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Fire safety engineering — Selection of design fire scenarios and design fires —

Part 1: Selection of design fire scenarios

Ingénierie de la sécurité incendie — Sélection de scénarios d'incendie et de feux de dimensionnement —

Partie 1: Sélection de scénarios d'incendie de dimensionnement

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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 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 document 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).

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For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 4, *Fire safety engineering*.

This second edition cancels and replaces the first edition (ISO 16733-1:2015), which has been technically revised.

The main changes are as follows:

— Annex C has been removed as the content is now included in ISO/TS 16733-2;

— revised to reference updated content in ISO 23932-1.

A list of all parts in the ISO 16733 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Selection of the fire scenarios requiring analysis is critical in fire-safety engineering. The number of possible fire scenarios in any built environment (a building or other structure) can be very large and it is not always possible to quantify them all. In order for these fire scenarios to be made amenable to analysis, they are reduced from this large set of possibilities to a small set of design fire scenarios.

The characterization of a fire scenario comprises a description of fire initiation, the growth phase, the fully-developed phase, decay and extinction, together with the likely smoke and fire spread routes. This includes a description of the interaction with the proposed fire protection features for the built environment. The possible consequences of each fire scenario should be considered.

This document introduces a methodology for the selection of design fire scenarios that is tailored to the fire-safety design objectives. Several fire-safety objectives can be addressed, including safety of life (for occupants and rescue personnel), conservation of property, protection of the environment and preservation of heritage. A different set of design fire scenarios can be required to assess the adequacy of a proposed design for each objective.

Following selection of the design fire scenarios, a description of the assumed characteristics of the fire on which the scenario quantification is based is needed. These assumed fire characteristics are referred to as “the design fire”. The design fire should be appropriate to the objectives of the fire-safety engineering analysis and result in a design solution that is commensurate with credible worst case scenarios.

Users of this document should be appropriately qualified and competent in the fields of fire-safety engineering and risk assessment. Users need to understand the parameters within which specific methodologies can be used.

ISO 23932-1 provides a performance-based methodology for engineers to assess the level of fire safety for new or existing built environments. Fire safety is evaluated through an engineered approach which is based on the quantification of the behaviour of fire and on knowledge of the consequences of such behaviour on life, property, heritage and the environment. ISO 23932-1 provides the process (necessary steps) and essential elements to design a robust, performance-based fire-safety programme.

ISO 23932-1 is supported by a set of fire-safety engineering standards on the methods and data needed for the steps in a fire-safety engineering design. It is summarized in ISO 23932-1:2018, Clause 4 and shown in Figure 1.

The following International Standards on fire-safety engineering are tied to the steps in the fire safety engineering design process outlined in ISO 23932-1: ISO 16730-1, ISO 16732-1, ISO 20414, ISO 20710-1, ISO 24678-1, ISO 24678-2, ISO 24678-3, ISO 24678-4, ISO 24678-5, ISO 24678-6, ISO 24678-7, ISO 24678-9 and ISO 24679-1.

Fire safety engineering — Selection of design fire scenarios and design fires —

Part 1: Selection of design fire scenarios

1 Scope

This document describes a methodology for the selection of design fire scenarios for use in fire-safety engineering analyses of any built environment, including

— buildings,

— structures, and

— transportation systems.

This document specifies procedures for selecting a manageable number of design fire scenarios using a qualitative or semi-quantitative approach.

NOTE See ISO 16732-1 for a full quantitative approach using risk assessment.

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 13943, *Fire safety — Vocabulary*

ISO 16730-1, *Fire safety engineering — Procedures and requirements for verification and validation of calculation methods — Part 1: General*

ISO 16732-1, *Fire safety engineering — Fire risk assessment — Part 1: General*

ISO 23932-1, *Fire safety engineering — General principles — Part 1: General*

3 Terms and definitions

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

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

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

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

3.1
design fire
quantitative description of assumed fire characteristics within the *design fire scenario* (3.2)

Note 1 to entry: A design fire is, typically, an idealized description of the variation with time of important fire variables such as the heat release rate, flame spread rate, smoke production rate, toxic gas yields and temperature.

