

TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

**Fire hazard testing –
Part 8-3: Heat release – Heat release of insulating liquids used in
electrotechnical products**

**Essais relatifs aux risques du feu –
Partie 8-3: Dégagement de chaleur – Dégagement de chaleur des liquides
isolants utilisés dans les produits électrotechniques**

WILLOW



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –

**Part 8-3: Heat release –
Heat release of insulating liquids used
in electrotechnical products**

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 60695-8-3, which is a technical specification, has been prepared by IEC technical committee 89: Fire hazard testing.

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

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
89/801/DTS	89/816/RVC

Full information on the voting for the approval of this technical specification 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.

This technical specification is to be used in conjunction with ISO 5660-1, ISO 5660-2 and IEC 60695-8-1.

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

IEC 60695-8, under the general heading *Fire hazard testing – Part 8: Heat release*, consists of the following parts:

Part 8-1: General guidance

Part 8-2: Summary and relevance of test methods

Part 8-3: Heat release of insulating liquids used in electrotechnical products

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

- transformed into an International standard;
- reconfirmed;
- withdrawn;
- replaced by a revised edition; or
- amended.

WITHDRAWN

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 equipment design, as well as the choice of materials, is to reduce to acceptable levels the potential risks of fire even in the event of foreseeable abnormal use, malfunction or failure. The future IEC 60695-1-10 [1]¹, together with its companion, the future IEC 60695-1-1 [2], provide guidance on how this is to be accomplished.

The primary aims are to prevent ignition caused by an electrically energized component part and, in the event of ignition, to confine any resulting fire within the bounds of the enclosure of the electrotechnical product. Secondary aims include the minimization of any flame spread beyond the product's enclosure and the minimization of harmful effects of fire effluents including heat, smoke and toxic or corrosive combustion products.

Fires involving electrotechnical products can also be initiated from external non-electrical sources. Considerations of this nature are dealt with in the overall risk assessment.

Fires are responsible for creating hazards to life and property as a result of the generation of heat (thermal hazard), the production of toxic and/or corrosive compounds, and the obscuration of vision due to smoke. Fire risk increases as the heat released increases, possibly leading to a flash-over fire.

One of the most important measurements in fire testing is the measurement of heat release, and it is used as an important factor in the determination of fire hazard; it is also used as one of the parameters in fire safety engineering calculations.

The measurement and use of heat release data, together with other fire test data, can be used to reduce the likelihood of (or the effects of) fire, even in the event of foreseeable abnormal use, malfunction or failure of electrotechnical products.

When a material is heated by some external source, fire effluent can be generated and can form a mixture with air which can ignite and initiate a fire. Some of the heat released in the process is carried away by the fire effluent-air mixture, some is radiatively lost, and some is transferred back to the material, to generate further pyrolysis products, thus continuing the process.

Heat may also be transferred to other nearby products, which may burn and then release additional heat and fire effluent.

The rate at which thermal energy is released in a fire is defined as the heat release rate. Heat release rate is important because of its influence on flame spread and on the initiation of secondary fires. Other characteristics are also important, such as ignitability, flame spread and the side-effects of the fire (see the IEC 60695 series).

This technical specification, is based on the use of the cone calorimeter which is an instrument which measures heat release rate as well as other useful fire hazard parameters such as smoke production, ignition time and mass loss.

The need for heat release data from the combustion of insulating liquids is mentioned in IEC 60695-1-40 [3]. This technical specification provides a method for measuring the heat release from such materials and is also applicable to other combustible liquids. Guidance on the use of the cone calorimeter is given in ISO 5660-3 [4] and in IEC 60695-8-2 [5].

¹ Figures in square brackets refer to the bibliography.

FIRE HAZARD TESTING –

Part 8-3: Heat release – Heat release of insulating liquids used in electrotechnical products

1 Scope

IEC 60695-8-3, which is a technical specification, specifies quantitative test methods for determining the heat release from the combustion of insulating liquids of electrotechnical products when exposed to a defined heat flux with spark ignition. Smoke production, ignition times and mass loss are also measured. This technical specification may also be applicable to other liquid test specimens.

This technical specification is intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and in 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.

HAZARD WARNING

The testing of volatile liquids with this apparatus can lead to explosions so it is essential to examine all liquids using the preliminary testing procedure described in 8.1.

