INTERNATIONAL STANDARD

ISO 16312-1

Third edition
2016-11-15

Guidance for assessing the validity of physical fire models for obtaining fire effluent toxicity data for fire hazard and risk assessment —

Part 1: Criteria

Lignes directrices pour évaluer la validité des modèles de feu physiques pour l'obtention de données sur les effluents du feu en vue de l'évaluation des risques et dangers —

Partie 1: Critères

Reference number
ISO 16312-1:2016(E)

Contents

Page

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 procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 92, *Fire safety*, Subcommittee SC 3, *Fire threat to people and environment*.

This third edition cancels and replaces the second edition (ISO 16312-1:2010), of which it constitutes a minor revision with the normative references and bibliography having been updated.

A list of all parts in the ISO 16312-series can be found on the ISO website.

Introduction

Providing the desired degree of life safety for an occupancy increasingly involves an explicit fire hazard or risk assessment. This assessment includes such components as the following:

— information on the room/building properties;

— the nature of the occupancy;

— the nature of the occupants;

— the types of potential fires;

— the outcomes to be avoided, etc.

This type of determination also requires information on the potential for harm due to the effluent produced in the fire. Because of the prohibitive cost of real-scale product testing under the wide range of fire conditions, most estimates of the potential harm from the fire effluent depend on data generated from a physical fire model, a reduced-scale test apparatus and procedure for its use.

The role of a physical fire model for generating accurate toxic effluent composition is to recreate the essential features of the complex thermal and reactive chemical environment in full-scale fires. These environments vary with the physical characteristics of the fire scenario and with time during the course of the fire, and close representation of some phenomena occurring in full-scale fires can be difficult or even not possible on a small-scale. The accuracy of the physical fire model, then, depends on two features:

a) degree to which the combustion conditions in the bench-scale apparatus mirror those in the fire stage being replicated;

b) degree to which the yields of the important combustion products obtained from burning of the commercial product at full scale are replicated by the yields from burning specimens of the product in the small-scale model. This measure is generally performed for a small set of products, and the derived accuracy is then presumed to extend to other test subjects. At least one methodology for effecting this comparison has been developed.[11]

This document provides guidance for accuracy assessment with and without the use of laboratory animals. Generally, accurate estimation of the toxic potency of the effluent can be obtained from analysis of a small number of gases (the *N*-gas hypothesis), as described in ISO 13571. This is especially true for product formulations similar to those for which the *N*-gas model has been confirmed. There are, however, cases where unusual toxicants have been generated in bench-scale apparatus. Thus, for novel commercial product formulations, confidence in the accuracy of the toxic potency measurement in the bench-scale device can be improved by a confirming bioassay and correlation with real-scale fire tests.

Guidance for assessing the validity of physical fire models for obtaining fire effluent toxicity data for fire hazard and risk assessment —

Part 1: Criteria

1 Scope

This document provides technical criteria and guidance for evaluating physical fire models (i.e. laboratory combustion devices and operating protocols) used in effluent toxicity studies for obtaining data on the effluent from products and materials under fire conditions relevant to life safety.[9] Relevant analytical methods, calculation methods, bioassay procedures and prediction of the toxic effects of fire effluents can be referenced in ISO 19701, ISO 19702, ISO 19703, ISO 19706 and ISO 13344. Comparisons are detailed in ISO 29903. Prediction of the toxic effects of fire effluents can be referenced in ISO 13571 and ISO/TR 13571-2.

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.

ISO 13571:2012, *Life-threatening components of fire — Guidelines for the estimation of time to compromised tenability in fires*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 General principles

4.1 Physical fire model

A physical fire model is characterized by the requirements placed on the form of the test specimen, the operational combustion conditions and the capability of analysing the products of combustion.

4.2 Model validity

For use in providing data for effluent toxicity assessment, the validity of a physical fire model is determined by the degree of accuracy with which it reproduces the yields of the principal toxic components in real-scale fires.

4.3 Test specimens

Fire safety engineering requires data on commercial products or product components. In a reduced-scale test, the manner in which a specimen of the product is composed can affect the nature and yields of the combustion products.