3.2
design fire scenario
specific *fire scenario* (3.4) on which an analysis will be conducted

3.3
exposed

3.3.1
exposed person
person intended to be protected either from the effects of fire and fire effluents (e.g. smoke and corrosive gas) or from fire suppression effluents, or both

3.3.2
exposed object
object intended to be protected either from the effects of fire and fire effluents (e.g. smoke and corrosive gas) or from fire suppression effluents, or both

3.3.3
exposed environment
environment intended to be protected either from the effects of fire and fire effluents (e.g. smoke and corrosive gas) or from fire suppression effluents, or both

3.4
fire scenario
qualitative description of the course of a fire with respect to time, identifying key events that characterize the studied fire and differentiate it from other possible fires

Note 1 to entry: See *fire scenario cluster* (3.6) and *representative fire scenario* (3.5).

Note 2 to entry: It typically defines the ignition and fire growth processes, the fully developed fire stage, the fire decay stage, and the environment and systems that will impact on the course of the fire.

Note 3 to entry: Unlike deterministic fire analysis, where fire scenarios are individually selected and used as *design fire scenarios* (3.2), in *fire risk assessment*, fire scenarios are used as representative fire scenarios within fire scenario clusters.

3.5
representative fire scenario
specific *fire scenario* (3.4) selected from a *fire scenario cluster* (3.6) from which the consequence can be used as a reasonable estimate of the average consequence of scenarios in the *fire scenario cluster*

3.6
fire scenario cluster
subset of *fire scenarios* (3.4) usually defined as part of a complete partitioning of the universe of possible fire scenarios

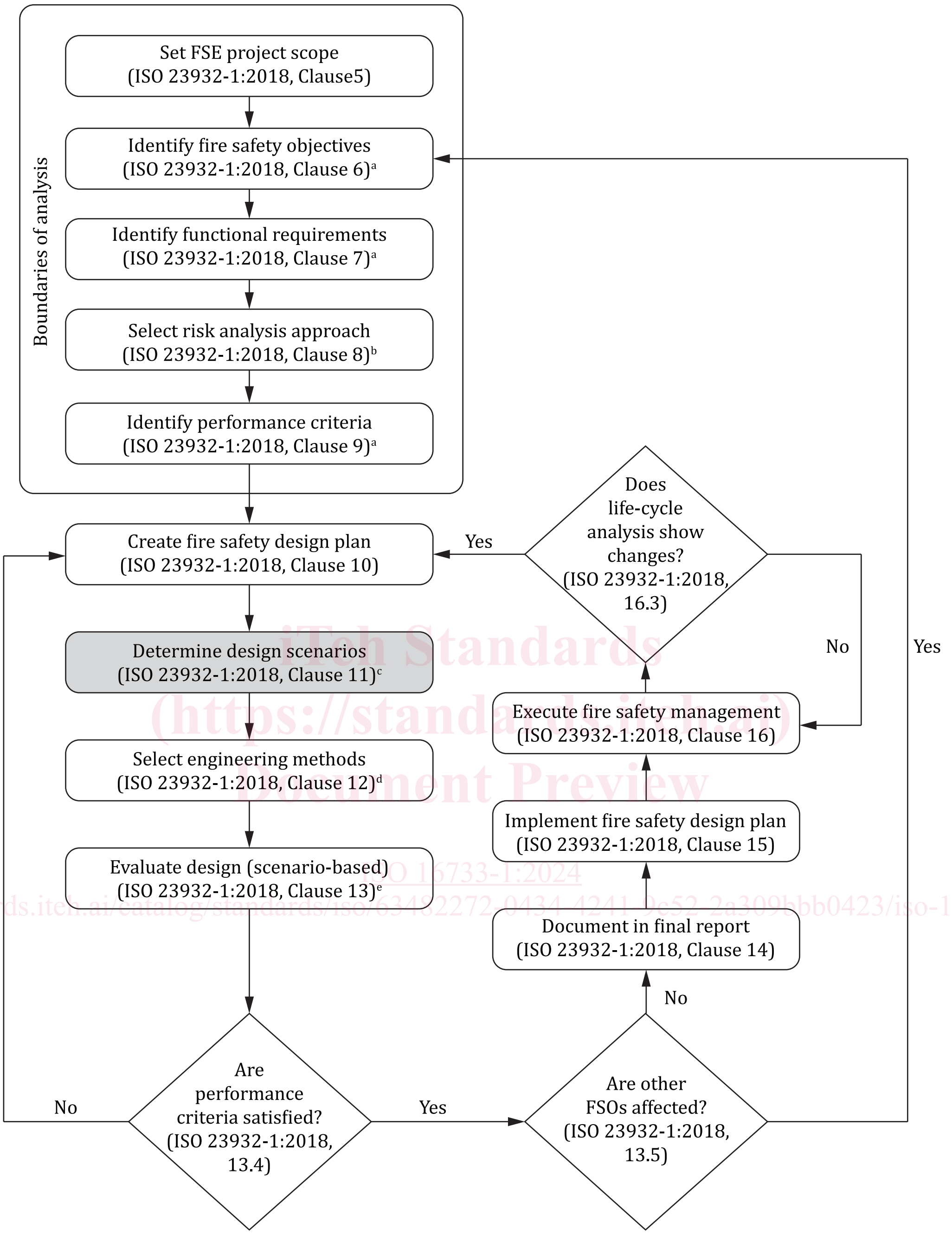
Note 1 to entry: This subset is usually defined so that the calculation of fire risk as the sum over all fire scenario clusters of fire scenario cluster frequency multiplied by *representative fire scenario* (3.5) consequence does not impose an undue calculation burden.

