

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Fire hazard testing – **STANDARD PREVIEW**  
Part 7-3: Toxicity of fire effluent – Use and interpretation of test results  
(standards.iteh.ai)

Essais relatifs aux risques du feu –  
Partie 7-3: Toxicité des effluents du feu – Utilisation et interprétation des  
résultats d'essai





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# INTERNATIONAL STANDARD

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(standards.iteh.ai)

**Essais relatifs aux risques du feu – Partie 7-3: Toxicité des effluents du feu – Utilisation et interprétation des résultats d'essai**

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## FIRE HAZARD TESTING –

**Part 7-3: Toxicity of fire effluent –  
Use and interpretation of test results**

## FOREWORD

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International Standard IEC 60695-7-3 has been prepared by IEC technical committee 89: Fire hazard testing.

This first edition cancels and replaces the second edition of IEC/TS 60695-7-3 published in 2004. It constitutes a technical revision and now has a status of an International Standard.

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

This International Standard is to be used in conjunction with IEC 60695-7-1 and IEC 60695-7-2.

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

- change of designation from a Technical Specification to an International Standard;

- the Foreword, Introduction, and Clauses 1, 2 and 3 have been updated;
- expanded in all areas to further clarify the alignment with ISO/TC 92 *Fire Safety* and in particular with ISO 13344, ISO 13571, ISO/IEC 13943, ISO 16312-1, ISO 16312-2, ISO 19701, ISO 19702 and ISO 19706;

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

FDIS	Report on voting
89/1058/FDIS	89/1072/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 60695 series, under the general title *Fire hazard testing*, can be found on the IEC website.

Part 7 consists of the following parts:

- Part 7-1: Toxicity of fire effluent – General guidance
- Part 7-2: Toxicity of fire effluent – Summary and relevance of test methods
- Part 7-3: Toxicity of fire effluent – Use and interpretation of test results
- Part 7-50: Toxicity of fire effluent – Estimation of toxic potency – Apparatus and test method
- Part 7-51: Toxicity of fire effluent – Estimation of toxic potency – Calculation and interpretation of test results

[IEC 60695-7-3:2011](#)

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

Electrotechnical products sometimes become involved in fires. However, except for certain specific cases (e.g. power generating stations, mass transit tunnels, computer suites), electrotechnical products are not normally present in sufficient quantities to form the major source of toxic hazard. For example, in domestic dwellings and places of public assembly, electrotechnical products are usually a very minor source of fire effluent compared with, for example, furnishings.

It should be noted that the IEC 60695-7 series of publications is subject to the ongoing evolution of fire safety philosophy within ISO/TC 92.

The guidance in this international standard is consistent with the principles of fire safety developed by ISO TC 92 SC 3 on toxic hazards in fire, as described in ISO 13344, ISO 13571, ISO 16312-1, ISO 16312-2, ISO 19701, ISO 19702 and ISO 19706. General guidance for the fire hazard assessment of electrotechnical products is given in IEC 60695-1-10 and IEC 60695-1-11.

In 1989, the following views were expressed in ISO/TR 9122-1.

"Small-scale toxic potency tests as we know them today are inappropriate for regulatory purposes. They cannot provide rank orderings of materials with respect to their propensity to produce toxic atmospheres in fires. All currently available tests are limited because of their inability to replicate the dynamics of fire growth which determine the time/concentration profiles of the effluent in full-scale fires, and the response of electrotechnical products, not just materials. This is a crucial limitation because the toxic effects of combustion effluent are now known to depend much more on the rates and conditions of combustion than on the chemical constitution of the burning materials."

[IEC 60695-7-3:2011](#)

Because of these limitations IEC TC 89 has developed IEC 60695-7-50 and ISO subsequently developed ISO/TS 19700 [1]<sup>1</sup>. Both these standards use the same apparatus. It is a practical small-scale apparatus which is used to measure toxic potency and which, by virtue of its ability to model defined stages of a fire, yields toxic potency data suitable for use, with appropriate additional data, in a full hazard assessment. Both methods use variations in air flow and temperature to give different physical fire models, but the ISO test method additionally uses the equivalence ratio as a key parameter.

