Central Fire Brigades Advisory Council
Scottish Central Fire Brigades Advisory Council
Joint Committee on Fire Research

Draft ISO Standard on Fire Safety Engineering Life Safety

Summary Report

by Cath Reynolds & Dave Berry

Research Report Number 74

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The International Standards Organisation (ISO) has been developing a standard for Fire Safety Engineering to provide guidance on a flexible, performance based approach to assessing the consequences of fire in terms of life safety, property loss, business interruption, contamination of the environment and destruction of heritage. This work has been progressing for four years and as a result, a suite of documents has been prepared. The first describes a framework approach to Fire Safety Engineering. Further documents describe the components of initiation, growth and suppression of fire and the analysis of the effect of fire on the life safety potential of a building design. The standard will be published as a draft for comment in early 1997.

This report outlines the principles of the standard and in particular the draft document on Life Safety, which provides engineering methods for assessing the effect of fire on people in a building in terms of their condition and location at any time during the fire. It also explains how these two factors are affected by the physiological and psychological effects of the fire and the occupants' impetus and ability to evacuate.

BACKGROUND

Historically, fire safety strategies have been based upon prescriptive codes designed to suit national requirements. As bigger and more complex buildings are being developed and more sophisticated tools, such as computer modelling techniques, become available to designers, the need for a more flexible, performance based approach to fire safety has emerged.

There are still many gaps in the available knowledge and it is, therefore, not possible to set down simple step-by-step procedures that can be applied to all buildings. The development of a draft standard on Fire Safety Engineering was therefore commissioned four years ago by the International Standards Organisation, with the aim of providing a framework for a flexible but formalised approach to fire safety design that can be readily assessed by both designers and enforcing agencies.

The Home Office Fire & Emergency Planning Directorate has played a key role in the production of this draft standard, by supplying the convenor of the ISO working group tasked with developing the Life Safety document and by providing technical advice and assistance through the Fire Research and Development Group.

FIRE SAFETY ENGINEERING STANDARD

The ISO committee overseeing the production of the Fire Safety Engineering standard is ISO TC92/SC4. This committee is served by 5 working groups, WG1 to WG5, each of which deals with a set of related topics which must be taken into account when designing and assessing a building for the purposes of life safety.

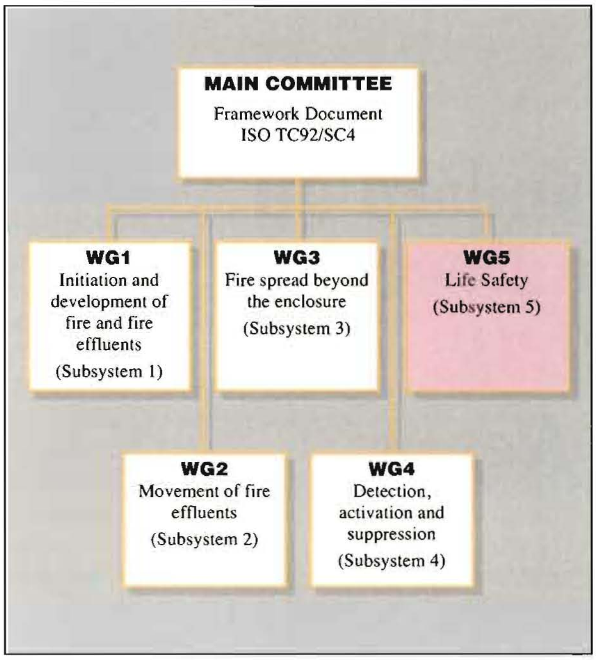


Figure 1: TC92/SC4 Committee Structure

Each working group is responsible for producing a document describing its area of concern. For example, WG 1 was tasked with producing a document describing the ignition of fire, the generation of fire effluents and the development of fire inside the room of origin. This is a subsystem of the total fire safety engineering process and is called Subsystem 1 in the standard.

The Life Safety document produced by WG 5 aims to provide guidance to designers, regulators and fire safety professionals on the use of engineering methods to evaluate the condition and location of the occupants of a building exposed to fire. This report discusses the Life Safety document in more detail below.

