ISO GLOBAL FIRE SAFETY ENGINEERING ANALYSIS AND INFORMATION SYSTEM

Deytec, Inc.

A Guide to Using ISO Fire Safety Standards

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Introduction

The following ISO documents are available for the fire safety engineering design process. The first list contains core standards which are the essential set of standards available for the fire safety engineering process. The second list contains supplementary documents which may be referred to for further guidance or information. The specific role of these documents in the fire safety engineering design process is explained later in the context of the global information system.

Core Standards

ISO 23932:2008, *Fire safety engineering – General principles*

ISO 16733-1:2015, *Fire safety engineering -- Selection of design fire scenarios and design fires.*

ISO 16732-1:2012, *Fire safety engineering -- Fire risk assessment -- Part 1: General.*

ISO 16734:2006, *Fire safety engineering -- Requirements governing algebraic equations -- Fire plumes.*

ISO 16735:2006, *Fire safety engineering -- Requirements governing algebraic equations -- Smoke layers.*

ISO 16736:2006, *Fire safety engineering -- Requirements governing algebraic equations -- Ceiling jet flows.*

ISO 16737:2012, *Fire safety engineering -- Requirements governing algebraic equations -- Vent flows.*

ISO/TS 24679:2011, *Fire safety engineering -- Performance of structures in fire.*

ISO/TR 13387-7:1999[1], *Fire safety engineering -- Part 7: Detection, activation and suppression.*

ISO 16730-1:2015, *Fire safety engineering — Procedures and requirements for verification and validation of calculation methods*.

ISO 29761:2015, *Fire Safety Engineering -- Selection of design occupant behavioural scenarios (for life safety applications).*

ISO/TS 13447, *Fire safety engineering -- Guidance for use of fire zone models.*

Supplementary Standards

ISO/TR 13387-4:1999, *Fire Safety Engineering – Part 4: Initiation and development of fire and generation of fire effluents.*

ISO/TR 13387-5:1999, *Fire safety engineering -- Part 5: Movement of fire effluents.*

ISO/TR 24679-2, *Fire safety Engineering -- Performance of structure in fire -- Part 2: Example of an airport terminal.*

ISO/TR 24679-3, *Fire safety Engineering -- Performance of structure in fire -- Part 3: Example of an open car park.*

ISO/TR 16738:2009, *Fire-safety engineering -- Technical information on methods for evaluating behaviour and movement of people.*

ISO/TR 13387-8:1999, *Fire safety engineering -- Part 8: Life safety -- Occupant behaviour, location and condition.*

ISO/TR 16730-2, *Fire safety engineering -- Assessment, verification and validation of calculation methods -- Part 2: Example of a Zone Model.*

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[1] The ISO/TR 13387 series of documents published in 1999 were withdrawn by ISO in 2013. They are listed here as useful references which now can only be obtained as archived documents. The documents are available at the website of Deytec, Inc. at www.deytecinc.com/store

ISO 16730-3, *Fire safety engineering -- Assessment, verification and validation of calculation methods -- Part 3: Example of a CFD Model.*

ISO/TR 16730-4, *Fire safety engineering -- Assessment, verification and validation of calculation methods -- Part 4: Example of a Structural Model.*

ISO/TR 16730-5, *Fire safety engineering -- Assessment, verification and validation of calculation methods -- Part 5: Example of an Egress Model.*

ISO/TR 16732-2:2012, *Fire Safety Engineering -- Fire risk assessment -- Part 2: Example of an office building.*

ISO/TR 16732-3, *Fire safety engineering -- Fire risk assessment -- Part 3: Example of an industrial property.*

Global fire safety engineering analysis and information system

The global fire safety engineering analysis and information system includes the methods and data needed for a fire safety engineering design which is conducted according to the steps shown in Figure 1 of ISO 23932 shown below and summarized in Chapter 4 of the main text of that document.

