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Life-threatening components of fire — Guidelines for the estimation of time to compromised tenability in fires

Composants dangereux du feu — Lignes directrices pour l'estimation du temps disponible avant que les conditions de tenabilité ne soient compromises

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 13571 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 3, *Fire threat to people and environment*.

This second edition cancels and replaces the first edition (ISO 13571:2007), which has been technically revised.

Introduction

Estimation of occupants' tenability when exposed to a fire environment ultimately involves their ability to perform cognitive and motor-skill functions at an acceptable level. Generally, acceptable performance may include any of a number of desirable outcomes, including escape to a place of refuge, or if escape is not a viable option, continued functioning in place as necessary. The latter situation includes occupants who are not mobile or whose egress is prohibited for a variety of reasons, e.g., from an aircraft in flight. The time from initiation of a fire to the point when tenability is compromised such that acceptable performance is not possible is a central component of fire safety design.

The time required to reach compromised tenability may depend upon each occupant's location and movement, along with numerous other characteristics specific to the occupant (see A.2.2). As a result, each occupant may have a different time to compromised tenability. Guidance for consideration of these factors is provided in other sources, e.g., ISO/TR 13387-8 and ISO/TR 16738.

Each occupant may also have a different time to compromised tenability, depending on their particular exposure to heat and fire effluent combustion products and their individual susceptibility to such exposures (see A.2.3). The purpose of the methodology described in this International Standard is to provide a framework for use in estimating the time at which compromised tenability may occur.

The methodology described cannot be used *alone* to evaluate the overall fire safety performance of specific materials or products and cannot, therefore, constitute criteria for a test method. Rather, the equations are to be used as input to a fire hazard or risk analysis [see ISO/TR 13387 (all parts)]. In such an analysis, the estimated time to compromised tenability also depends on the nature both of the fire (e.g. heat release rate, quantity and types of combustibles, fuel chemistry) and of the enclosure (e.g. dimensions, ventilation). These determine the toxic-gas concentrations, the gas and wall temperatures and the density of smoke throughout the enclosure as a function of time. Furthermore, estimation of exposure is determined, in part, by assumptions regarding the position of the occupants' heads relative to the hot smoke layer that forms near ceilings and descends as the fire grows.

The guidance in this International Standard is based on the best available scientific judgment in using a state-of-the-art but less-than-complete knowledge base of the consequences of human exposure to fire effluents. For ethical reasons, much of the methodology described has not been and cannot be validated experimentally with humans. However, for carbon monoxide, the major contributor to prevention of escape and the most frequent cause of fire fatalities, the database is actually quite extensive and well-validated with human experience.

As with all predictive methodology, uncertainty exists in the application of this International Standard. An estimation of the uncertainty for each procedure is provided, with the user being encouraged to determine the significance of these uncertainties in the estimation of the outcome of a given fire scenario.

Life-threatening components of fire — Guidelines for the estimation of time to compromised tenability in fires

1 Scope

This International Standard is one of many tools available for use in fire safety engineering. It is intended to be used in conjunction with models for analysis of the initiation and development of fire, fire spread, smoke formation and movement, chemical species generation, transport and decay, and people movement, as well as fire detection and suppression. This International Standard is to be used only within this context.

This International Standard is intended to address the consequences of human exposure to the life-threatening components of fire. The time-dependent concentrations of fire effluents and the thermal environment of a fire are determined by the rate of fire growth, the yields of the various fire gases produced from the involved fuels, the decay characteristics of those fire gases and the ventilation pattern (see A.1). Once these are determined, the methodology presented in this International Standard can be used for the estimation of the time at which individuals can be expected to experience compromised tenability.

With care, this guidance can also be applied to estimation of the time limit for rescuing people who are immobile due to injury, medical condition, etc.

This International Standard establishes procedures to evaluate the life-threatening components of fire hazard analysis in terms of the status of exposed human subjects at discrete time intervals. It makes possible the estimation of the time at which occupants can experience compromised tenability (see A.2). It enables estimation of a compromised tenability endpoint for each of the fire effluent components, with the most important endpoint being the earliest to occur.

Although the concept of compromised tenability is consistent with the definition of incapacitation (see ISO 13943), the latter term is not used in this International Standard due to its potentially broad interpretation to include many effects, including collapse and unconsciousness, that are not addressed. This International Standard focuses specifically on compromised tenability as influenced by both physiological and behavioural responses resulting from exposure to a fire's life-threatening components.

The life-threatening components addressed include fire-effluent toxicity, heat, and visual obscuration due to smoke. In cases where the effluent composition is available, the toxic gas model is to be used for assessment of fire-effluent toxicity. For those cases where the effluent composition is unknown, an additional mass-loss model using generic toxic potency values is provided.

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.

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

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