The Framework Document, produced by the main committee, links together all the subsystems so that they build into a complete fire safety engineering standard. It describes how the documents developed by each subsystem interact, and provides information which is relevant to all the subsystems, such as the role of fire safety management in a building.

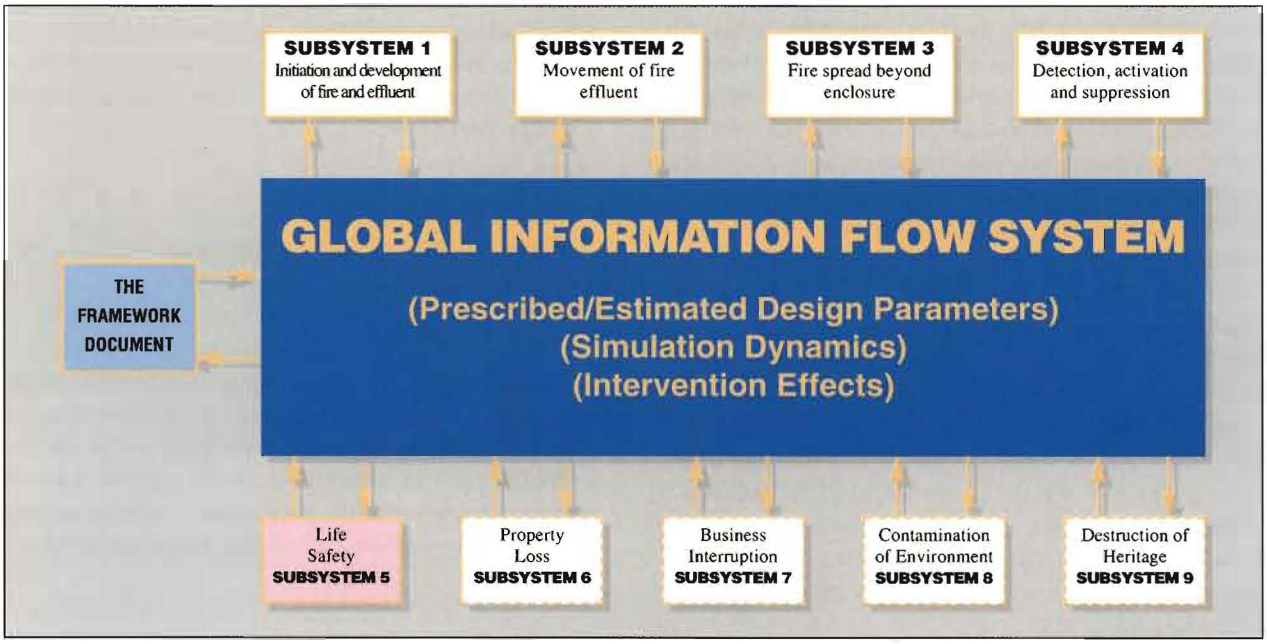
The evaluation of the building design also takes place in the Framework Document. This evaluation is carried out in the following steps:

1. Establishment of a set of acceptance criteria

2. The undertaking of a Qualitative Design Review (QDR) by conducting a fire hazard analysis (incorporating identification of potential fire hazards together with their possible consequences and selecting those fire scenarios which should form part of the quantified analysis).

3. Quantified analyses of the scenarios identified in step 2, using the acceptance criteria established in step 1. For the design analysis for Life Safety this will entail comparing information on the effect of the fire on the occupants (calculated in Subsystem 5) with the Life Safety criteria required by the designers and regulators.

Figure 2: Subsystems 1 to 9, the Framework Document and the "Global Information Flow System"



THE GLOBAL INFORMATION FLOW SYSTEM

The "Global Information Flow System" is the term used for a concept common to all the documents. Essentially, it is a central store of information which all the subsystems can access. Initially, the store will contain information such as the characteristics of the building and the occupants before the fire begins. As the fire grows, the information store is regularly updated with data such as the temperature in a room, the amount of smoke being produced by the fire and its effects on the occupants.