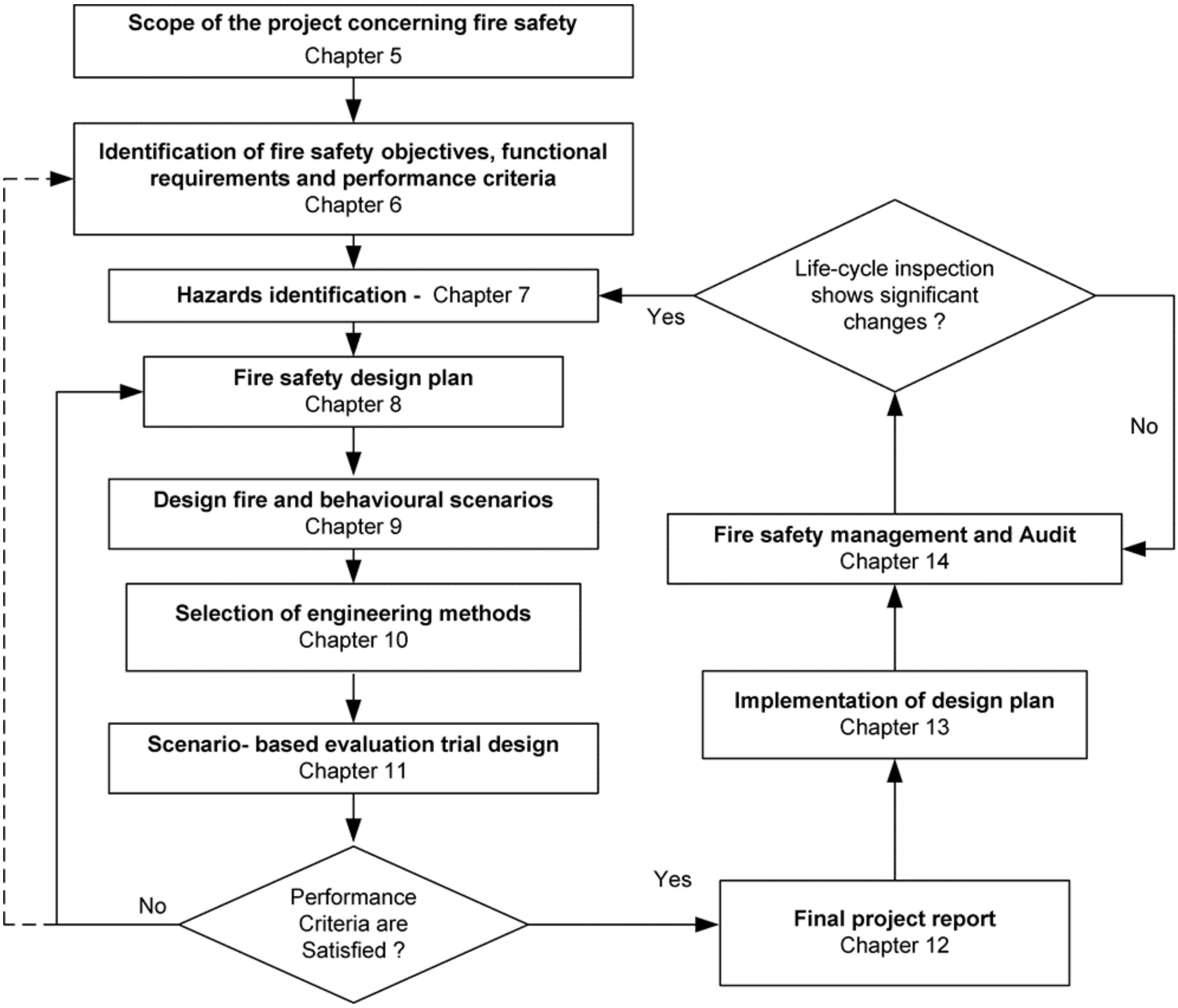

Figure 1 Global Fire Safety Engineering Analysis and Information System

The global information system provides an awareness of the interrelationships between fire evaluations when using ISO fire safety engineering standards. The goal is to promote an awareness of the interactions between the different parts of the process and fire phenomena.

Each ISO standard supporting the global analysis and information system includes language in the introductory material of the standard to tie the standard to the steps in the fire safety engineering design process outlined in ISO 23932. The evaluations in the design step that the standard requires in the context of the global analysis and information system is presented. Each ISO fire safety engineering standard also identifies the data to be used and produced by the evaluations in the standard, from and for the global information bus. The global information bus consists of data needed for and produced by the evaluations in the ISO fire safety engineering standards for the fire safety design. The global information bus is described in an accompanying document, "Guide for Input Data for Fire Safety Engineering," available from http://www.deytecinc.com/store

The boundary conditions of the fire safety engineering analysis is set by prescribed design parameters (provided by the architect), specific fire safety objectives and functional requirements, and design scenarios for the safety objectives under consideration.

Table 1 presents the core ISO fire safety engineering standards that complement ISO 23932, and identifies the specific link of the standard to a chapter in ISO 23932. The standards and the links are further described later.

