IEC®

IEC 60695-7-1

Edition 3.0 2010-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Fire hazard testing –
Part 7-1: Toxicity of fire effluent – General guidance

Essais relatifs aux risques du feu –
Partie 7-1: Toxicité des effluents du feu – Lignes directrices générales

IEC 60695-7-1:2010

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: 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 corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC

IEC 60695-7-1

Edition 3.0 2010-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Fire hazard testing –
Part 7-1: Toxicity of fire effluent – General guidance

Essais relatifs aux risques du feu –
Partie 7-1: Toxicité des effluents du feu – Lignes directrices générales

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX **T**

ICS 13.220.40; 29.020

ISBN 978-2-88912-013-0

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –

Part 7-1: Toxicity of fire effluent – General guidance

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 60695-7-1 has been prepared by IEC technical committee 89: Fire hazard testing.

This third edition cancels and replaces the second edition published in 2004. It constitutes a technical revision.

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

- minor editorial and technical changes throughout;
- Introduction – text referring to IEC 60695-7-50 and ISO/TS 19700 has been updated;
- references to the ISO 9122 series have been deleted (other than an historical reference to ISO 9122-1 in the Introduction) and the text throughout has been updated;
- definitions have been updated in accordance with ISO/IEC 13943:2008;

– dispersal volume is stated to be an important parameter in the assessment of toxic hazard;
– Table 2 has been updated;
– Figures 1 and 2 have both been updated.

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

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

FDIS	Report on voting
89/990/FDIS	89/1003/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.

This standard is to be used in conjunction with IEC 60695-7-2.

A list of all the parts of IEC 60695 series, under the general title of *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

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 (for example, 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.

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 19706. General guidance for the fire hazard assessment of electrotechnical products is provided in IEC 60695-1-10 and IEC 60695-1-11. Guidance on the estimation of escape times from fires is provided in ISO 13571. The determination of the lethal toxic potency of fire effluents is described in ISO 13344.

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."

Because of these limitations IEC TC 89 developed IEC 60695-7-50 and ISO subsequently developed ISO/TS 19700 [1] [1]. 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 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 4.3.4). 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 of smoke obscuration is provided in IEC 60695-6-1 [2].

IEC TC 89 recognizes that the 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.

---

1 Figures in square brackets refer to the bibliography.

FIRE HAZARD TESTING –

Part 7-1: Toxicity of fire effluent – General guidance

1 Scope

This part of IEC 60695 provides guidance on the factors which affect the toxic hazard from fires involving electrotechnical products, and provides information on the methodologies recommended by ISO TC 92 (SC 3) for estimating and reducing the toxic hazard from fires, as expressed in ISO 19706, ISO 13344 and ISO 13571.

There is no single test to realistically assess toxic hazard in fires. Small-scale toxic potency tests are not capable on their own of assessing the toxic hazard in fires. Current toxicity tests attempt to measure the toxic potency of a laboratory generated fire effluent. Toxic potency should not be confused with toxic hazard.

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

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

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 their inclusion in standards*

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

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

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 19703:2005, *Generation and analysis of toxic gases in fire – Calculation of species yields, equivalence ratios and combustion efficiency in experimental fires*

ISO 19706:2007, *Guidelines for assessing the fire threat to people*

NOTE ISO 9122-1:1989, *Toxicity testing of fire effluents – Part: General,* has been withdrawn and replaced by ISO 19706:2007.

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 use' convenience, as well as the followings apply.

3.1
acute toxicity
toxicity that causes rapidly occurring toxic effects

cf. **toxic potency**

[ISO/IEC 13943, definition 4.5]

3.2
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, definition 4.17]

3.3
burn, intransitive verb
undergo combustion

[ISO/IEC 13943, definition 4.28]

3.4
burn, transitive verb
cause combustion

[ISO/IEC 13943, definition 4.29]

3.5
combustible, adj.
capable of being ignited and burned

[ISO/IEC 13943, definition 4.43]

3.6
combustible, noun
item capable of combustion

[ISO/IEC 13943, definition 4.44]

3.7
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, definition 4.46]

3.8
concentration
mass per unit volume

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

NOTE 2 For a toxic gas, concentration is usually expressed as a volume fraction at T = 298 K and P = 1 atm, with typical units of microlitres per litre (µL/L), which is equivalent to cm^3/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, definition 4.52]

3.9
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, definition 4.81]

3.10
exposure dose
measure of the maximum amount of a toxic gas or fire effluent which 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 ($g \cdot min \cdot m^{-3}$).

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

[ISO/IEC 13943, definition 4.89]

3.11
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 (3.11) and fire (3.12), 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, definition 4.96]

3.12
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, definition 4.97]

3.13
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, definition 4.98]

3.14
fire effluent
totality of gases and aerosols, including suspended particles, created by combustion or pyrolysis in a fire

[ISO/IEC 13943, definition 4.105]

3.15
fire hazard
physical object or condition with a potential for an undesirable consequence from fire

[ISO/IEC 13943, definition 4.112]

3.16
fire risk
probability of a fire combined with a quantified measure of its consequence

[ISO/IEC 13943, definition 4.124]

3.17
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, definition 4.129]

3.18
flame spread
propagation of a flame front

[ISO/IEC 13943, definition 4.142]

3.19
flashover
⟨stage of fire⟩ transition to a state of total surface involvement in a fire of combustible materials within an enclosure

[ISO/IEC 13943, definition 4.156]

3.20
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 fractional effective concentration is dimensionless.