4 Fire safety engineering applications

4.1 Fire safety engineering process

ISO 23932-1 provides a performance-based methodology for engineers to assess the level of fire safety for new or existing built environments. Fire safety is evaluated through an engineered approach based on the quantification of the behaviour of fire and based on knowledge of the consequences of such behaviour on life, property, heritage and the environment.

ISO 23932-1 specifies the process, including the necessary steps and essential elements, to design a robust, performance-based fire-safety programme. This document specifies how to develop design fire scenarios in accordance with ISO 23932-1:2018, Clause 11. This step in the fire-safety engineering process is shown as a shaded box in Figure 1.



a Refer to ISO/TR 16576 for examples.

b Refer to ISO 16732-1, ISO 16733-1 (this document), ISO/TS 16733-2, ISO/TS 29761.

c Refer to ISO 16732-1, ISO 16733-1, ISO/TS 16733-2, ISO/TS 29761.

d Refer to ISO/TS 13447, ISO 16730-1, ISO/TR 16730-2 to ISO/TR 16730-5 for examples, ISO/TR 16738, ISO 24678-1, ISO 24678-2, ISO 24678-3, ISO 24678-4, ISO 24678-5, ISO 24678-6, ISO 24678-7 and ISO 24678-9.

e Refer to ISO/TR 16738 and ISO/TS 16733-2.

NOTE Figure 1 adapted from ISO 23932-1:2018.

Figure 1 — Fire-safety engineering process

4.1.1 Establish project scope

The project scope shall describe the purpose and function of each part of the design, as well as the fixtures, furnishings, decorations, equipment and combustible products that are to be installed, stored or used in the built environment. Where this information is not available, assumptions shall be made. The validity of each assumption shall be checked and confirmed both during and after the project. The scope of the design work shall be defined, including the extent to which an FSE approach will be applied.

ISO 23932-1:2018, Clause 5 shall be followed.

4.1.2 Identify fire safety objectives

There can be several fire-safety objectives which shall be taken into account when they apply.

— Safety of life (for occupants and rescue personnel).

— Conservation of property.

— Protection of the environment.

— Preservation of heritage.

It shall be taken into account that a different set of design fire scenarios can be required to assess the adequacy of the proposed design for each objective.

ISO 23932-1:2018, Clause 6 shall be followed.