Figure 2 depicts the "Global Information Flow System" and also shows the additional subsystems yet to be developed (in the dashed boxes). Currently, the standard only considers the consequences of fire on life safety. As they are developed, the other subsystems shown will provide guidance on the impact of fire on property loss, business interruption, contamination of the environment and destruction of heritage.

The "Global Information Flow System" holds information of three basic types:

i) **"Prescribed/Estimated Design Parameters"**
This section of the central information store holds data describing the initial conditions which affect the fire, such as the building, its occupants, the environment, fire loads and fire scenarios. "Prescribed" parameters are those which are directly measurable, such as the height of a building. "Estimated" parameters are pieces of information which cannot be measured directly but which the building designer needs to estimate to input to the analysis, such as the effect an unusually strong wind outside might have on people trying to leave the building.

ii) **"Simulation dynamics"**
This section contains information on the fire, the people, the building and its contents as the fire develops. As the fire grows, its heat and smoke and their effects on the building and the people, are logged dynamically in this section.

iii) **"Intervention effects"**
This section contains information on the state of the alarm and suppression system as the fire develops.

Each subsystem draws on information from the store, performs calculations on it and then returns updated information back to the store. For example, Subsystem 1 may draw information on the fire load and fire scenarios from the "Prescribed/ Estimated Design Parameters" section, calculate the effects of ignition of the fire and then return information on fire size and smoke spread back to the "Simulation Dynamics" section ready for use by other subsystems. In this way a time based approach emerges for the flow of information on the development of the fire.

The calculations which each subsystem performs are known as "processes" and "evaluations" within the documents. In the example given for Subsystem 1, the "processes" for ignition of the fire may include electrical sparks or friction. The "evaluations" which the subsystem carries out may then include the size of the fire which is started by these "processes".

THE LIFE SAFETY SUBSYSTEM

The Life Safety subsystem document describes the effect of the development of the fire on the people and their safety. The subsystem evaluates the location and condition of occupants, with respect to time, as the fire develops.

The location and condition of the people in the building will depend on many factors, which principally include:

- **The life safety strategy**
For example, whether partial or total evacuation is required.
- **Fire safety management**
The effectiveness of fire safety management, such as training of staff.
- **The building characteristics**
For example, its height and the number of exits.
- **The occupant characteristics**
For example, whether they are physically or mentally disabled.
- **Fire brigade intervention**
The effect of fire brigade intervention for fire-fighting, assisted evacuation or rescue.

Data for these factors is stored in the "Prescribed/Estimated Design Parameters" section of the "Global Information Flow System" (except for the