[ISO/IEC 13943, definition 4.159]

3.21
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, definition 4.160]

3.22
fully developed fire
state of total involvement of combustible materials in a fire

[ISO/IEC 13943, definition 4.164]

3.23
hyperventilation
rate and/or depth of breathing which is greater than normal

[ISO/IEC 13943, definition 4.180]

3.24
ignition
sustained ignition (deprecated)
⟨general⟩ initiation of combustion

[ISO/IEC 13943, definition 4.187]

3.25
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, definition 4.194]

3.26
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, definition 4.203]

3.27
irritant, noun
⟨pulmonary⟩ gas or aerosol that stimulates nerve receptors in the lower respiratory tract, which may result in breathing discomfort

NOTE Examples of breathing discomfort are dyspnoea and an increase in respiratory rate. In severe cases, pneumonitis or pulmonary oedema (which can be fatal) can occur some hours after exposure.

[ISO/IEC 13943, definition 4.204]

3.28
lethal exposure dose 50
$\boldsymbol{LCt_{50}}$
product of LC_{50} and the exposure time over which it is determined

NOTE 1 LCt_{50} is a measure of lethal toxic potency.

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

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

[ISO/IEC 13943, definition 4.208]

3.29
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, definition 4.251]

3.30
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, definition 4.266]

3.31
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, definition 4.292]

3.32
smoke
visible part of fire effluent

[ISO/IEC 13943, definition 4.293]

3.33
toxic
poisonous

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

[ISO/IEC 13943, definition 4.335]

3.34
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, definition 4.336]

3.35
toxic hazard
potential for harm resulting from exposure to toxic combustion products

[ISO/IEC 13943, definition 4.337]

3.36
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, definition 4.338]

3.37
toxic risk
result of the multiplication of

– the probability of occurrence of a toxic hazard expected in a given technical operation or state, and

– the consequence or extent of injury to be expected on the occurrence of the toxic hazard

NOTE The toxic risk is part of the fire risk.

[ISO/IEC 13943, definition 4.339]

3.38
toxicant
toxin
toxic substance

[ISO/IEC 13943, definition 4.340]

3.39
toxicity
toxic quality

[ISO/IEC 13943, definition 4.341]

3.40
volume fraction
⟨gas in a gas mixture⟩ ratio of

- the volume that the gas alone would occupy at a defined temperature and pressure, to:
- the volume occupied by the gas mixture at the same temperature and pressure

NOTE 1 The concentration of a gas at a temperature, *T*, and at 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.

NOTE 2 Unless stated otherwise, a temperature of 298 K and a pressure of 1 atm are assumed.

NOTE 3 The volume fraction is dimensionless and is usually expressed in terms of microlitres per litre (µL/L), which is equivalent to cm^3/m^3 or 10^{-6}), or as a percentage.

[ISO/IEC 13943, definition 4.351]

3.41
yield
mass of a combustion product generated during combustion divided by the mass loss of the test specimen

NOTE The yield is dimensionless.

[ISO/IEC 13943, definition 4.354]

4 Factors determining toxic hazard

4.1 Evaluation of the toxic hazard

The main questions concerning the evaluation of the toxic hazard from fire are:

a) How much product is burned or pyrolyzed, and at what rate ?

b) How toxic is the fire effluent ?

c) Into what volume is the toxic effluent being dispersed ?

d) How is escape impeded ?

4.2 Burning rate

The quantity of effluent generated is proportional to the quantity of product burned or pyrolyzed. The rate of effluent generation is determined by the rate of burning or pyrolysis. Therefore in order to minimize the toxic hazard, it is necessary to decrease ignitability and to decrease the burning rate, i.e. decrease the rates of fire growth and flame spread.

4.3 Toxicity of fire effluent

4.3.1 General

Fire effluent consists of a complex mixture of solid particulates, liquid aerosols, and gases. Although fires may generate effluent of widely differing compositions, toxicity tests have shown that gases are a major factor in the causes of acute toxicity. The predominant acute toxic effects may be separated into two classes:

a) asphyxiant effects,

b) sensory and/or upper respiratory irritation.

Asphyxiants are discussed in 4.3.2. Sensory and/or upper respiratory irritants are discussed in 4.3.3.

NOTE In ISO 13344 several equations are given for the calculation of 30 min lethality FED values. These equations treat both asphyxiants and irritants in a similar way and they use 30 min LC_{50} values for rats. ISO 13571 recommends that if such equations are used then one half of the LCt_{50} is an approximate exposure dose when relating incapacitation to lethality.

There are also other important, non-toxic, threats to life. These include the effects of heat and radiant energy, the effects of depletion of oxygen, and the effects of smoke obscuration.

It has been widely recognized by many technical studies that most products and materials give fire atmospheres of generally similar toxic potency. No study has found evidence that substances of unusually high toxicity are important in fires.

Combustible fuel in a fire often consists of a mixture of materials and products that are unidentified as to their nature and relative quantity. In these cases, for the purpose of