The evidence from fires and fire casualties, when taken with data from experimental fire and combustion toxicity studies, suggests that chemical species with unusually high toxicity are not important (see Clause 7). Carbon monoxide is by far the most significant agent contributing to toxic hazard. Other agents of major significance are hydrogen cyanide, carbon dioxide and irritants. There are also other important, non-toxic, threats to life such as the effects of heat, radiant energy, depletion of oxygen and smoke obscuration, all of which are discussed in ISO 13571. General guidance on smoke obscuration is provided in IEC 60695-6-1.

IEC TC89 recognizes that effective mitigation of toxic hazard from electrotechnical products is best accomplished by tests and regulations leading to improved resistance to ignition and to reduced rates of fire growth, thus limiting the level of exposure to fire effluent and facilitating escape.

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



## FIRE HAZARD TESTING –

### Part 7-3: Toxicity of fire effluent – Use and interpretation of test results

#### 1 Scope

This part of IEC 60695 concerns laboratory tests used to measure the toxic components of the fire effluent from either electrotechnical products or materials used in electrotechnical products. It provides guidance on the use and interpretation of results from such tests. It discusses currently available approaches to toxic hazard assessment consistent with the approach of ISO TC 92 SC 3, as set out in ISO 13344, ISO 13571, ISO 16312-1, ISO 16312-2, ISO 19701, ISO 19702 and ISO 19706. It also provides guidance on the use of toxic potency data in fire hazard assessment and on principles which underlie the use of combustibility and toxicological information in fire hazard assessment.

The methods described are applicable to data concerning both the incapacitating effects and the lethal effects of fire effluents.

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 60695-1-10, *Fire hazard testing – Part 1-10: Guidance for assessing fire hazard of electrotechnical products – General guidelines*

IEC 60695-1-11, *Fire hazard testing – Part 1-11: Guidance for assessing the fire hazard of electrotechnical products – Fire hazard assessment*

IEC 60695-7-1, *Fire hazard testing – Part 7-1: Toxicity of fire effluent – General guidance*

IEC 60695-7-2, *Fire hazard testing – Part 7-2: Toxicity of fire effluent – Summary and relevance of test methods*

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

ISO 13344:2004, *Estimation of the lethal toxic potency of fire effluents*

ISO 13571:2007, *Life-threatening components of fire – Guidelines for the estimation of time available for escape using fire data*

ISO 16312-1, *Guidance for assessing the validity of physical fire models for obtaining fire effluent toxicity data for fire hazard and risk assessment – Part 1: Criteria*

ISO/TR 16312-2, *Guidance for assessing the validity of physical fire models for obtaining fire effluent toxicity data for fire hazard and risk assessment – Part 2: Evaluation of individual physical fire models*

ISO 19701, *Methods for sampling and analysis of fire effluents*

ISO 19702, *Toxicity testing of fire effluents – Guidance for analysis of gases and vapours in fire effluents using FTIR gas analysis*

ISO 19706<sup>2</sup>, *Guidelines for assessing the fire threat to people*

### 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, apply.

#### 3.1 asphyxiant

toxicant that causes hypoxia, which can result in central nervous system depression or cardiovascular effects

NOTE Loss of consciousness and ultimately death can occur.  
[ISO/IEC 13943:2008, definition 4.17]

#### 3.2 burn, intransitive verb

undergo combustion

[ISO/IEC 13943:2008, definition 4.28]

#### 3.3 burn, transitive verb

cause combustion

[ISO/IEC 13943:2008, definition 4.29]

#### 3.4 combustible, adjective

capable of being ignited and burned

[ISO/IEC 13943:2008, definition 4.43]

#### 3.5 combustible, noun

item capable of combustion

[ISO/IEC 13943:2008, definition 4.44]

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<sup>2</sup> ISO 9122-1: *Toxicity testing of fire effluents – Part 1: General* has been withdrawn and replaced by ISO 19706.