Chapter in ISO 23932	**List of standards available**	**Comments**
Scope of the project concerning fire safety – Chapter 5		Provided by architect to fire safety engineer
Identification of fire safety objectives, functional requirements and performance criteria – Chapter 6	ISO 29761	The standards cover the life safety objective. Other safety objectives have not yet been elaborated.
Hazard Identification - Chapter 7 and Design scenarios – Chapter 9	ISO 16733-1, ISO 16732, ISO 29761	ISO 16733-1 covers design scenarios generically, ISO 16732 includes risk methods for scenario selection, and ISO 29761 covers the life safety objective.
Scenario based evaluation of trial design – Chapter 11		1. Covers fire plumes, smoke layers, ceiling jet flows, and vent flows, respectively.
1. *Movement of fire effluents*	ISO 16734, ISO 16735, ISO 16736, ISO 16737	
2. *Structural response and fire beyond enclosure of origin*	ISO/TS 24679-1	

3. *Detection, activation, and suppression*	ISO/TR 13387-7	
General to ISO 23932	ISO 16732-1, ISO 16730-1	ISO 16732-1 is used for a fire risk assessment approach. ISO 16730-1 is for verifying & validating methods used for Chapter 11.

Table 1 ISO Fire safety engineering standards that complement ISO 23932

Scope of the project concerning fire safety – Chapter 5

Initial parameters and data which are known and provided by the architect to the fire safety engineer, including trial fire safety systems design should be developed. Prescribed design parameters fall into the following categories:

a) aspects of the building design, its contents and its use, including the part of the building that will be subject to the fire safety engineering design;

b) fire safety system and facilities for fire brigade intervention;

c) occupants;

d) environment.

These design parameters are determined from the scope of the project concerning fire safety pursuant to Chapter 5 in ISO 23932 and is the first step in the fire safety engineering design process as shown in Figure 1 above.

Identification of fire safety objectives, functional requirements and performance criteria – Chapter 6

Specific fire safety objectives, functional requirements, and performance criteria, e.g., for life safety, are included in the documents supporting that fire safety objective. The fire safety objectives in these documents expand on the brief discussion of objectives, functional requirements, and performance criteria in ISO 23932.

For assessing the life safety objective, ISO/TR 16738:2009, Technical information on methods for evaluating behaviour and movement of people, which presents methods for the calculation of the Required Safe-Egress Time (RSET) is available. ISO/TR 13387-8, Life safety -- Occupant behaviour, location and condition, provides supporting in-depth discussion of the methods available for determining occupant behaviour, response, and movement. ISO 29761, Selection of design occupant behavioural scenarios, discusses special considerations for the selection of design fire scenarios when considering occupant location and behaviour. Finally, ISO 16732, Fire risk assessment -- Part 1: General, provides methods for a risk assessment if the life safety objective is formulated in probabilistic terms.

ISO documents for other fire safety objectives such as conservation of property, continuity of operations, protection of the environment, and preservation of heritage are not yet elaborated.

Hazard Identification - Chapter 7 and Design fire scenarios – Chapter 9

Design fire scenarios and design fires prescribe the boundary conditions or design basis for the fire safety engineering analysis. The ISO standards supporting Chapter 7 and 9 describe the steps for identifying fire hazards and developing design scenarios and design fires, utilizing methods for the fire initiation and growth within the compartment and methods for calculating the phenomena.

ISO 16733-1, Selection of design fire scenarios and design fires, provides steps for developing design scenarios and design fires that are generic to different fire safety objectives, while ISO 13387-4, Initiation and development of fire and generation of fire effluents, describes the fire initiation and growth within the compartment and methods for calculating the phenomena when formulating design fires.

The evaluations discussed in ISO 13387-4 are:

- Initiation of fire
- Fire development inside room of origin
- Smoke generation
- Toxic species generation (carbon monoxide, carbon dioxide, hydrogen cyanide, hydrogen halides)

ISO 16733-1 draws upon information in ISO/TR 13387-4.

Complete information on the selection of design fire scenarios and design fires based on probabilistic methods is provided in ISO 16732, Fire risk assessment -- Part 1: General. Parts 2 and 3 of ISO 16732 provide examples of this selection process for specific applications.

Guidance on the development of design fire scenarios and design fires for a specific fire safety objective are given in documents specific to that safety objective. ISO 29761, Selection of design occupant behavioural scenarios, discusses special considerations for the selection of design fire scenarios when considering occupant location and behaviour.

Scenario based evaluation of trial design – Chapter 11

Scenario based evaluations of the trial design require the examination and simulation of the following fire phenomena.

Movement of fire effluents

The evaluations covered in this fire phenomena category are:

- Movement of fire effluents between separated enclosures
- Non-thermal damage (acid gases, soot, and super toxicants)

The ISO standards listed below supporting this subsystem provide engineering methods (hand calculation, computer method or fire test) for assessing the potential for movement of fire effluents during the course of a fire. The documents also provide means to assess the effectiveness of fire safety measures meant to reduce the adverse effects of the movement of fire effluents.

ISO/TR 13387-5, Movement of fire effluents, supports the evaluations in this category and discusses engineering methods for assessing the potential for movement of fire effluents during the course of a fire. ISO 16734, Requirements governing algebraic equations -- Fire plumes, ISO 16735, Requirements governing algebraic equations -- Smoke layers, ISO 16736, Requirements governing algebraic equations -- Ceiling jet flows, and ISO 16737, Requirements governing algebraic equations -- Vent flows, are available for specific calculations to calculate the movement of the fire effluent.