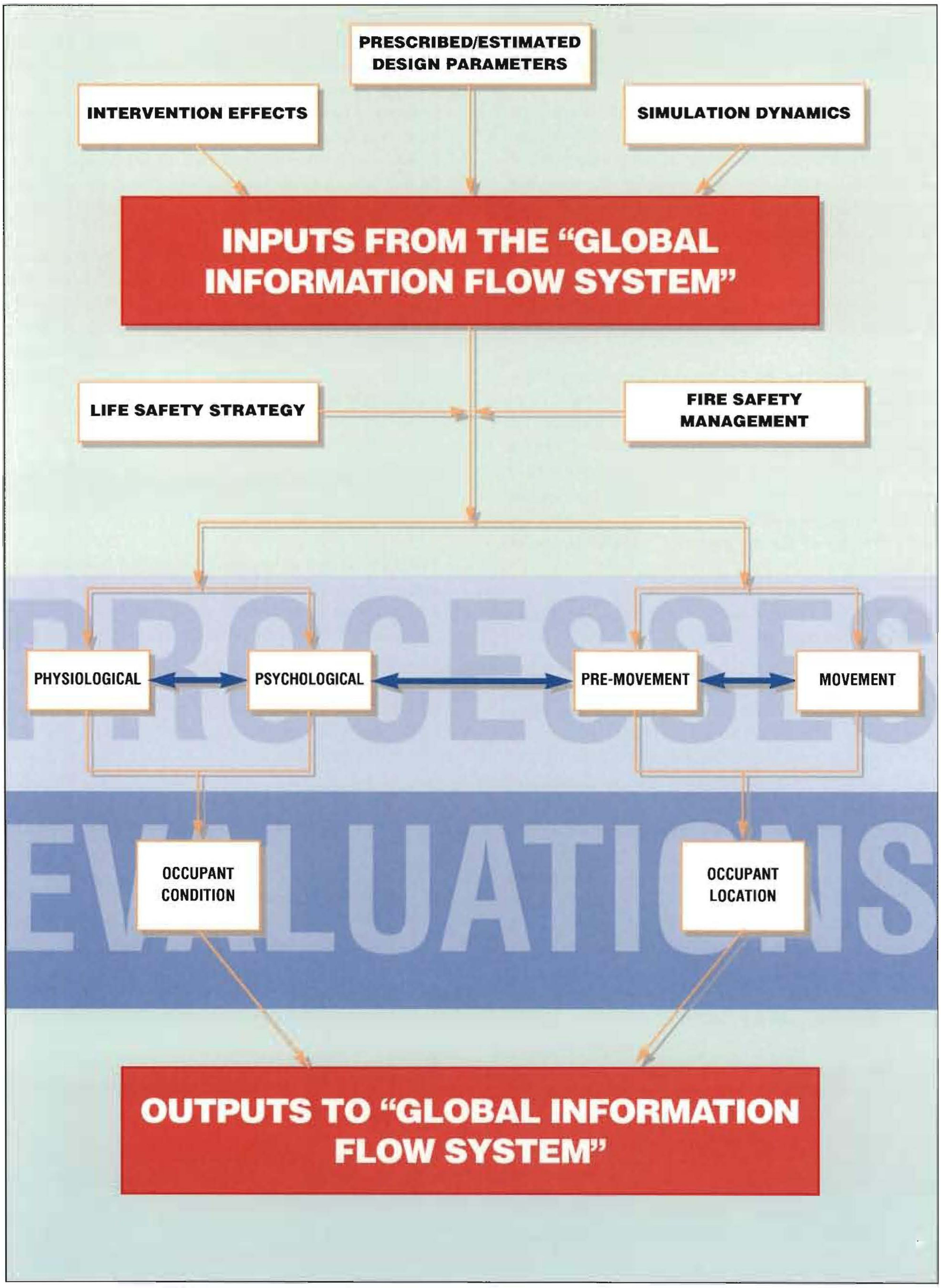


Figure 3: Life Safety Engineering Flow Chart

life safety strategy and fire safety management, which are discussed in the Framework Document).

Additionally, other factors may directly affect the *location* of occupants, of which the most significant are:

- **"Pre-movement" processes**
  Actions such as ignoring the alarm, gathering more information, collecting belongings and fighting the fire take time which might otherwise be used for evacuation. These are termed "pre-movement" processes because they do not contribute directly to the movement of the occupants of the building towards the exits (although they may involve quite significant spatial movement).

- **"Movement" processes**
  These processes consider the effect of such things as the number of people in the building and the width of exits, on the direct movement of the occupants of the building towards the exits.

Other factors which may directly affect the *condition* of the occupants include:

- **Physiological effect of the fire**
  For example, the effect of heat, smoke inhalation and reduction of visibility on the body.

- **Psychological effect of the fire**
  For example, the fear of moving through smoke.

Each of these processes are highly interdependent. For example fear of smoke is likely to increase as the smoke gets thicker and visibility is reduced. The interaction of the Subsystem 5 processes and the "Global Information Flow System" is shown as a flow chart, in Figure 3.

Subsystem 5 returns information on the condition and location of the occupants to the "Global Information Flow System", where they can be compared with the acceptance criteria which were set in the Framework Document. From this an evaluation of the design of the building for life safety purposes can be made.

THE FUTURE

The Fire Safety Engineering standard will be published by the International Standards Organisation as a Committee Draft for comment in early 1997.

The cover photograph shows the interior of a town shopping centre.

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