### 3.6 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]

### 3.7 concentration

mass per unit volume

NOTE 1 For a fire effluent, the typical units are grams per cubic metre ( $\text{g} \times \text{m}^{-3}$ ).

NOTE 2 For a toxic gas, concentration is usually expressed as a volume fraction at  $T = 298 \text{ K}$  and  $P = 1 \text{ atm}$ , with typical units of microlitres per litre ( $\mu\text{L/L}$ ), which is equivalent to  $\text{cm}^3/\text{m}^3$  or  $10^{-6}$ .

NOTE 3 The concentration of a gas at a temperature,  $T$ , and a pressure,  $P$  can be calculated from its volume fraction (assuming ideal gas behaviour) by multiplying the volume fraction by the density of the gas at that temperature and pressure.

[ISO/IEC 13943:2008, definition 4.52]

### 3.8 effective concentration 50

$EC_{50}$

concentration of a toxic gas or fire effluent, statistically calculated from concentration-response data, that causes a specified effect in 50 % of a population of a given species within a specified exposure time and post-exposure time

NOTE 1 For fire effluent, typical units are grams per cubic metre ( $\text{g} \times \text{m}^{-3}$ ).

NOTE 2 For a toxic gas, typical units are microlitres per litre ( $\mu\text{L/L}$ ) (at  $T = 298 \text{ K}$  and  $P = 1 \text{ atm}$ ); see volume fraction.

NOTE 3 The observed effect is usually a behavioural response, incapacitation, or death. The  $EC_{50}$  for incapacitation is termed the  $IC_{50}$ . The  $EC_{50}$  for lethality is termed the  $LC_{50}$ .

[ISO/IEC 13943:2008, definition 4.72]

### 3.9 effective exposure dose 50

$ECt_{50}$

product of  $EC_{50}$  and the exposure time over which it was determined

NOTE 1 For fire effluent, typical units are grams times minutes per cubic metre ( $\text{g} \times \text{min} \times \text{m}^{-3}$ ).

NOTE 2 For a toxic gas, typical units are microlitres times minutes per litre ( $\mu\text{L} \times \text{min} \times \text{L}^{-1}$ ) (at  $T = 298 \text{ K}$  and  $P = 1 \text{ atm}$ ); see volume fraction.

NOTE 3  $ECt_{50}$  is a measure of toxic potency

[ISO/IEC 13943:2008, definition 4.73]

### 3.10 equivalence ratio

fuel/air ratio divided by the fuel/air ratio required for a stoichiometric mixture

NOTE 1 Standard, dry air contains 20,95 % oxygen by volume. In practice, the oxygen concentration in entrained air may vary and calculation of the equivalence ratio to a standard, dry air basis is required.

NOTE 2 The equivalence ratio is dimensionless.

[ISO/IEC 13943:2008, definition 4.81]

**3.11****exposure dose**

measure of the maximum amount of a toxic gas or fire effluent that is available for inhalation, calculated by integration of the area under a concentration-time curve

NOTE 1 For fire effluent, typical units are grams times minutes per cubic metre ( $\text{g} \times \text{min} \times \text{m}^{-3}$ ).

NOTE 2 For a toxic gas, typical units are microlitres times minutes per litre ( $\mu\text{L} \times \text{min} \times \text{L}^{-1}$ ) (at  $T = 298 \text{ K}$  and  $P = 1 \text{ atm}$ ); see volume fraction.

[ISO/IEC 13943:2008, definition 4.89]

**3.12****fire**

(general) process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame, glowing or a combination thereof

NOTE In the English language, the term “fire” is used to designate three concepts, two of which, fire (3.13) and fire (3.14), relate to specific types of self-supporting combustion with different meanings and two of them are designated using two different terms in both French and German.

