

INTERNATIONAL STANDARD

NORME INTERNATIONALE

HORIZONTAL PUBLICATION
PUBLICATION HORIZONTALE

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

**Essais relatifs aux risques du feu –
Partie 7-2: Toxicité des effluents du feu – Résumé et pertinence des méthodes
d'essai**



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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
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

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 It also gives information on projects, replaced and withdrawn publications.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 Just Published - 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.

IEC Customer Service Centre - 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.

IEC online collection - 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.

Electropedia - 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.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



INTERNATIONAL STANDARD

NORME INTERNATIONALE

HORIZONTAL PUBLICATION
PUBLICATION HORIZONTALE

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

**Essais relatifs aux risques du feu –
Partie 7-2: Toxicité des effluents du feu – Résumé et pertinence des méthodes
d'essai**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 13.220.40; 29.020

ISBN 978-2-8322-1003-1

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	9
4 Role of small-scale toxicity tests.....	13
4.1 General.....	13
4.2 <i>Toxic potency</i>	13
4.3 Toxic hazard, <i>exposure dose and fractional effective dose (FED)</i>	14
4.4 <i>Fractional effective concentration (FEC)</i>	14
4.5 Generic toxic potencies.....	14
5 General aspects of small-scale toxicity tests.....	15
5.1 General.....	15
5.2 Physical fire models.....	15
5.3 Fire stages in a compartment fire.....	16
5.4 Methods of analysis	16
5.4.1 General	16
5.4.2 Chemical analysis based methods.....	19
5.4.3 Methods based on animal exposure.....	19
6 Summary of published chemical analysis based test methods	19
6.1 General.....	19
6.2 UK Ministry of Defence – DEF STAN 02-713.....	19
6.2.1 Summary	19
6.2.2 Purpose and principle	20
6.2.3 Test specimen	20
6.2.4 Test method	20
6.2.5 Repeatability and reproducibility	21
6.2.6 Relevance of test data and special observations.....	21
6.3 Airbus industry.....	22
6.3.1 Summary	22
6.3.2 Purpose and principle.....	22
6.3.3 Test specimen	22
6.3.4 Test method	22
6.3.5 Repeatability and reproducibility	22
6.3.6 Relevance of test data and special observations.....	23
6.4 Comitato Elettrotecnico Italiano (CEI)	23
6.4.1 Summary	23
6.4.2 Purpose and principle	23
6.4.3 Test specimen	23
6.4.4 Test method	23
6.4.5 Repeatability and reproducibility	23
6.4.6 Relevance of test data and special observations.....	23
6.5 Norme Française (NF)	24
6.5.1 Summary	24
6.5.2 Purpose and principle	24
6.5.3 Test specimen	24

6.5.4	Test method	24
6.5.5	Repeatability and reproducibility	24
6.5.6	Relevance of test data and special observations	24
6.6	ISO test methods	25
6.6.1	ISO/TS 19021	25
6.6.2	ISO/TS 19700	26
6.7	International Maritime Organization (IMO)	27
6.7.1	Summary	27
6.7.2	Purpose and principle	27
6.7.3	Test specimen	27
6.7.4	Test method	27
6.7.5	Repeatability and reproducibility	28
6.7.6	Relevance of test data and special observations	28
6.8	Toxicity test for rolling stock cables	28
6.8.1	Summary	28
6.8.2	Purpose and principle	29
6.8.3	Test specimen	29
6.8.4	Test method	29
6.8.5	Repeatability and reproducibility	29
6.8.6	Relevance of test data and special observations	30
6.9	Toxicity test of materials and components (other than cables) used in railway applications	30
6.9.1	Summary	30
6.9.2	Purpose and principle	30
6.9.3	Test specimen	30
6.9.4	Test method	30
6.9.5	Repeatability and reproducibility	31
6.9.6	Relevance of test data and special observations	31
7	Summary of published test methods relating to animal exposure	31
7.1	General	31
7.2	Deutsches Institut für Normung, DIN 53436	31
7.2.1	Summary	31
7.2.2	Purpose and principle	31
7.2.3	Test specimen	31
7.2.4	Test method	32
7.2.5	Repeatability and reproducibility	32
7.2.6	Relevance of test data and special observations	32
7.3	National Bureau of Standards (NBS)	33
7.3.1	Summary	33
7.3.2	Purpose and principle	33
7.3.3	Test specimen	33
7.3.4	Test method	33
7.3.5	Repeatability and reproducibility	33
7.3.6	Relevance of test data and special observations	34
7.3.7	Reference documents	34
7.4	National Institute of Standards and Technology, NIST Radiant furnace	34
7.4.1	Summary	34
7.4.2	Purpose and principle	34
7.4.3	Test specimen	35