The evaluations conducted for the movement of fire effluent draw on the prescription or characterisation of the fire discussed in Section 2.3 above. The prediction of the spread of smoke and flames through openings is addressed in these ISO standards while the spread of fire through barriers is discussed below.

Structural response and fire beyond the enclosure of origin

The evaluations in this fire phenomena category are:

- Thermal response of structures and boundaries
- Mechanical response of structures
- Fire spread

The ISO standards supporting the above evaluations provide the engineering methods (hand calculation, computer method or fire test) for assessing the structural response and the potential for fire spread through barriers in a given situation (application). This entails an analysis of the unit physical and chemical processes involved in each of the modes of fire spread (e.g. room to room, building to building, room to external items, etc.).

The evaluations in this category draw on the prescription or characterisation of the fire discussed in Section 2.3 above. For example the standards discussed in Section 2.3 provide methods for predictions of the time to flashover and the temperature history in the room of fire origin. These data, along with the description of the building assemblies (trial design parameters) are employed to predict the likelihood (and time) of fire spread, and the likelihood (and time) of structural collapse.

Should fire spread from the room (compartment) of fire origin or should local structural collapse occur, not only will additional property damage be incurred, but the safety of building occupants and firefighters outside the room (compartment) of fire origin can be compromised. Hence data generated through evaluations in this category become inputs to determine if specific fire safety objectives are met. Guidance on interpreting the results of an analysis of the potential of fire spread is also provided. This includes guidance on the selection of criteria for assessing the effectiveness of fire safety measures meant to reduce the potential of fire spread.

ISO/TS 24679, Performance of structures in fire, provides the methods for determining the structural response and fire spread beyond the enclosure of origin. Parts 2 and 3 of ISO/TS 24679 provide examples of specific applications.

Detection, activation, and suppression

The evaluations covered in this category are:

- Detection time of fire

- Activation time of suppression systems
- Performance of suppression systems

The ISO standard supporting the above evaluations provide guidance on the use of engineering methods for the prediction of the time to detect smoke or flames by a wide range of commercial devices, including the time required for heat-sensitive elements in suppression or other control devices to respond to the gas flow generated by an incipient or growing fire. Guidance is also provided on how to predict, once detection has occurred, the time required to activate the desired response to a fire, such as an alarm, a smoke damper or a specified flow of extinguishing agent from typical distribution devices. Methods of estimating the effectiveness of many common fire-suppression and control strategies are also addressed.

ISO/TR 13387-7, Detection, activation and suppression, provides full details for the evaluations for detection, activation and suppression.

These evaluations utilize the characterisation of the size of the fire as well as the temperature, species concentration and gas velocity fields generated by the fire at any time after ignition/initiation of the design fire event. This information, along with a description of sensor locations from the building design parameters, is employed in these evaluations to predict detection times and the operation of elements, such as those in automatic sprinklers, that allow release of pressurised extinguishing agent (e.g. water) at a nozzle.

The effect of various suppression strategies on the fire heat release rate is addressed in these evaluations. Once an assumed suppression strategy (usually in terms of a required agent flow rate) takes effect, there is considerable feedback required between these evaluations and evaluations for development and movement of fire effluent so that the resultant fire environment (e.g. gas temperatures and species concentrations) can be determined. If the established performance criteria cannot be met, alternative suppression strategies may have to be considered.

Activation times are also determined in these evaluations, most often from a wealth of input information available from the vendors and manufacturers of the various detection and suppression systems to be installed in a building. The hydraulic design of sprinkler piping systems is considered to be part of this activation process since such piping design ensures that the required flow rate of water or other agent will be available when distribution nozzles are activated by the detection elements.

General Documents

Several documents are available that provide guidance on the methods available and their assessment for use in fire safety engineering. ISO 16730-1, Procedures and requirements for verification and validation of calculation methods presents verification and validation procedures for these methods, determining their suitability for specific applications, and for developing the uncertainties in predictions. Parts 2, 3, 4, and 5 to ISO 16730 are also available providing examples of the verification and validation methods for a zone, computational fluid dynamic, structural, and an egress model. ISO/TS 13447, Guidance for use of fire zone models, provides the capabilities and limitations of using zone models.

ISO 16732-1, Fire risk assessment -- Part 1: General, provides guidelines for the use of the risk assessment methodology in fire safety engineering analysis. This methodology should be selected early in the design process and it overlays the methodologies and ISO fire safety engineering standards discussed above with probabilistic considerations of the phenomena and systems involved in fire safety. As such, it utilizes all of the evaluations discussed above.