[ISO/IEC 13943:2008, definition 4.96]

**3.13****fire**

(controlled) self-supporting combustion that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

[ISO/IEC 13943:2008, definition 4.97]

**3.14****fire**

(uncontrolled) self-supporting combustion that has not been deliberately arranged to provide useful effects and is not limited in its extent in time and space

[ISO/IEC 13943:2008, definition 4.98]

**3.15****fire effluent**

totality of gases and aerosols, including suspended particles, created by combustion or pyrolysis in a fire

[ISO/IEC 13943:2008, definition 4.105]

**3.16****fire hazard**

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

[ISO/IEC 13943:2008, definition 4.112]

**3.17****fire model****fire simulation**

calculation method that describes a system or process related to fire development, including fire dynamics and the effects of fire

[ISO/IEC 13943:2008, definition 4.116]

**3.18****fire scenario**

qualitative description of the course of a fire with respect to time, identifying key events that characterise the studied fire and differentiate it from other possible fires

NOTE It typically defines the ignition and fire growth processes, the fully developed fire stage, the fire decay stage, and the environment and systems that impact on the course of the fire.

[ISO/IEC 13943:2008, definition 4.129]

### 3.19

#### **flame spread**

propagation of a flame front

[ISO/IEC 13943:2008, definition 4.142]

### 3.20

#### **flashover**

⟨stage of fire⟩ transition to a state of total surface involvement in a fire of combustible materials within an enclosure

[ISO/IEC 13943:2008, definition 4.156]

### 3.21

#### **fractional effective concentration**

##### *FEC*

ratio of the concentration of an irritant to that concentration expected to produce a specified effect on an exposed subject of average susceptibility

NOTE 1 As a concept, FEC may refer to any effect, including incapacitation, lethality or other endpoints.

NOTE 2 When not used with reference to a specific irritant, the term “FEC” represents the summation of FEC values for all irritants in a fire-generated atmosphere.

NOTE 3 The FEC is dimensionless.

[ISO/IEC 13943:2008, definition 4.159]

### 3.22

#### **fractional effective dose**

##### *FED*

ratio of the exposure dose for an asphyxiant to that exposure dose of the asphyxiant expected to produce a specified effect on an exposed subject of average susceptibility

NOTE 1 As a concept, fractional effective dose may refer to any effect, including incapacitation, lethality or other endpoints.

NOTE 2 When not used with reference to a specific asphyxiant, the term “FED” represents the summation of FED values for all asphyxiants in a combustion atmosphere.

NOTE 3 The FED is dimensionless.

[ISO/IEC 13943:2008, definition 4.160]

### 3.23

#### **fully developed fire**

state of total involvement of combustible materials in a fire

[ISO/IEC 13943:2008, definition 4.164]

### 3.24

#### **hyperventilation**

rate and/or depth of breathing which is greater than normal

[ISO/IEC 13943:2008, definition 4.180]

### 3.25

#### **ignition**

sustained ignition (deprecated)

⟨general⟩ initiation of combustion

[ISO/IEC 13943:2008, definition 4.187]

### 3.26

#### **incapacitation**

state of physical inability to accomplish a specific task

NOTE An example of a specific task is to accomplish escape from a fire.

[ISO/IEC 13943:2008, definition 4.194]

### 3.27

#### **irritant**, noun

⟨sensory/upper respiratory⟩ gas or aerosol that stimulates nerve receptors in the eyes, nose, mouth, throat and respiratory tract, causing varying degrees of discomfort and pain with the initiation of numerous physiological defence responses

NOTE Physiological defence responses include reflex eye closure, tear production, coughing, and bronchoconstriction.

