEC 60695-4:2012, 3.2.21]

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 the ISO 294 series, compression moulding in accordance with ISO 293 or ISO 295, or transfer moulding to the necessary shape as specified in 4.2. 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, all dust and any particles shall be removed 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 of thickness include 0,1 mm ± 0,02 mm, 0,2 mm ± 0,03 mm, 0,4 mm ± 0,04 mm, 0,75 mm ± 0,15 mm, 1,5 mm ± 0,15 mm, 3,0 mm ± 0,25 mm, or 6,0 mm ± 0,4 mm.

NOTE A set of 30 test specimens per thickness will, in general, be adequate to concurrently establish the GWIT and the glow-wire flammability index, GWFI (see IEC 60695-2-12).

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 involved parties, the test programmes outlined in 4.3.2 and 4.3.3 may be employed in order to evaluate these variations.

4.3.2 Density, melt flow, and filler/reinforcement

Test specimens covering all combinations of minimum and maximum levels of density, melt flows and filler/reinforcement content shall be provided and considered representative of the range if the test results yield the same GWIT. If the test results do not yield the same GWIT 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 GWIT determination. However, as an alternative, the least favourable performance of the specific levels of density, melt flows and filler/reinforcement tested shall 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 GWIT.

If the colours do not yield the same GWIT, when evaluating a range of colours, the GWIT with the least favourable performance should yield the GWIT for an all colour range.

5 Apparatus

The test apparatus of IEC 60695-2-10 shall be used.

6 Temperature measuring system verification

The verification of the temperature measuring system as specified in IEC 60695-2-10 shall have been performed.

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 °C ± 2 °C and at a relative humidity between 40 % and 60 % (in accordance with ISO 291:2008, Clause 6, Table 2, Class 2). Once removed from the conditioning atmosphere, the test specimens shall be tested within 4 h.

7.2 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 %.

8 Test procedure

8.1 General

The test specimens shall be identified.

The general test procedure shall be as specified in 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.

Table 1 – Initial test temperatures

Initial test temperature °C	Tolerances °C
500	±10
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 initial 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 °C (60 °C for 960 °C) lower.

If the three test specimens 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 °C (60 °C for 900 °C) higher.

Repeat the tests with three new test specimens each time and reduce the interval of test temperatures to 25 °C (30 °C for 960 °C) in the final approach to determine the maximum test temperature at which all three test specimens 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 specimens will not withstand the test criteria as defined in 10.1.