PD ISO/TR 16730-2:2013

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Fire safety engineering — Assessment, verification and validation of calculation methods

Part 2: Example of a fire zone model

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Fire safety engineering — Assessment, verification and validation of calculation methods —

Part 2: Example of a fire zone model

Ingénierie de la sécurité incendie — Évaluation, vérification et validation des méthodes de calcul —

Partie 2: Exemple d'un modèle de zone

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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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 92, *Fire safety*, Subcommittee SC 4, *Fire safety engineering*.

ISO 16730 consists of the following parts, under the general title *Fire safety engineering — Assessment, verification and validation of calculation methods*:

— *Part 2: Example of a fire zone model* (Technical report)

— *Part 3: Example of a CFD model* (Technical report)

— *Part 4: Example of a structural model* (Technical report)

— *Part 5: Example of an Egress model* (Technical report)

The following parts are under preparation:

— *Part 1: General* (revision of ISO 16730:2008)

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Introduction

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For the particular case of the example application of ISO 16730-1 described in this document, ISO takes no responsibility for the correctness of the code used or the validity of the verification or the validation statements for this example. By publishing the example, ISO does not endorse the use of the software or the model assumptions described therein and states that there are other calculation methods available.

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Fire safety engineering — Assessment, verification and validation of calculation methods —

Part 2: Example of a fire zone model

1 Scope

This part of ISO 16730 shows how ISO 16730-1 is applied to a calculation method for a specific example. It demonstrates how technical and users' aspects of the method are properly described in order to enable the assessment of the method in view of verification and validation.

The example in this part of ISO 16730 describes the application of procedures given in ISO 16730-1 for a fire zone model (CFAST).

The main objective of the specific model treated here is the simulation of a fire in confined compartments with a natural or forced ventilation system.

2 General information on the zone model considered

The name given to the zone model considered in this Technical Report is "CFAST". CFAST is a two-zone fire model capable of predicting the environment in a multi-compartment structure subjected to a fire. It calculates the time-evolving distribution of smoke and fire gases and the temperature throughout a building during a user-prescribed fire. This Technical Report describes the equations which constitute the model, the physical basis for these equations, and an evaluation of the sensitivity and predictive capability of the model.

The modelling equations take the mathematical form of an initial value problem for a system of ordinary differential equations (ODEs). These equations are derived using the conservation of mass, the conservation of energy (equivalently, the first law of thermodynamics), the ideal gas law, and relations for density and internal energy. These equations predict as functions of time quantities such as pressure, layer height, and temperature given the accumulation of mass and enthalpy in the two layers. The model then consists of a set of ODEs to compute the environment in each compartment and a collection of algorithms to compute the mass and enthalpy source terms required by the ODEs.

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3 Methodology used in this Technical Report

For the calculation method considered, checks based on ISO 16730-1 and as outlined in this Technical Report are applied. This Technical Report lists in Annexes A and B the important issues to be checked in the left-hand column of a two-column table. The issues addressed are then described in detail, and it is shown how these were dealt with during the development of the calculation method in the right-hand column of the Annexes A and B cited above, where Annex A covers the description of the calculation method and Annex B covers the complete description of the assessment (verification and validation) of the particular calculation method. Annex C describes a worked example and Annex D adds a user's manual.

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Annex A
(informative)

Description of the calculation method

A.1 Purpose	
Definition of problem solved or function performed	The model has been developed for solving practical fire problems in fire protection engineering while at the same time providing a tool to study fundamental fire dynamics and smoke spread. It is intended for system modelling of building and building components. It is not intended for detailed study of flow within a compartment such as is needed for smoke detector siting. Space scales from ~1 m^3 to 1 000 m^3 and time scales from ~1 s to approximately a few hours.
(Qualitative) description of results of the calculation method	The outputs of the model are the sensible variables that are needed for assessing the environment in a building subjected to a fire. These include temperatures of the upper and lower gas layers within each compartment, the ceiling/wall/floor temperatures within each compartment, the visible smoke and gas species concentrations within each layer, target temperatures, and sprinkler activation time.
Justification statements and feasibility studies	The model predicts the environment within compartmented structures resulting from a fire prescribed by the user. It is an example of the class of models called finite element. This particular implementation is called a zone model and, essentially, the space to be modelled is broken down to a few elements. The physics of the compartment fire phenomena is driven by fluid flow, primarily buoyancy. The usual set of elements or zones are the upper and lower gas layers, partitioning of the wall/ceiling/floor to an element each, one or more plumes, and objects such as fires, targets, and detectors. One feature of this implementation of a finite element model is that the interface between the elements (in this case, the upper and lower gas layers) can move, with its position defined by the governing equations. The attached bibliography[1-4] has a compendium of all validation testing which has been done.

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