4.1.3 Determine functional requirements

A functional requirement is a statement of a condition necessary to achieve the fire-safety objective, e.g. spaces used for evacuation shall be free from harmful fire effects. All functional requirements shall be identified, so that the potential of any possible fire scenarios to threaten the fulfilment of the functional requirement can be assessed. If a fire scenario does not threaten the achievement of a functional requirement, then it is not relevant. An example of a functional requirement for life safety can be: “ensure that the structure does not fail and protect the paths of egress from harmful fire effects until evacuation is completed”.

ISO 23932-1:2018, Clause 7 shall be followed.

4.1.4 Select risk analysis approach

The choice of which risk analysis approach to take depends on the level of treatment of uncertainty required in the analysis. The relevant risk analysis approach enables a comparison between estimated and tolerable risk using some form of risk measure or performance criteria.

The risk analysis approach can be qualitative, deterministic, or probabilistic analysis. In general, it is not necessary and is often either impractical or cost-prohibitive or both, to conduct a full, quantitative fire risk assessment on an entire built environment. The complexity of the relevant method determines the level of effort required and it should reflect the level of detail necessary for informed decision making.

ISO 23932-1:2018, Clause 8 shall be followed.

4.1.5 Identify performance criteria

The type of analysis (deterministic, probabilistic) and the performance criteria used shall be selected. Performance criteria are the engineering metrics that are expressed in deterministic or probabilistic (e.g. measures of fire risk) form to determine if each functional requirement has been satisfied by the fire-safety design. Performance criteria shall be developed for a life safety functional requirement. For example, setting the maximum concentration or dose of carbon monoxide that an occupant can be exposed to.

ISO 23932-1:2018, Clause 9 shall be followed.

4.1.6 Fire safety design plan

The trial fire-safety design plan shall include a detailed fire-safety strategy. It shall be documented in a fire design report, with enough detailed information provided to evaluate whether it meets the fire-safety objectives when assessed against the design fire scenarios. The fire-safety design plan shall include descriptions of the functions of different parts of the built environment and their contribution to satisfying the fire-safety strategy. Figure 1 illustrates the fire-safety design process specified in ISO 23932-1.

ISO 23932-1:2018, Clause 10 shall be followed.

4.1.7 Determine design scenarios

Design scenarios can be divided into the following two categories of sub-scenarios:

— design fire scenarios (for fire behaviour);

— design behavioural scenarios (for human behaviour, either of occupants or rescue service personnel), addressing both life safety and potential impact on the fire development related to some aspects of fire scenarios.

Also ISO/TS 29761 should be referred to for details of a methodology for the selection of design occupant behavioural scenarios and ISO 23932-1:2018, Clause 11 shall be followed.

4.1.8 Select engineering methods

Engineering methods shall be selected in order to assess whether the trial fire-safety design plan meets the fire-safety objectives. This selection process involves determining which engineering methods have acceptable accuracy and efficiency in demonstrating that the relevant performance criteria are satisfied as the result of one or more design fire scenarios.

ISO 23932-1:2018, Clause 12 shall be followed.

4.1.9 Evaluate design

The trial fire-safety design plan shall be evaluated by carrying out an engineering analysis using select engineering methods to determine whether the relevant performance criteria are achieved for the design fire scenarios.

ISO 23932-1:2018, Clause 13 shall be followed.

4.1.10 Document in final report

All of the information used in developing the fire-safety design shall be documented, from FSE project scope to final design and shall include details regarding the ongoing operations and maintenance of the facility.

ISO 23932-1:2018, Clause 14 shall be followed.

4.1.11 Implement fire-safety design plan

When deviations from the final fire-safety design plan are necessary, they shall be documented in a report. Evidence that products used in construction or components used in manufacturing conform with any assumptions made in the fire-safety assessment shall be documented in a conformity assessment report.

ISO 23932-1:2018, Clause 15 shall be followed.

4.1.12 Execute fire-safety management

Once a fire-safety design is implemented in the built environment, fire-safety management and inspection shall be conducted throughout the lifetime of the built environment. The management and inspection processes shall ensure that the design scenarios used by fire-safety designers are relevant.