ISO FIRE SAFETY ENGINEERING INTERNATIONAL STANDARDS

Deytec, Inc.

A GUIDE TO ISO FIRE SAFETY STANDARDS – Dr. Monideep Dey

December 2016

Introduction

The following set of International Standards are available for fire safety engineering design and management as defined in ISO 23932. The first list contains International Standards which are the basic set available for fire safety engineering design and management. The second list contains supplementary technical reports which may be referred to for further guidance or information. The specific role of these International Standards for fire safety engineering design and management is explained later in the context of the global approach to fire safety engineering.

Core Standards and Technical Specifications

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

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

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 24678-6:2016 *Fire safety engineering -- Requirements governing algebraic formulae -- Part 6: Flashover related phenomena.*

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

ISO 16730-1:2015, *Fire safety engineering -- Assessment, verification and validation of calculation methods -- Part 1: General.*

ISO/TS 13447:2013, *Fire safety engineering -- Guidance for use of fire zone models.*

ISO/TS 29761:2015, *Fire Safety Engineering -- Selection of design occupant behavioural scenarios.*

Supplementary technical reports

ISO/TR 16576 *Fire safety engineering – Examples of fire safety objectives, functional requirements and safety criteria.*

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 24679-4 *Fire safety engineering – Performance of structures in fire – Part 4: Example of a multi-story building in Japan.*

ISO TR 24679-5 *Fire safety engineering – Performance of structures in fire – Part 5: Example of a six-story reinforced concrete building*.

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

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

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

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

ISO 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 approach to fire safety engineering design and management

Fire safety engineering and management is conducted according to the process shown in Figure 1 taken from ISO 23932 which outlines the basic requirements for fire safety engineering analysis. A wide range of technical methods and data are needed for the implementation of this process. A global approach to fire safety engineering is important to provide an awareness of the interrelationships between fire evaluations and data in the different parts of the process, when using the set of fire safety engineering International Standards.

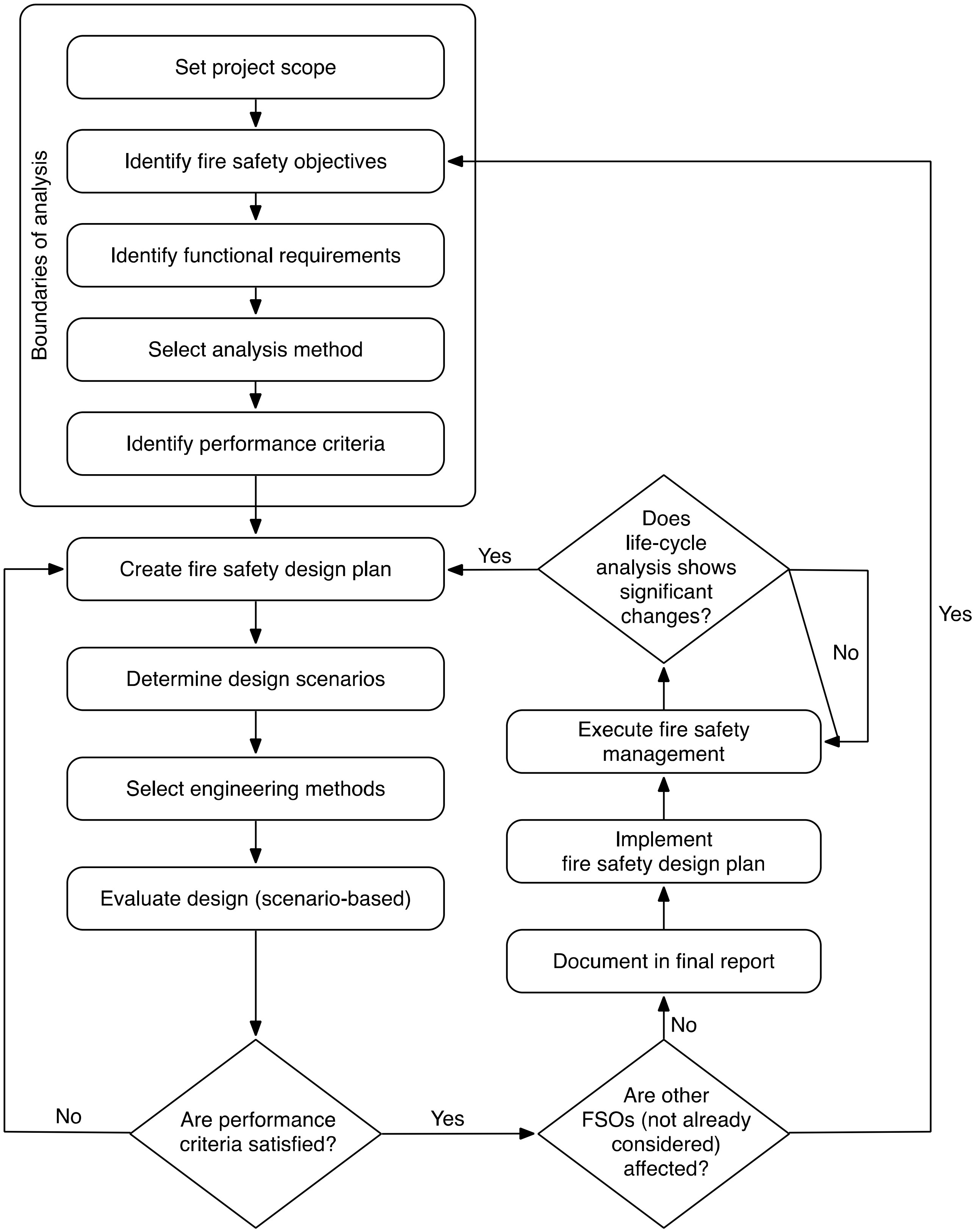

Figure 1 Fire safety engineering process - Design, implementation and management

Each fire safety engineering standard which is part of the set of International Standards includes language in the introductory material to link it to the steps in fire safety engineering design and management process shown above in Figure 1 taken from ISO 23932. The evaluations for design or management that the International Standard requires in the context of the global approach is presented in the introductory section. Each ISO fire safety engineering International Standard also identifies the data used and produced by the evaluations required in the standard. A global information bus, containing data needed and produced by the different evaluations, may be compiled and be useful to understand the interactions between the evaluations necessary for fire safety engineering design and management.

