

Implementation of
ISO/TR 9122-5:1993

Toxicity testing of fire effluents —

Part 5: Prediction of toxic effects of fire
effluents

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- British Electrical Systems Association (BEAMA Ltd.)
- British Plastics Federation
- British Railways Board
- British Rigid Urethane Foam Manufacturers Association
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- Department of Trade and Industry (Consumer Safety Unit, CA Division)
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- Warrington Fire Research Centre

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National foreword

This British Standard reproduces verbatim ISO/TR 9122-5:1993 and implements it as the UK national standard. It is related to PD 6503-1:1990 which is the UK adoption of ISO/TR 9122-1:1989. When ISO/TR 9122-1 1989 is revised, it is intended that it will be implemented as the UK national standard.

The Technical Committee had earlier decided not to implement ISO/TR 9122-2 as the UK national standard but to publish a national document (PD 6503-2) instead. PD 6503-2:1988 remains current until the 1990 edition of ISO/TR 9122-2 is revised when it is envisaged that the new edition of ISO/TR 9122-2 will be implemented as a British Standard.

To avoid any further confusion, the decision has been made to implement all the remaining Parts of the ISO/TR 9122 series as British Standards rather than producing national documents as further Parts of PD 6503.

This British Standard is published under the direction of the Consumer Products and Services Sector Board whose Technical Committee FSH/16 has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international committee any enquiries on interpretation, or proposals for change, and keep UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO title page, pages ii to iv, pages 1 to 18 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

TECHNICAL
REPORT

ISO
TR 9122-5

First edition
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Toxicity testing of fire effluents —

Part 5:

Prediction of toxic effects of fire effluents

Essais de toxicité des effluents du feu —

Partie 5: Prédications concernant les effets toxiques des effluents du feu



Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard (“state of the art”, for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 9122-5, which is a Technical Report of type 2, was prepared by Technical Committee ISO/TC 92, *Fire tests on building materials, components and structures*, Sub-Committee SC 3, *Toxic hazards in fire*.

This document is being issued in the type 2 Technical Report series of publications (according to subclause G.4.2.2 of part 1 of the IEC/ISO Directives) as a “prospective standard for provisional application” in the field of toxicity testing of fire effluents because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this type 2 Technical Report will be carried out not later than two years after its publication with the options of: extension for another two years; conversion into an International Standard; or withdrawal.

ISO/TR 9122 consists of the following parts, under the general title *Toxicity testing of fire effluents*:

- *Part 1: General*;
- *Part 2: Guidelines for biological assays to determine the acute inhalation toxicity of fire effluents (basic principles, criteria and methodology)*;
- *Part 3: Methods for the analysis of gases and vapours in fire effluents*;
- *Part 4: The fire model (furnaces and combustion apparatus used in small-scale testing)*;
- *Part 5: Prediction of toxic effects of fire effluents*.

Annexes A and B of this part of ISO/TR 9122 are for information only.

1 Scope

This part of ISO/TR 9122 reviews the progress of bioanalytical methodology, including the application of mathematical models which are available and may be used in the toxicological assessment of fire effluent atmospheres. Attention is also given to the application of such models as a means to minimize the use of laboratory animals in the testing of materials for fire effluent toxicity.

2 Background

A major thrust in the assessment of the toxic effects of fire effluents has been in the development of mathematical models for predicting such effects from appropriate data on the composition and concentrations of the fire gases. The objectives of these efforts are twofold. Assessment of smoke toxicity from analytical data could obviate much of the use of live animals in conventional bioassay methodology. Furthermore, providing that both qualitative and quantitative differences in toxicological effects between laboratory animals and man are understood, such modelling methodology can also be used for estimating the time to development of untenable conditions in either real or simulated fire scenarios.

The development of smoke toxicity modelling began in the late 1960's and continued into the 1970's, with concepts proposed by Y. Tsuchiya and K. Sumi at the National Research Council Laboratories in Canada^[1 and 2]. A deterrent to its acceptability at that time was the widely-held perception that the toxicity of smoke could be as complex and as exotic as its composition. However, work in the United Kingdom by D.A. Purser and W.D. Woolley^[3] demonstrated that smoke toxicity could, to a large extent, be explained both qualitatively and quantitatively in terms of a small number of important toxic gases. This provided support for the potential validity of smoke toxicity modelling. A publication in 1981 by S.C. Packham and G.E. Hartzell^[4] together with the work of P.W. Smith^[5], established a foundation for such modelling in the United States. Research in this area advanced considerably during the 1980's, such that more recent publications by G.E. Hartzell^[6 to 8], B.C. Levin^[9 and 10], D.A. Purser^[11] and Y. Tsuchiya^[12] set the stage for the development of toxic hazard modelling which takes into account combinations of toxic insults as they would occur in a fire.

3 General concepts

Basic to all the modelling techniques is some expression of the concentration of a toxicant relative to that concentration known to cause a particular toxic effect resulting from a given time of exposure. Lacking in some of the early development efforts was a clear concept of the "dose" of a toxicant, along with appreciation of its utility as a tool in modelling. Also lacking was a good base of toxicological data appropriate for short exposures to relatively high concentrations of toxicants. Additionally, there was insufficient understanding of relevant laboratory decomposition models upon which the toxicological modelling was to be based.

Quantification of "dose" has been fundamental to the development of methodology for modelling the toxicological effects of inhalation of fire gases, whether in laboratory animals or humans. Physiological responses are usually dose-related, i.e., the magnitude of the effect increases with increasing amounts or accumulated body burden of a physiologically active agent. Since the actual dose of toxicants from inhalation of fire effluents cannot be measured directly, the assumption is made that the dose is a function of fire effluent (or toxicant) concentration and exposure time^[13]. This dose is really an expression of the insult to which a subject is exposed. The term "exposure dose" is probably more accurate and has become the preferred term in combustion toxicology.

Concentrations of common fire gas toxicants, such as carbon monoxide and hydrogen cyanide, are usually expressed as parts per million by volume [ppm (V/V)]. Therefore, the exposure dose can be expressed as the product of the concentration, C , and time, t , (usually expressed in ppm min). In the case of a changing concentration of a gaseous toxicant, the exposure dose is actually the integrated area under a concentration vs. time curve.

Often, the concentrations of fire gas toxicants are not known. In that event, one can still deal with the concept of exposure dose as it applies to smoke. Since smoke concentration cannot be quantified, an approximation is made that the smoke concentration is proportional to the mass loss during a fire. The integrated area under a mass loss per unit volume vs. time curve thus becomes a measure of smoke exposure dose (usually expressed in $\text{g m}^{-3} \text{ min}$)^[14 and 15]. (This concept of smoke exposure dose is described in ISO/TR 9122-2.) Smoke exposure dose at any point in time can be calculated from data obtained from a laboratory combustion device, instrumented experimental fires, data generated from mathematically modelled fires and even data estimated from real fires.