4.4 Combustion conditions

The yields of combustion products depend on such apparatus conditions as the fuel/air equivalence ratio, whether the decomposition is flaming or non-flaming, the persistence of flaming of the sample, the temperature of the specimen and the effluent produced, the stability of the decomposition conditions, and the interaction of the apparatus with the decomposition process, with the effluent and the flames.

4.5 Effluent characterization

4.5.1 For the effluent from most common materials, the major acute toxic effects have been shown to depend upon a small number of major asphyxiant gases and a somewhat wider range of inorganic and organic irritants. In ISO 13571, a base set of combustion products has been identified for routine analysis. Novel materials can evolve previously unidentified toxic products. Thus, a more detailed chemical analysis can be needed in order to provide a full assessment of acute effects and to assess chronic or environmental toxicants. A bioassay can provide guidance on the importance of toxicants not included in the base set. ISO 19706 contains a fuller discussion of the utility of bioassays.

4.5.2 It is essential that the physical fire model enable accurate determinations of chemical effluent composition.

4.5.3 It is desirable that the physical fire model accommodate a bioassay method.

5 Significance and use

5.1 Most computational models of fire hazard and risk require information regarding the potential of fire effluent (gases, heat and smoke) to cause harm to people and to affect their ability to escape or to seek refuge.

5.2 The quality of the data on fire effluent has a profound effect on the accuracy of the prediction of the degree of life safety offered by an occupancy design.

5.3 Due to the large number of products to be included in fire safety assessments, the high cost of performing real-scale tests of products, and the small number of large-scale test facilities, information on effluent toxicity is most often obtained from physical fire models.

5.4 There are numerous physical fire models cited in national regulations. These apparatus vary in design and operation, as well as in their degree of characterization. This document defines what apparatus characteristics should define a physical fire model, identifies the data appropriate for assessing the validity of a physical fire model and provides technical criteria for evaluating them with regard to the accuracy of their data relevant to life safety.

5.5 This document does not address means for combining the effluent component yields to estimate the effects on laboratory animals (see ISO 13344) or for extrapolating the test results to people (see ISO 13571).

6 The ideal fire effluent toxicity test method

6.1 Fire stages

6.1.1 The combustion and/or pyrolysis conditions in the combustor section of the apparatus reproduce the conditions in one or more stages of actual fires, including incipient, growing and fully developed fires.

6.1.2 Specimens are burned under constant, pre-selected conditions of thermal insult and oxygen availability (ventilation). The decomposition conditions and decomposition behaviour of the specimen enable yields to be characterized for specific condition parameters.

6.1.3 For initial and progressive smouldering, the effects of specimen bulk and thermal properties are considered.

6.1.4 For growth and early fire simulations, including oxidative pyrolysis and well ventilated flaming, the in-use exposed surface of a material or product is exposed to the appropriate thermal insult.

6.1.5 For simulation of the developed stages of a fire, full burning of the test specimen is required.

6.2 Applicability

This method tests homogeneous materials (both solid and cellular) and commercial products (especially layered, non-uniform specimens), both melting and non-melting, in relevant form and under simulated fire scenarios. The nature and quantity of the decomposition products are representative of actual fire scenarios.

6.3 Apparatus independence

The apparatus does not impose any significant influence on the results, i.e. the results reflect the burning behaviour of the test specimen and not the apparatus effects. Flame quenching on surfaces should not affect the nature of the effluent and the effluent should not be subject to ageing effects. The combustion zone and effluent plume treatment are designed to ensure that these are achieved.

6.4 Operational efficiency

The test equipment is as simple as possible and capable of safe operation.

6.5 Data generated

6.5.1 The method produces direct measurements of the yields of toxic gases and smoke and/or measurements of the mass concentration of gases and smoke over time, from which the yields may be calculated. The gases include those expected to contribute to the toxic potency of fire effluent: CO_2, CO, HCN, HCl, HBr, HF, NO, NO_2, SO_2, acrolein and formaldehyde.

NOTE The relative importance of the various gases can depend on the harmful effect being considered.

6.5.2 The method produces a measurement of the mass of the test specimen. Preferably, this is obtained throughout the test to determine whether the yields of the combustion products are changing as the combustion proceeds. A determination of the final mass allows for the calculation of average yields over the duration of the test.

6.5.3 The physical fire model is compatible with the use of bioassay methods.