[ISO/IEC 13943:2008, definition 4.203]

### 3.28

#### **lethal concentration 50**

##### *LC*<sub>50</sub>

concentration of a toxic gas or fire effluent, statistically calculated from concentration-response data, that causes death of 50 % of a population of a given species within a specified exposure time and post-exposure time

NOTE 1 For fire effluent, typical units are  $\text{g} \times \text{m}^{-3}$ .

NOTE 2 For a toxic gas, the typical units are microlitres per litre ( $\mu\text{L}/\text{L}$ ) ( $T = 298 \text{ K}$  and  $P = 1 \text{ atm}$ ); see volume fraction.

[ISO/IEC 13943:2008, definition 4.207]

### 3.29

#### **lethal exposure dose 50**

##### *LCt*<sub>50</sub>

product of *LC*<sub>50</sub> and the exposure time over which it is determined

NOTE 1 *LCt*<sub>50</sub> is a measure of lethal toxic potency.

NOTE 2 For fire effluent, the typical units are grams times minutes per cubic metre ( $\text{g} \times \text{min} \times \text{m}^{-3}$ ).

NOTE 3 For a toxic gas, typical units are microlitres times minutes per litre ( $\mu\text{L} \times \text{min} \times \text{L}^{-1}$ ) at  $T = 298 \text{ K}$  and  $P = 1 \text{ atm}$ ; see volume fraction.

[ISO/IEC 13943:2008, definition 4.208]

### 3.30

#### **mass loss concentration**

⟨closed system⟩ mass of the test specimen consumed during combustion divided by the test chamber volume

NOTE The typical units are grams per cubic metre ( $\text{g} \times \text{m}^{-3}$ ).

[ISO/IEC 13943:2008, definition 4.222]

### 3.31

#### **mass loss concentration**

⟨open system⟩ mass of the test specimen consumed during combustion divided by the total volume of air passed through the test apparatus

NOTE 1 The definition assumes that the mass is dispersed in the air flow uniformly over time.

NOTE 2 The typical units are grams per cubic metre ( $\text{g} \times \text{m}^{-3}$ ).

[ISO/IEC 13943:2008, definition 4.223]

### 3.32

#### **physical fire model**

laboratory process, including the apparatus, the environment and the fire test procedure intended to represent a certain phase of a fire

[ISO/IEC 13943:2008, definition 4.251]

### 3.33

#### **pyrolysis**

chemical decomposition of a substance by the action of heat

NOTE 1 Pyrolysis is often used to refer to a stage of fire before flaming combustion has begun.

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

[ISO/IEC 13943:2008, definition 4.266]

### 3.34

#### **small-scale fire test**

fire test performed on a test specimen of small dimensions

NOTE A fire test performed on a test specimen of which the maximum dimension is less than 1 m is usually called a small-scale fire test.

[ISO/IEC 13943:2008, definition 4.292]

### 3.35

#### **smoke**

visible part of fire effluent

[IEC 60695-7-3:2011](https://standards.iteh.ai/catalog/standards/sist/6bd68bd3-144a-4172-9589-5a3896060d0d/iec-60695-7-3-2011)

[ISO/IEC 13943:2008, definition 4.293]

### 3.36

#### **toxic**

poisonous

NOTE A poisonous substance produces adverse effects upon a living organism, e.g. irritation, narcosis or death.

[ISO/IEC 13943:2008, definition 4.335]

### 3.37

#### **toxic gas**

toxic vapour

NOTE In the context of fire effluent, the term is usually applied to a single chemical element or compound.

[ISO/IEC 13943:2008, definition 4.336]

### 3.38

#### **toxic hazard**

potential for harm resulting from exposure to toxic combustion products

[ISO/IEC 13943:2008, definition 4.337]

### 3.39

#### **toxic potency**

measure of the amount of toxicant required to elicit a specific toxic effect

NOTE A small value of toxic potency corresponds to a high toxicity, and vice versa.

[ISO/IEC 13943:2008, definition 4.338]