7.4.4	Test method	35
7.4.5	Repeatability and reproducibility	35
7.4.6	Relevance of test data and special observations.....	35
7.4.7	Reference documents	36
7.5	University of Pittsburgh, Upitt Box furnace	36
7.5.1	Summary	36
7.5.2	Purpose and principle	36
7.5.3	Test specimen	36
7.5.4	Test method	36
7.5.5	Repeatability and reproducibility	37
7.5.6	Relevance of test data and special observations.....	37
7.5.7	Reference documents	37
7.6	Japanese fire toxicity test for building components	37
7.6.1	Summary	37
7.6.2	Purpose and principle	37
7.6.3	Test specimen	37
7.6.4	Test method	38
7.6.5	Repeatability and reproducibility	38
7.6.6	Relevance of test data and special observations.....	38
8	Overview of methods and relevance of data	38
	Bibliography.....	41
	Figure 1 – Different phases in the development of a fire within a compartment	16
	Table 1 – Characteristics of fire types (ISO 19706)	18
	Table 2 – C_f values for various gases	21
	Table 3 – <i>Volume fraction</i> limits for gas components.....	22
	Table 4 – Decomposition conditions.....	26
	The results are expressed as gas <i>volume fractions</i> . Maximum permitted values are given below (see Table 5 – <i>Volume fraction</i> limits for gas component	28
	Table 5 – <i>Volume fraction</i> limits for gas component	28
	Table 6 – CC_z values taken from EN 50305	29
	Table 7 – Reference concentrations of the gas components.....	31
	Table 8 – Overview of toxicity test methods	39
	Table 9 – Overview of toxicity test methods (continued, with comments).....	40

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –**Part 7-2: Toxicity of fire effluent –
Summary and relevance of test methods**

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.

International Standard IEC 60695-7-2 has been prepared by IEC technical committee 89: Fire hazard testing.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

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

- New text in the introduction;
- New text in the scope;
- Clause 2 has been updated;
- Many terms and definitions in Clause 3 reproduced from ISO 13943 have been deleted. Other terms and definitions have been added.
- New text in Subclauses 4.3 and 4.4;
- New text in Subclause 6.1;

- References to IEC 60695-7-50 and -51 (now withdrawn) have been removed;
- Reference to DEF STAN 07-247 has been added;
- Details of ISO/TS 19021 have been added;
- Details of EN 17084 have been added;
- New text added concerning ISO/TS 19700;
- New text added concerning the IMO FTP toxicity test;
- New Subclause 7.1 has been added;
- The Annex in Edition1 has been replaced by new Clause 8;
- The bibliography has been updated.

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

Draft	Report on voting
89/1489/CDV	89/1508/RVC

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.

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

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.

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

IEC 60695-7 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*

In this document the following print types are used:

- Words *in italics* in the text are defined in Clause 3.

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 an 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 the risk of fire to a tolerable level even in the event of reasonably foreseeable (mis)use, malfunction or failure.

IEC 60695-1-10, IEC 60695-1-11 [1]¹, and IEC 60695-1-12 [2] provide guidance on how this is to be accomplished.

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

The aim of the IEC 60695 series of standards is to save lives and property by reducing the number of fires or reducing the consequences of the fire. This can be accomplished by:

- trying to prevent ignition caused by an electrically energised component part and, in the event of ignition, to confine any resulting fire within the bounds of the enclosure of the electrotechnical product;
- trying to minimise flame spread beyond the product's enclosure and to minimise the harmful effects of fire effluents including heat, smoke, and toxic or corrosive combustion products.

Electrotechnical products, primarily as the objects of a fire, may contribute to the fire hazard due to the release of toxic effluent, which may be a significant contributing factor to the overall fire hazard.

The IEC 60695-7 series provides guidance to IEC product committees on the adoption and implementation of the recommendations of ISO for the minimization of toxic hazard from fires involving electrotechnical products. This part of IEC 60695-7 describes fire effluent toxicity test methods in common use to assess electrotechnical products or materials used in electrotechnical products.

IEC product committees incorporating requirements for the assessment of toxic hazard from fire in product standards should note that *toxic potency* and other measurements of toxicity which are described in this part of IEC 60695 should not be used directly in product specifications. Data from *toxic potency* test methods should only be used as part of a toxic hazard assessment, in conjunction with other product-based reaction to fire data such as mass loss rate.

¹ Numbers in square brackets refer to the bibliography.

FIRE HAZARD TESTING –

Part 7-2: Toxicity of fire effluent – Summary and relevance of test methods

1 Scope

This part of IEC 60695-7 gives a brief summary of the test methods that are in common use in the assessment of the toxicity of fire effluent. It includes special observations on their relevance to real fire scenarios and gives recommendations on their use.

It advises which tests provide *toxic potency* data that are relevant to real fire scenarios, and which are suitable for use in fire hazard assessment and fire safety engineering.

The list of test methods is not to be considered exhaustive.

This summary cannot be used in place of published standards which are the only valid reference documents.

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

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

IEC 60695-7-3, *Fire hazard testing - Part 7-3: Toxicity of fire effluent - Use and interpretation of test results*

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*

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