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 60695-8-1, *Fire hazard testing – Part 8-1: Heat release – General guidance*

ISO 5660-1:2002, *Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method)*

ISO 5660-2:2002, *Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 2: Smoke production rate (dynamic measurement)*

ISO/IEC Guide 51:1999, *Safety aspects – Guidelines for their inclusion in standards*

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1**combustion**

exothermic reaction of a substance with an oxidizer

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

[ISO/IEC 13943, definition 23] [7]

3.2**critical ignition flux**

minimum heat flux, which is a multiple of $5 \text{ kW} \cdot \text{m}^{-2}$ and which with spark ignition causes a test specimen to ignite in less than 1 200 s

3.3**extinction coefficient of smoke**

natural logarithm of the opacity of smoke divided by the path length of the light used to measure the smoke opacity

[IEC 60695-4, definition 3.18] [6]

3.4**fire**

⟨general⟩ process of combustion characterized by the emission of heat and fire effluent accompanied by smoke, and/or flame, and/or glowing

3.5**fire**

⟨controlled⟩ self-supporting combustion which has been deliberately arranged to provide useful effects and which is controlled in its extent in time and space

NOTE In the English language the word "fire" can have two meanings which translate into two different words in both French and German.

[ISO/IEC 13943, definition 40] [7]

3.6**fire**

⟨uncontrolled⟩ self-supporting combustion which spreads uncontrolled in time and space

[ISO/IEC 13943, definition 41] [7]

3.7**fire effluent**

totality of gases and/or aerosols (including suspended particles) created by combustion or pyrolysis

[ISO/IEC 13943, definition 45] [7]

3.8**fire hazard**

physical object or condition with a potential for an undesirable consequence from fire

3.9**fire safety engineering**

application of engineering methods based on scientific principles to the development or assessment of designs in the built environment through the analysis of specific fire scenarios or through the quantification of risk for a group of fire scenarios

3.10

flame spread

propagation of a flame front

[IEC 60695-4, definition 3.36] [6]

3.11

heat flux

amount of thermal energy emitted, transmitted or received per unit area and unit time

NOTE It is expressed in watts per square metre.

3.12

heat release

thermal energy produced by combustion

NOTE The typical units are joules.

3.13

heat release rate

rate of thermal energy production generated by combustion

NOTE The typical units are watts.

3.14

ignition

initiation of combustion

NOTE The term "ignition" in French has a very different meaning (state of body combustion).

[ISO/IEC 13943, definition 96] [7]

3.15

mass loss rate

mass of material lost per unit time under specified conditions

NOTE It is expressed in kilograms per second.

[ISO/IEC 13943, definition 119] [7]

3.16

opacity (of smoke)

the ratio (I/I_0) of incident luminous flux (I) to transmitted luminous flux (I_0) through smoke, under specified test conditions

[IEC 60695-4, definition 3.67] [6]

3.17

oxygen consumption principle

proportional relationship between the mass of oxygen consumed during combustion and the heat released

NOTE A value of 13,1 kJ·g⁻¹ is commonly used.

3.18

pyrolysis

chemical decomposition of a substance by the action of heat

NOTE 1 The term is often used to refer to a stage of fire before flaming combustion has occurred.

NOTE 2 In fire science no assumption is made about the presence or absence of oxygen.

3.19

quantitative fire test

fire test which takes into account the circumstances of product use on which the test conditions are based or to which they can be related, and which measures a parameter or parameters, expressed in well defined terms and using rational scientific units, can be used in the quantitative assessment of fire risk

NOTE Such a test is sometimes referred to as a “performance-based fire test”.

3.20

smoke

a visible suspension of solid and/or liquid particles in gases resulting from combustion or pyrolysis

[IEC 60695-4, definition 3.79] [6]

3.21

smoke production

amount of smoke which is produced in a fire or fire test

3.22

smoke production rate

amount of smoke produced per unit time in a fire or fire test

NOTE 1 It is calculated as the product of the volumetric flow rate of smoke and the extinction coefficient of the smoke at the point of measurement.

NOTE 2 The typical units are $\text{m}^2\cdot\text{s}^{-1}$.

4 General description of the test

The test is performed to determine the heat release rate, total heat release, smoke production rate, total smoke production, time to ignition and mass loss rate of insulating liquids used in electrotechnical products when exposed to specified heating conditions. For the purpose of the test, the test apparatus specified in ISO 5660-1 and ISO 5660-2 and additional equipment given in this standard shall be used.

The liquid test specimen, contained in a test specimen tray, is heated by a heat flux radiated from a conical electric heater set above the test specimen tray, and an electrical spark is applied as an ignition source.

The heat release rate is measured using the oxygen consumption technique. The smoke production rate is measured by a laser beam system installed in the exhaust duct of the test apparatus. A load cell records mass measurements.

5 Test apparatus

5.1 Cone calorimeter

The test apparatus specified in ISO 5660-1 and ISO 5660-2 shall be used with the exception of the test specimen tray which is replaced by the test specimen tray described in 5.2.

5.2 Test specimen tray

The test specimen tray shall have the shape of a square pan with an opening of $100\text{ mm} \pm 1\text{ mm} \times 100\text{ mm} \pm 1\text{ mm}$ at the top and an inside depth of $15\text{ mm} \pm 1\text{ mm}$. It shall be made of stainless steel plate with a thickness of $2,15\text{ mm} \pm 0,25\text{ mm}$. It shall include a handle to facilitate insertion and removal, and shall include a mechanism to ensure the central location