Table 1 presents the ISO fire safety engineering set of International Standards that complement ISO 23932, and identifies the specific link of the standard to a chapter in ISO 23932. The International Standards and the links between them are discussed further later.

Chapter in ISO 23932	**List of standards available**	**Comments**
Boundaries of Analysis - Setting project scope Ch. 5 - Identification of fire safety objectives, functional requirements and performance criteria Ch. 6, 7 & 9		Set by project team. The main text and ISO/TR 16576 provide examples of fire safety objectives, functional requirements and performance criteria.
Hazard Identification – Ch. 10 Fire and behavioural scenarios – Ch. 12	ISO 16733-1, ISO 16732-1, ISO/TS 29761	ISO 16733-1 covers hazard identification and design scenarios generically, ISO 16732-1 includes risk methods for scenario selection, and ISO/TS 29761 covers scenarios for the life safety objective.
Scenario based evaluation of trial design – Chapter 14		
1. *Movement of fire effluents*	ISO 16734, ISO 16735, ISO 16736, ISO 16737, ISO 24678-6	Covers fire plumes, smoke layers, ceiling jet flows, vent flows, and flashover respectively.
2. *Structural response and fire beyond enclosure of origin*	ISO/TS 24679-1	
3. *Detection, activation, and suppression*		Standards under development.
General to ISO 23932	ISO 16732-1, ISO 16730-1, ISO/TS 13447	ISO 16732-1 is used for a fire risk assessment approach, ISO 16730-1 covers verification & validation of fire calculation methods, ISO/TS 13447 provides guidance on the use of zone models.

Table 1 ISO Fire safety engineering standards that complement ISO 23932

The boundaries of the fire safety engineering analysis is set by the project scope and prescribed design parameters (provided by the architect), specific fire safety objectives, functional requirements, and performance criteria (specific to the analysis method). ISO/TR 16576 *Fire safety engineering – Examples of fire safety objectives, functional requirements and safety criteria* is available as a guide for this step of the process.

An analysis method needs to be chosen for the fires safety engineering design. The analysis method may be deterministic, probabilistic, or a combination of both. 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 in the ISO fire safety engineering standards discussed below with probabilistic considerations of the phenomena and systems involved in fire safety. As such, it utilizes all of the evaluations discussed below.

A fire safety design plan is created that is followed by the development of design scenarios and design fires. Design fire scenarios and design fires prescribe the boundary conditions or design basis for the fire safety engineering analysis. The ISO standards supporting the steps for identifying fire hazards and developing design scenarios and design fires, utilize methods for the fire initiation and growth within the compartment and methods for calculating the phenomena. ISO 16733-1, *Fire safety engineering -- Selection of design fire scenarios and design fires -- Part 1: Selection of design fire scenarios*, provides steps for developing design scenarios that are generic to different fire safety objectives. ISO/TS 29761:2015 *Fire safety engineering -- Selection of design occupant behavioural scenarios* discusses special considerations for the selection of design fire scenarios when considering occupant location and behaviour, and ISO/TR 16738:2009, *Fire-safety engineering -- Technical information on methods for evaluating behaviour and movement of people* provides supporting technical information.

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.

Scenario based evaluations of the trial design require the examination and simulation of the following fire phenomena which are categorized as subsystems.

Movement of fire effluents

The evaluations in this fire phenomena category cover the movement of fire effluents between separated enclosures. The ISO standards for this subsystem provide engineering methods (hand calculation, or computer method) for assessing the potential for movement of fire effluents during the course of a fire. The standards also provide means to assess the effectiveness of fire safety measures meant to reduce the adverse effects of the movement of fire effluents.

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*, ISO 24678-6:2016 *Fire safety engineering -- Requirements governing algebraic formulae -- Part 6: Flashover related phenomena* are available for specific calculations to calculate the movement of the fire effluent. Computer models, zone and computational fluid dynamic (CFD), are also available for calculation of fire phenomena in this subsystem. It is important to maintain an awareness of the interrelationships between fire evaluations when computer models contain sub-models that simulate several fire phenomena. ISO/TS 13447, *Guidance for use of fire zone models*, provides the capabilities and limitations of using zone models for such analysis.

ISO 16730-1, *Verification and validation procedures of fire calculation methods -- Part 1: General*, presents verification and validation procedures for these fire calculation 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, CFD, structural, and an egress model.

The evaluations conducted for the movement of fire effluent draw on the prescription or characterisation of the fire discussed 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: (1) Thermal response of structures and boundaries; (2) Mechanical response of structures; and (3) Fire spread.

The ISO standards supporting the above evaluations provide the engineering methods (hand calculation, computer method) for assessing the structural response and the potential for fire spread through barriers in a given situation. 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 above. For example the standards discussed above 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, 3, 4 and 5 of ISO/TS 24679 provide examples of specific applications.

Detection, activation, and suppression

The evaluations covered in this category are: (1) Detection time of fire; (2) Activation time of suppression systems; (3) Performance of suppression systems.

ISO standards that are under development supporting the above evaluations will specify the requirements for the use of engineering methods for the prediction of the time to detect smoke or flames. Guidance will also be 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 will also be addressed.

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.

